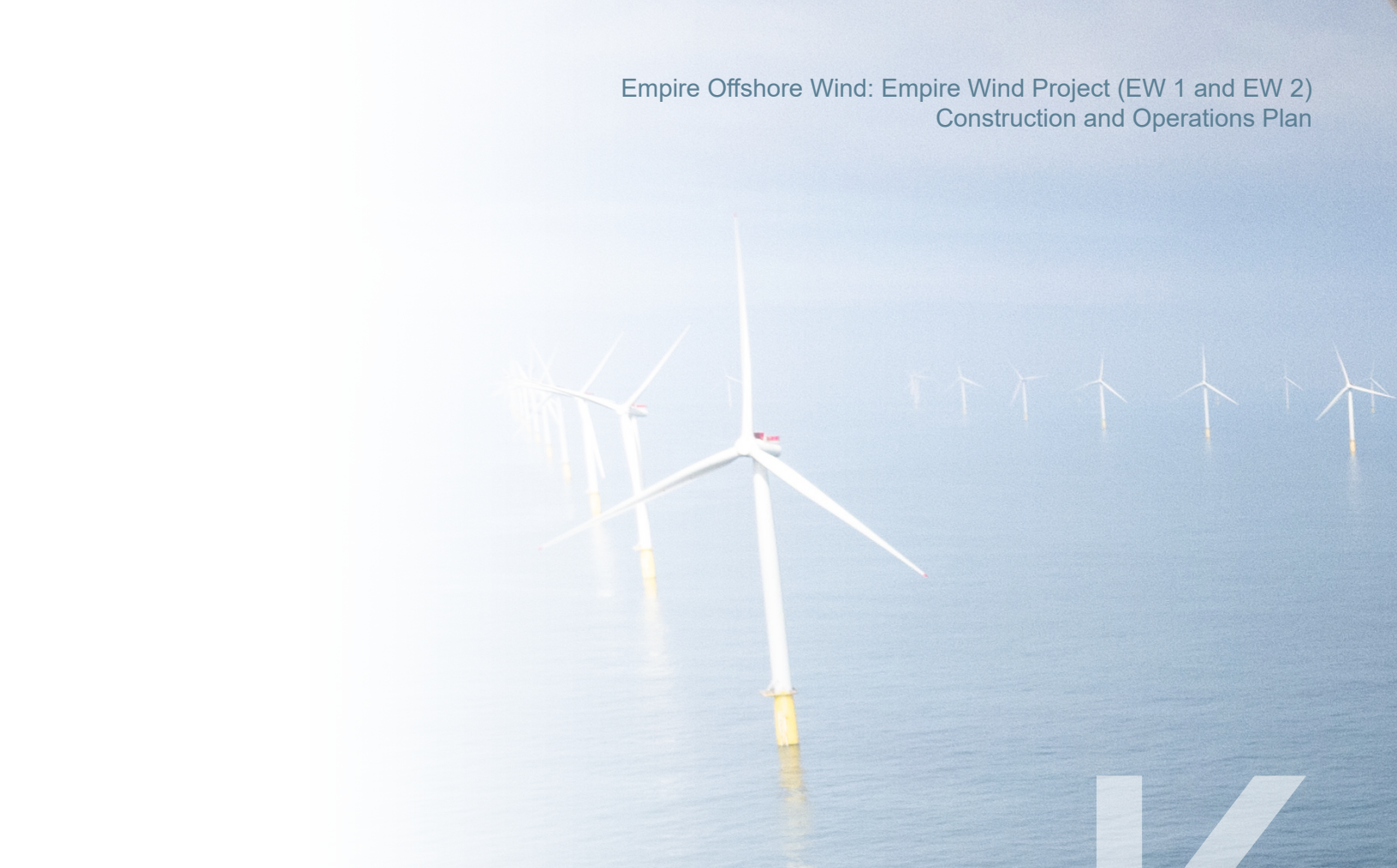

APPENDIX K

Air Emissions Calculations and Methodology

Prepared for

equinor

TETRA TECH

JULY 2021

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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ACRONYMS AND ABBREVIATIONS

AQCR	Air Quality Control Region
BOEM	Bureau of Ocean Energy Management
Btu	British thermal units
CFR	Code of Federal Regulations
CH_4	methane
CMV	commercial marine vessels
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalents
EPA	U.S. Environmental Protection Agency
Empire	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
nm	nautical mile
NO_X	nitrogen oxides
N_2O	nitrous oxide
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
SF_6	sulfur hexafluoride
SO_2	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 Calculations**[2]. 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:
  - Nitrogen oxides (NO_X);
  - Volatile organic compounds (VOCs);
  - Carbon monoxide (CO);
  - Total particulate matter (PM);
  - Particulate matter with aerodynamic diameter 10 micrometers or less (PM_{10});
  - Particulate matter with aerodynamic diameter 2.5 micrometers or less ($PM_{2.5}$); and
  - Sulfur dioxide (SO_2).

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

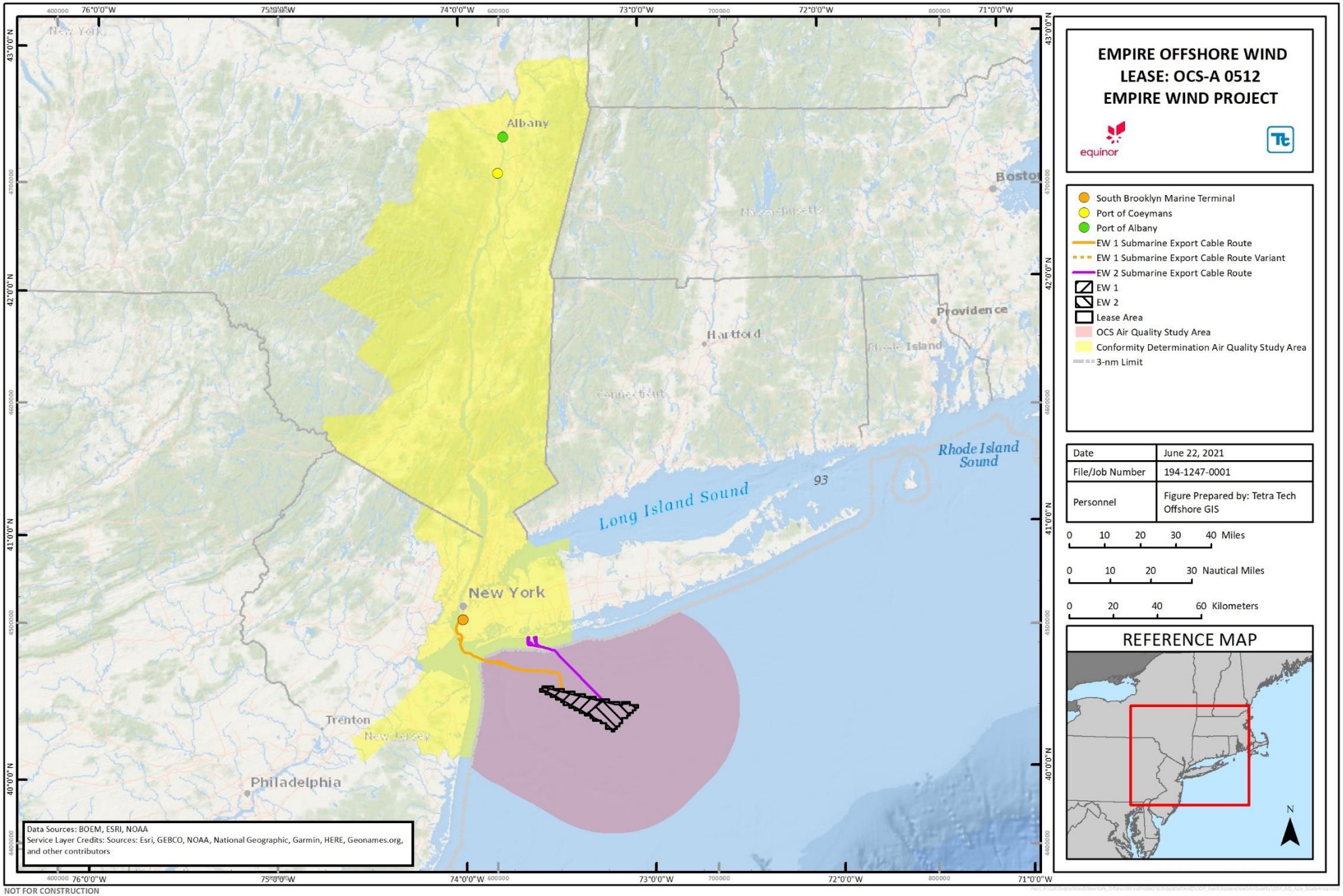

Figure K-1 Project Overview

- HAPs, which include but are not limited to:
  - Formaldehyde;
  - Acetaldehyde;
  - Benzene;
  - Naphthalene;
  - Acrolein;
  - 1,3-Butadiene;
  - Ethylbenzene; and
  - Polycyclic Organic Matter.

- GHGs:
  - Carbon dioxide (CO_2);
  - Methane (CH_4);
  - Nitrous oxide (N_2O); and
  - Sulfur hexafluoride (SF_6).

For the purposes of this analysis, emissions of $PM_{2.5}$, PM_{10}, 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 "CO_2 equivalent" or (CO_2e), 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

Minimum Power (kW)		Emission Factor (g/kW-hr)							
		NO_X	VOC	CO	$PM_{10}/PM_{2.5}$	SO_2	CO_2	CH_4	N_2O
Harbor Craft – Maximum Rate for Tier 1 and Tier 2 Engines									
Category 1	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
	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-going 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

Notes:

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 PM_{10} 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 PM_{10} 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 PM_{10} 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 PM_{10}, 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 PM_{10} 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, SO_2 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/m^3 (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:

$$E = kW \times Act \times LF \times EF$$

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 CO_2e (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 SO_2 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 SO_2. 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 (CO_2, CH_4, and N_2O) 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 SO_2 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 SO_2. 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 (CO_2, CH_4, and N_2O) 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 CH_4 and N_2O 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 CH_4/gal fuel and 0.26 g N_2O/gal fuel, respectively) (EPA 2016). Fuel consumption for each type of equipment was estimated based on CO_2 emission factor (g/hp-hr) generated from the MOVES2014b model and the emission factor for the mass of CO_2 generated per gallon of diesel fuel (10.21 kg CO_2/gal fuel), as presented in Table A-1 of the EPA (2016) report.

Therefore, CH_4 and N_2O emissions were calculated based on the following equation:

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

Where:

E = Emissions, tons/year
FC = Fuel consumption, gal/hp-hr
ϱ = Density, lb/gal
EF = Emission Factor, g (CH_4 or N_2O)/kg fuel
Eng. Rating = Engine Rating, hp
Act = Activity, hours/year
LF = Load Factor

The CO_2e (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, NO_X, CO, PM, SO_2, and CO_2e 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, SO_2, CO_2, CH_4, and N_2O, 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 (SF_6) as an insulating material. SF_6 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 SF_6 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 CO_2, CH_4, and N_2O, as well as leakage of SF_6 from gas-insulated switchgear. GHGs (CO_2, CH_4, N_2O, and SF_6) are typically presented as CO_2 equivalent or "CO_2e", 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 CO_2. Gases with a higher GWP absorb more energy, per pound, than gases with a lower GWP.

Factors used to calculate CO_2e (GWP) were taken from Table A-1 of 40 CFR § 98, Subpart A. The GWPs are 25 for CH_4, 298 for N_2O, and 22,800 for SF_6.

Therefore, the equation to calculate CO_2e for each source is:

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

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):
  - Kings County, NY: 7.8 nm (14.5 km)
  - Queens County, NY: 3.0 nm (5.5 km)
  - Monmouth County, NJ: 2.7 nm (5 km)
  - 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):
  - State waters within Hampton Roads AQCR, Virginia: 30.0 nm (55.6 km)
  - Non-OCS federal waters: 250 nm (463.0 km)
  - Monmouth County, NJ: 2.7 nm (5 km)
  - Queens County, NY: 3.0 nm (5.5 km)
  - 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):
  - State waters within Corpus Christi-Victoria AQCR, Texas: 30.0 nm (55.6 km)
  - Non-OCS federal waters: 1,940 nm (3,592.9 km)
  - 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 Terminal[4]. 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):
  - Albany County, NY: 1.3 nm (2.4 km)
  - Greene County, NY: 22.7 nm (42.0 km)
  - Ulster County, NY: 33.5 nm (62.0 km)
  - Orange County, NY: 18.0 nm (33.3 km)
  - Rockland County, NY: 21.6 nm (40.0 km)
  - Bergen County, NJ: 12.7 nm (23.5 km)
  - Hudson County, NJ: 7.5 nm (13.9 km)
  - 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):
  - Albany County, NY: 0.1 nm (0.2 km)
  - Rensselaer County, NY: 1.2 nm (2.2 km)
  - Columbia County, NY: 26.0 nm (48.1 km)
  - Dutchess County, NY: 39.9 nm (73.9 km)
  - Putnam County, NY: 8.2 nm (15.2 km)
  - Westchester County, NY: 27.0 nm (50.0 km)
  - Bronx County, NY: 2.2 nm (4.0 km)
  - New York County, NY: 12.9 nm (23.9 km)
  - 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):
  - Virginia state waters: 30.0 nm (55.6 km)
  - Non-OCS federal waters: 250 nm (463.0 km)
  - Monmouth County, NJ: 2.7 nm (5 km)
  - Queens County, NY: 3.0 nm (5.5 km)
  - Kings County, NY: 7.8 nm (14.5 km)
    - **TOTAL: 293.5 nm (543.6 km)**

- SBMT to center of Lease Area (each way):
  - Kings County, NY: 7.8 nm (14.5 km)
  - Queens County, NY: 3.0 nm (5.5 km)
  - Monmouth County, NJ: 2.7 nm (5.0 km)
  - 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):
  - Albany County, NY: 10.3 nm (19.1 km)
  - Greene County, NY: 22.7 nm (42.0 km)
  - Ulster County, NY: 33.5 nm (62.0 km)
  - Orange County, NY: 18.0 nm (33.3 km)
  - Rockland County, NY: 21.6 nm (40.0 km)
  - Bergen County, NJ: 12.7 nm (23.5 km)
  - Hudson County, NJ: 7.5 nm (13.9 km)
  - 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):
  - Albany County, NY: 0.1 nm (0.2 km)
  - Rensselaer County, NY: 10.2 nm (18.9 km)
  - Columbia County, NY: 26.0 nm (48.1 km)
  - Dutchess County, NY: 39.9 nm (73.9 km)
  - Putnam County, NY: 8.2 nm (15.2 km)
  - Westchester County, NY: 27.0 nm (50.0 km)
  - Bronx County, NY: 2.2 nm (4.0 km)
  - New York County, NY: 12.9 nm (23.9 km)
  - Kings County, NY: 1.8 nm (3.3 km)
    - **TOTAL: 128.3 nm (237.6 km)**

- SBMT to center of Lease Area (each way):
  - Kings County, NY: 7.8 nm (14.5 km)
  - Queens County, NY: 3.0 nm (5.5 km)
  - Monmouth County, NJ: 2.7 nm (5.0 km)
  - 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):
  - Kings County, NY: 8.0 nm (15 km)
  - Queens County, NY: 6.5 nm (12 km)
  - 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):
  - Nassau County, NY: 7.0 nm (13 km)
  - 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):
  - Queens County, NY: 1.5 statute miles (2.4 km)
  - Nassau County, NY: 8.5 statute miles (13.7 km)
  - 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):
  - 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.
  - 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_2e)
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**

Note:
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 SO_2) that are precursors for more than one General Conformity pollutant.

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

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
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**

Note:
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 SO_2) that are precursors for more than one General Conformity pollutant.

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

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
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**

Note:
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 SO_2) that are precursors for more than one General Conformity pollutant.

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

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
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	0.08	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**

Note:
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 SO_2) 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_2e)
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**

Note:
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 SO_2) that are precursors for more than one General Conformity pollutant.

Table K-7 Calendar Year 2028 and Onward Potential Emissions (tons)

Geographic Area	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	HAP	GHG (CO_2e)
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**

Note:
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 SO_2) 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_2O	CO_2e
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	CO_2	CH_4	N_2O	CO_2e
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	CH_4	N_2O	CO_2e
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	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	CO_2	CH_4	N_2O	CO_2e
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	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	CO_2	CH_4	N_2O	CO_2e
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)

Emissions by geographic area	VOC	NO_X	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	CO_2	CH_4	N_2O	CO_2e
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	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	CO_2	CH_4	N_2O	CO_2e
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**

Year 2

Emissions by geographic area	VOC	NO_X	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	CO_2	CH_4	N_2O	CO_2e
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**

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	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	CO_2	CH_4	N_2O	CO_2e
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

Emissions by geographic area	VOC	NO_X	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	CO_2	CH_4	N_2O	CO_2e
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	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	CO_2	CH_4	N_2O	CO_2e
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**

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	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	CO_2	CH_4	N_2O	CO_2e
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**

Year 2

Emissions by geographic area	VOC	NO_X	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	CO_2	CH_4	N_2O	CO_2e
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**

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	CO_2	CH_4	N_2O	CO_2e
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

Emissions by geographic area	VOC	NO_X	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	CO_2	CH_4	N_2O	CO_2e
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**

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	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	CO_2	CH_4	N_2O	CO_2e
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	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	CO_2	CH_4	N_2O	CO_2e
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**

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 (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_2O tons**	**CO_2e tons**
Helicopter - Twin-Engine Heavy		N/A																										
-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	76	0.5	0	0	0	0	100%	0%	11,960	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)																									
-Main Engines	4			3	9,651	Diesel	50,000	3.18	20	59	100	0	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		1	661 x 290 x 162 (43)																									
-Main Engines	6			3	6,568	Diesel	80,000	3.18	1	6	0	188	24	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
-Main Engines	4			3	6,032	Diesel			1	6	0	188	24	4,512	29%	29%			13.06	344.80	28.73	4.84	4.70	10.36	1.15	16,876.47	0.10	0.81	17,120.39
-Main Engines	2			3	7,373	Diesel			1	6	0	188	24	4,512	29%	29%			7.98	210.71	17.56	2.96	2.87	6.33	0.70	10,313.40	0.06	0.49	10,462.46
Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)																									
-Main Engines	6			3	4,500	Diesel	50,000	3.18	1	6	0	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
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	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	Diesel			80	6	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	660	Diesel			0	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)																									
-Main Generators	3			3	6,032	Diesel	50,000	3.18	80	6	0	170	24	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. Generator	1			2	1,609	Diesel			80	6	0	170	24	4,080	72%	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 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	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	Diesel			80	6	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	660	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Tug 1 for GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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 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 GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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 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 3 for GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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 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 4 for GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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 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
GBS Base Barge 1	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A	0	N/A	40	18	0	180	24	4,320	N/A	N/A	N/A	N/A											
-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
GBS Base Barge 2	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A	0	N/A	40	18	0	180	24	4,320	N/A	N/A	N/A	N/A											
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%	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	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%	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	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	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A	0	N/A	8	69	0	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	1,000	Diesel	4,000	3.18	52	9	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 Generators	2			1	27	Diesel			52	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	5,000	3.18	12	9	0	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	27	Diesel			12	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	**3,277,579**	**27,161,950**	**234.19**	**5,920.03**	**942.33**	**128.71**	**124.85**	**147.04**	**21.55**	**312,334**	**11.13**	**13.58**	**316,659**

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.
   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 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 PM_2 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 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 (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_2O tons**	**CO_2e tons**
Helicopter - Twin-Engine Heavy		N/A																										
-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	76	0.5	0	0	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)																									
-Main Engines	4			3	9,651	Diesel	50,000	3.18	20	59	100	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
Heavy 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	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	6,032	Diesel			1	6	0	188	24	4,512	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	Diesel			1	6	0	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
Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)																									
-Main Engines	6			3	4,500	Diesel	50,000	3.18	1	6	0	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)																									
-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%	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
Fall Pipe Vessel - Solid ballast		1	520 x 118 x 44 (31)																									
-Main Generators	3			3	6,032	Diesel	50,000	3.18	80	6	0	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
-Aux. Generator	1			2	1,609	Diesel			80	6	0	170	24	4,080	72%	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
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%	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 GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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	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 GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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	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 3 for GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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	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 4 for GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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	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
GBS Base Barge 1	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A	0	N/A	40	18	0	180	24	4,320	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	0	N/A	40	18	0	180	24	4,320	N/A	N/A	N/A	N/A											
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%	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
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%	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	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A	0	N/A	8	69	0	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	1,000	Diesel	4,000	3.18	52	9	0	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	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																									
-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	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
																TOTALS	**3,277,579**	**27,161,950**	**27.89**	**648.63**	**164.75**	**21.67**	**21.02**	**11.89**	**2.69**	**37,409**	**2.50**	**1.45**	**37,902**

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.
   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 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 PM_2 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 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 Emissions (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_2O tons**	**CO_2e tons**
Helicopter - Twin-Engine Heavy		N/A																										
-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	76	0.5	0	0	0	0	100%	0%	11,960	0	0	0	0	0	0	0	0	0	0	0	0
Heavy 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	188	24	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
-Main Engines	4			3	6,032	Diesel			1	6	0	188	24	4,512	29%	29%			13.06	344.80	28.73	4.84	4.70	10.36	1.15	16,876.47	0.10	0.81	17,120.39
-Main Engines	2			3	7,373	Diesel			1	6	0	188	24	4,512	29%	29%			7.98	210.71	17.56	2.96	2.87	6.33	0.70	10,313.40	0.06	0.49	10,462.46
Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)																									
-Main Engines	6			3	4,500	Diesel	50,000	3.18	1	6	0	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
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	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	Diesel			80	6	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	660	Diesel			0	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)																									
-Main Generators	3			3	6,032	Diesel	50,000	3.18	80	6	0	170	24	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. Generator	1			2	1,609	Diesel			80	6	0	170	24	4,080	72%	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 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	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	Diesel			80	6	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	660	Diesel			0	0	0	0	0	0	0%	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 Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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 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 GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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 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 3 for GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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 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 4 for GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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 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 1 for Ballast Barge		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	40	18	0	180	24	4,320	35%	35%	94,340	566,038	4.50	88.15	44.98	5.57	5.40	0.06	0.48	6,206.63	0.81	0.18	6,280.48
-Aux. Engines	2			1	95	Diesel			40	18	0	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
Tug 2 for Ballast Barge		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	40	18	0	180	24	4,320	35%	35%	94,340	566,038	4.50	88.15	44.98	5.57	5.40	0.06	0.48	6,206.63	0.81	0.18	6,280.48
-Aux. Engines	2			1	95	Diesel			40	18	0	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
GBS Ballast Barge 1			400 x 105 x 25																									
	N/A	N/A		N/A	N/A	N/A	0	N/A	40	18	0	180	24	4,320	N/A	N/A	N/A	N/A										
GBS Ballast Barge 2			400 x 105 x 25																									
	N/A	N/A		N/A	N/A	N/A	0	N/A	40	18	0	180	24	4,320	N/A	N/A	N/A	N/A										
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%	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	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%	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	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	0	N/A	8	69	0	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	1,000	Diesel	4,000	3.18	52	9	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 Generators	2			1	27	Diesel			52	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	5,000	3.18	12	9	0	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	27	Diesel			12	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	**2,693,197**	**26,721,698**	**229.23**	**5,729.08**	**1,003.67**	**134.75**	**130.71**	**135.98**	**21.27**	**306,872**	**12.68**	**13.08**	**311,085**

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:
   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 PM_2or 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_4 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 Emissions (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_2O tons**	**CO_2e tons**
Helicopter - Twin-Engine Heavy		N/A																										
-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	76	0.5	0	0	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	661 x 290 x 162 (43)																									
-Main Engines	6			3	6,568	Diesel	80,000	3.18	1	6	0	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	6,032	Diesel			1	6	0	188	24	4,512	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	Diesel			1	6	0	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
Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)																									
-Main Engines	6			3	4,500	Diesel	50,000	3.18	1	6	0	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)																									
-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%	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
Fall Pipe Vessel - Solid ballast		1	520 x 118 x 44 (31)																									
-Main Generators	3			3	6,032	Diesel	50,000	3.18	80	6	0	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
-Aux. Generator	1			2	1,609	Diesel			80	6	0	170	24	4,080	72%	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
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%	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 GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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	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 GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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	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 3 for GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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	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 4 for GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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	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 1 for Ballast Barge		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	40	18	0	180	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	95	Diesel			40	18	0	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
Tug 2 for Ballast Barge		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	40	18	0	180	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	95	Diesel			40	18	0	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			400 x 105 x 25																									
	N/A	N/A		N/A	N/A	N/A	0	N/A	40	18	0	180	24	4,320	N/A	N/A	N/A	N/A										
GBS Ballast Barge 2			400 x 105 x 25																									
	N/A	N/A		N/A	N/A	N/A	0	N/A	40	18	0	180	24	4,320	N/A	N/A	N/A	N/A										
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%	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
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%	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	0	N/A	8	69	0	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	1,000	Diesel	4,000	3.18	52	9	0	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	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																									
-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	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
																		TOTALS	**2,693,197**	**26,721,698**	**22.48**	**495.93**	**164.90**	**20.98**	**20.35**	**6.42**	**2.24**	**30,583**	**2.73**	**1.08**	**30,972**

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:
   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 PM_2 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 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, Self-Install Option)

																		Total Emissions (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_2O tons**	**CO_2e tons**
Helicopter - Twin-Engine Heavy		N/A																										
-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	76	0.5	0	0	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)																									
-Main Engines	6			3	4,500	Diesel	50,000	3.18	1	6	0	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
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	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	Diesel			80	6	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	660	Diesel			0	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)																									
-Main Generators	3			3	6,032	Diesel	50,000	3.18	80	6	0	170	24	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. Generator	1			2	1,609	Diesel			80	6	0	170	24	4,080	72%	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 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	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	Diesel			80	6	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	660	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Tug 1 for GBS Tow/Installation		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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
-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 GBS Tow/Installation		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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
-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 3 for GBS Tow/Installation		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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
-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 4 for GBS Tow/Installation		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	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
-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 1 for Ballast Barge		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	40	18	0	180	24	4,320	35%	35%	94,340	566,038	4.50	88.15	44.98	5.57	5.40	0.06	0.48	6,206.63	0.81	0.18	6,280.48
-Aux. Engines	2			1	95	Diesel			40	18	0	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
Tug 2 for Ballast Barge		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	40	18	0	180	24	4,320	35%	35%	94,340	566,038	4.50	88.15	44.98	5.57	5.40	0.06	0.48	6,206.63	0.81	0.18	6,280.48
-Aux. Engines	2			1	95	Diesel			40	18	0	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
GBS Ballast Barge 1	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A	0	N/A	40	18	0	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	18	0	180	24	4,320	N/A	N/A	N/A	N/A											
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%	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	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%	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	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	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A	0	N/A	8	69	0	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	1,000	Diesel	4,000	3.18	52	9	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 Generators	2			1	27	Diesel			52	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	5,000	3.18	12	9	0	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	27	Diesel			12	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	**2,686,908**	**24,319,182**	**205.83**	**4,982.36**	**1,100.22**	**142.55**	**138.27**	**102.60**	**19.54**	**278,306**	**15.76**	**11.21**	**282,040**

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:
   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 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 PM 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 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, Self-Install Option)

																		Total Emissions (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_2O tons	CO_2e tons
Helicopter - Twin-Engine Heavy		N/A																											
-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	76	0.5	0	0	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 - TP installation		1	600 x 154 x 60 (44)																										
-Main Engines	6			3	4,500	Diesel	50,000	3.18	1	6	0	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)																										
-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%	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
Fall Pipe Vessel - Solid ballast		1	520 x 118 x 44 (31)																										
-Main Generators	3			3	6,032	Diesel	50,000	3.18	80	6	0	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
-Aux. Generator	1			2	1,609	Diesel			80	6	0	170	24	4,080	72%	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
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%	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 GBS Tow/Installation		N/A	146 x 46 x 25 (21)																										
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	365	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	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 GBS Tow/Installation		N/A	146 x 46 x 25 (21)																										
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	365	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	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 3 for GBS Tow/Installation		N/A	146 x 46 x 25 (21)																										
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	365	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	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 4 for GBS Tow/Installation		N/A	146 x 46 x 25 (21)																										
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	65	0	365	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	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 1 for Ballast Barge		N/A	136 x 36 x 19 (17)																										
-Main Engines	2			2	3,600	Diesel	10,000	3.18	40	18	0	180	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	95	Diesel			40	18	0	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
Tug 2 for Ballast Barge		N/A	136 x 36 x 19 (17)																										
-Main Engines	2			2	3,600	Diesel	10,000	3.18	40	18	0	180	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	95	Diesel			40	18	0	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			400 x 105 x 25																										
	N/A	N/A		N/A	N/A	N/A	0	N/A	40	18	0	180	24	4,320	N/A	N/A	N/A	N/A											
GBS Ballast Barge 2			400 x 105 x 25																										
	N/A	N/A		N/A	N/A	N/A	0	N/A	40	18	0	180	24	4,320	N/A	N/A	N/A	N/A											
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%	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
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%	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	0	N/A	8	69	0	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	1,000	Diesel	4,000	3.18	52	9	0	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	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																										
-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	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
																		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**	**30,898**

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:
   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 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 PM 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 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)

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)	Total Emissions (Non-Transit) 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_2O tons	CO_2e 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	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	0	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	0	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	0	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)																										
-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	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	Diesel			80	6	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	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	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	Diesel			80	6	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	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%	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	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%	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	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	0	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%	2,358	196,226	0.62	22.50	11.48	0.59	0.57	1.50E-02	6.22E-02	1,584.23	0.21	4.59E-02	1,603.08
-Aux. Generator	1			1	133	Diesel			5	9	0	156	24	3,744	64%	50%			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
-Bow Thruster Engine	1			1	325	Diesel			0	0	0	156	24	3,744	0%	50%			0.13	4.88	2.49	1.28E-01	1.24E-01	3.25E-03	1.35E-02	343.25	4.48E-02	9.95E-03	347.33
-Aux. Engine	1			1	133	Diesel			0	0	0	156	24	3,744	0%	50%			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	Diesel	4,000	3.18	52	9	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 Generators	2			1	27	Diesel			52	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	5,000	3.18	12	9	0	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	27	Diesel			12	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	**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 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 $PM_{2.5}$ 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4, 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)

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)	Total Emissions (Transit) 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_2O tons	CO_2e 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	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%	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%	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%	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
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%	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	0	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%	2,358	196,226	9.54E-03	0.35	0.18	9.12E-03	8.84E-03	2.31E-04	9.58E-04	24.38	3.18E-03	7.07E-04	24.67
-Aux. Generator	1			1	133	Diesel			5	9	0	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	325	Diesel			0	0	0	156	24	3,744	0%	50%			0	0	0	0	0	0	0	0	0	0	0
-Aux. Engine	1			1	133	Diesel			0	0	0	156	24	3,744	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	4,000	3.18	52	9	0	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	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																										
-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	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
																TOTALS	906,461	21,244,969	**7.73**	**193.45**	**32.07**	**4.37**	**4.24**	**4.74**	**0.71**	**10,402**	**0.40**	**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 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 $PM_{2.5}$ 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4, 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 (Monopile Design)

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)	Total Emissions (Non-Transit)								
																			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_2O tons	CO_2e tons
Helicopter - Twin-Engine Heavy		N/A																									
-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	56	0.5	0	0	0	0	100%	0%	8,813	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	0	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 - 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	198	24	4,752	37%	37%	3,931	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	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	1,609	Diesel			16	6	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	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	16	6	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	1,609	Diesel			16	6	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	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	4,000	3.18	7	9	0	198	24	4,752	64%	50%	3,302	249,057	0.79	28.56	14.57	0.75	0.73	1.91E-02	7.90E-02	2,010.75	0.26	5.83E-02	2,034.67
-Aux. Generator	1			1	133	Diesel			7	9	0	198	24	4,752	64%	50%			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	Diesel			0	0	0	198	24	4,752	0%	50%			0.17	6.19	3.16	1.63E-01	1.58E-01	4.13E-03	1.71E-02	435.66	5.68E-02	1.26E-02	440.85
-Aux. Engine	1			1	133	Diesel			0	0	0	198	24	4,752	0%	50%			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																								
-Main Engines	2			1	1,000	Diesel	4,000	3.18	52	9	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 Generators	2			1	27	Diesel			52	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	5,000	3.18	12	9	0	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	27	Diesel			12	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	252,052	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.
   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 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 $PM_{2.5}$ 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4, 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 (Monopile Design)

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)	Total Emissions (Transit)								
																			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_2O tons	CO_2e tons
Helicopter - Twin-Engine Heavy		N/A																									
-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	56	0.5	0	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		1	715 x 184 x 41 (32)																								
-Main Engines	4			3	9,651	Diesel	50,000	3.18	20	6	0	140	24	3,360	37%	37%	78,616	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
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	198	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		1	520 x 118 x 44 (31)																								
-Main Generators	3			3	6,032	Diesel	50,000	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
Fall Pipe Vessel - Scour protection		1	520 x 118 x 44 (31)																								
-Main Generators	3			3	6,032	Diesel	50,000	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	4,000	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	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	4,000	3.18	52	9	0	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	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																								
-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	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
																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.
   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 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 $PM_{2.5}$ 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4, 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 (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_2O tons**	**CO_2e 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	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)																									
-Main Engines	4			3	9,651	Diesel	50,000	3.18	40	59	200	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
Heavy 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	376	24	9,024	29%	29%	6,289	9,459,119	42.66	1126.35	93.86	15.81	15.34	33.86	3.77	55,129.79	0.34	2.65	55,926.60
-Main Engines	4			3	6,032	Diesel			1	6	0	376	24	9,024	29%	29%			26.12	689.60	57.47	9.68	9.39	20.73	2.31	33,752.93	0.21	1.62	34,240.78
-Main Engines	2			3	7,373	Diesel			1	6	0	376	24	9,024	29%	29%			15.96	421.42	35.12	5.92	5.74	12.67	1.41	20,626.79	0.13	0.99	20,924.92
Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)																									
-Main Engines	6			3	4,500	Diesel	50,000	3.18	1	6	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
Fall Pipe Vessel - Seabed filter layer		1	520 x 118 x 44 (31)																									
-Main Generators	3			3	6,032	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	90,172.80
-Aux. Generator	1			2	1,609	Diesel			160	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	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)																									
-Main Generators	3			3	6,032	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	16.17	15.69	34.63	3.85	56,384.22	0.35	2.71	57,199.16
-Aux. Generator	1			2	1,609	Diesel			160	6	0	340	24	8,160	72%	72%			3.88	76.02	38.79	4.80	4.66	0.05	0.41	5,352.64	0.70	0.16	5,416.33
-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	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	90,172.80
-Aux. Generator	1			2	1,609	Diesel			160	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	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Tug 1 for GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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			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 GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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			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 3 for GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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			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 4 for GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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			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
GBS Base Barge 1	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A	0	N/A	80	18	0	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	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)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			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 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	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 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	N/A	N/A	400 x 105 x 25	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		N/A	65 x 17 x 5																									
-Main Engines	2			1	1,000	Diesel	4,000	3.18	52	9	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 Generators	2			1	27	Diesel			52	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	5,000	3.18	12	9	0	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	27	Diesel			12	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	**6,505,779**	**53,290,881**	**463.83**	**11,674.94**	**1,800.42**	**253.08**	**245.48**	**293.96**	**42.64**	**613,042**	**20.75**	**26.82**	**621,554**

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 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 PM_2 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 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 (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_2O tons**	**CO_2e 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	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 - Foundation Pillars (from VA)		1	715 x 184 x 41 (32)																									
-Main Engines	4			3	9,651	Diesel	50,000	3.18	40	59	200	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
Heavy 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	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	6,032	Diesel			1	6	0	376	24	9,024	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	Diesel			1	6	0	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
Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)																									
-Main Engines	6			3	4,500	Diesel	50,000	3.18	1	6	0	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		1	520 x 118 x 44 (31)																									
-Main Generators	3			3	6,032	Diesel	50,000	3.18	160	6	0	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			160	6	0	536	24	12,864	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	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 - Solid ballast		1	520 x 118 x 44 (31)																									
-Main Generators	3			3	6,032	Diesel	50,000	3.18	160	6	0	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	1,609	Diesel			160	6	0	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	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	160	6	0	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			160	6	0	536	24	12,864	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	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 GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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	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 GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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	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 3 for GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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	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 4 for GBS Bases (from Coeymans)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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	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
GBS Pillar Barge 1	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A	0	N/A	80	18	0	360	24	8,640	N/A	N/A	N/A	N/A											
GBS Base Barge 1	N/A	N/A	400 x 105 x 25	N/A	N/A	N/A	0	N/A	80	18	0	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	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)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	16	69	0	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 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	16	69	0	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 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	N/A	N/A	400 x 105 x 25	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		N/A	65 x 17 x 5																									
-Main Engines	2			1	1,000	Diesel	4,000	3.18	52	9	0	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	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																									
-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	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
																TOTALS	**6,505,779**	**53,290,881**	**55.51**	**1,289.37**	**326.70**	**43.17**	**41.88**	**23.68**	**5.36**	**74,264**	**4.96**	**2.87**	**75,244**

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 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 PM_2 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 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 Emissions (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_2O tons**	**CO_2e 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	0	100%	0%	16,366	0	0	0	0	0	0	0	0	0	0	0	0
Heavy 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	376	24	9,024	29%	29%	6,289	9,459,119	42.66	1126.35	93.86	15.81	15.34	33.86	3.77	55,129.79	0.34	2.65	55,926.60
-Main Engines	4			3	6,032	Diesel			1	6	0	376	24	9,024	29%	29%			26.12	689.60	57.47	9.68	9.39	20.73	2.31	33,752.93	0.21	1.62	34,240.78
-Main Engines	2			3	7,373	Diesel			1	6	0	376	24	9,024	29%	29%			15.96	421.42	35.12	5.92	5.74	12.67	1.41	20,626.79	0.13	0.99	20,924.92
Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)																									
-Main Engines	6			3	4,500	Diesel	50,000	3.18	1	6	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
Fall Pipe Vessel - Seabed filter layer		1	520 x 118 x 44 (31)																									
-Main Generators	3			3	6,032	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	90,172.80
-Aux. Generator	1			2	1,609	Diesel			160	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	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)																									
-Main Generators	3			3	6,032	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	16.17	15.69	34.63	3.85	56,384.22	0.35	2.71	57,199.16
-Aux. Generator	1			2	1,609	Diesel			160	6	0	340	24	8,160	72%	72%			3.88	76.02	38.79	4.80	4.66	0.05	0.41	5,352.64	0.70	0.16	5,416.33
-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	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	90,172.80
-Aux. Generator	1			2	1,609	Diesel			160	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	0	0	0	0%	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 Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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			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 GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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			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 3 for GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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			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 4 for GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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			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 1 for Ballast Barge		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	80	18	0	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. Engines	2			1	95	Diesel			80	18	0	360	24	8,640	35%	35%			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
Tug 2 for Ballast Barge		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	80	18	0	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. Engines	2			1	95	Diesel			80	18	0	360	24	8,640	35%	35%			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			400 x 105 x 25																									
	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										
GBS Ballast Barge 2			400 x 105 x 25																									
	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)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			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 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	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 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	0	N/A	16	69	0	730	24	17,520	N/A	N/A	N/A	N/A										
Crew Transfer Vessel 1		N/A	65 x 17 x 5																									
-Main Engines	2			1	1,000	Diesel	4,000	3.18	52	9	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 Generators	2			1	27	Diesel			52	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	5,000	3.18	12	9	0	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	27	Diesel			12	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	**5,337,016**	**52,410,377**	**453.91**	**11,293.05**	**1,923.09**	**265.16**	**257.20**	**271.85**	**42.09**	**602,117**	**23.85**	**25.81**	**610,406**

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:
   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 PM_2 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 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 Emissions (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_2O tons**	**CO_2e 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	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 - Foundation installation		1	661 x 290 x 162 (43)																									
-Main Engines	6			3	6,568	Diesel	80,000	3.18	1	6	0	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	6,032	Diesel			1	6	0	376	24	9,024	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	Diesel			1	6	0	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
Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)																									
-Main Engines	6			3	4,500	Diesel	50,000	3.18	1	6	0	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		1	520 x 118 x 44 (31)																									
-Main Generators	3			3	6,032	Diesel	50,000	3.18	160	6	0	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			160	6	0	536	24	12,864	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	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 - Solid ballast		1	520 x 118 x 44 (31)																									
-Main Generators	3			3	6,032	Diesel	50,000	3.18	160	6	0	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	1,609	Diesel			160	6	0	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	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	160	6	0	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			160	6	0	536	24	12,864	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	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 GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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	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 GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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	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 3 for GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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	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 4 for GBS Tow		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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	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 1 for Ballast Barge		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	80	18	0	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. Engines	2			1	95	Diesel			80	18	0	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	55.24
Tug 2 for Ballast Barge		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	80	18	0	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. Engines	2			1	95	Diesel			80	18	0	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	55.24
GBS Ballast Barge 1			400 x 105 x 25																									
	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										
GBS Ballast Barge 2			400 x 105 x 25																									
	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)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	16	69	0	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 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	16	69	0	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 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	0	N/A	16	69	0	730	24	17,520	N/A	N/A	N/A	N/A										
Crew Transfer Vessel 1		N/A	65 x 17 x 5																									
-Main Engines	2			1	1,000	Diesel	4,000	3.18	52	9	0	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	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																									
-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	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
																		TOTALS	**5,337,016**	**52,410,377**	**44.70**	**983.98**	**327.00**	**41.79**	**40.54**	**12.73**	**4.46**	**60,611**	**5.40**	**2.14**	**61,384**

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:
   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 PM_2or 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_4 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)

																		Total Emissions (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_2O tons**	**CO_2e 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	0	100%	0%	16,366	0	0	0	0	0	0	0	0	0	0	0	0
Heavy Lift Vessel - TP installation		1	600 x 154 x 60 (44)																									
-Main Engines	6			3	4,500	Diesel	50,000	3.18	1	6	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
Fall Pipe Vessel - Seabed filter layer		1	520 x 118 x 44 (31)																									
-Main Generators	3			3	6,032	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	90,172.80
-Aux. Generator	1			2	1,609	Diesel			160	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	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)																									
-Main Generators	3			3	6,032	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	16.17	15.69	34.63	3.85	56,384.22	0.35	2.71	57,199.16
-Aux. Generator	1			2	1,609	Diesel			160	6	0	340	24	8,160	72%	72%			3.88	76.02	38.79	4.80	4.66	0.05	0.41	5,352.64	0.70	0.16	5,416.33
-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	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	90,172.80
-Aux. Generator	1			2	1,609	Diesel			160	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	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Tug 1 for GBS Tow/Installation		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			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 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 GBS Tow/Installation		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			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 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 3 for GBS Tow/Installation		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			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 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 4 for GBS Tow/Installation		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			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 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 1 for Ballast Barge		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	80	18	0	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. Engines	2			1	95	Diesel			80	18	0	360	24	8,640	35%	35%			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
Tug 2 for Ballast Barge		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	80	18	0	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. Engines	2			1	95	Diesel			80	18	0	360	24	8,640	35%	35%			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			400 x 105 x 25																									
	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										
GBS Ballast Barge 2			400 x 105 x 25																									
	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)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			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 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	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 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	0	N/A	16	69	0	730	24	17,520	N/A	N/A	N/A	N/A										
Crew Transfer Vessel 1		N/A	65 x 17 x 5																									
-Main Engines	2			1	1,000	Diesel	4,000	3.18	52	9	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 Generators	2			1	27	Diesel			52	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	5,000	3.18	12	9	0	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	27	Diesel			12	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	**5,330,727**	**47,605,346**	**407.11**	**9,799.60**	**2,116.20**	**280.76**	**272.33**	**205.09**	**38.63**	**544,987**	**30.01**	**22.08**	**552,316**

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:
   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 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 PM 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 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)

																		Total Emissions (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_2O tons	CO_2e 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	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 - TP installation		1	600 x 154 x 60 (44)																										
-Main Engines	6			3	4,500	Diesel	50,000	3.18	1	6	0	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		1	520 x 118 x 44 (31)																										
-Main Generators	3			3	6,032	Diesel	50,000	3.18	160	6	0	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			160	6	0	536	24	12,864	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	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 - Solid ballast		1	520 x 118 x 44 (31)																										
-Main Generators	3			3	6,032	Diesel	50,000	3.18	160	6	0	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	1,609	Diesel			160	6	0	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	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	160	6	0	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			160	6	0	536	24	12,864	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	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 GBS Tow/Installation		N/A	146 x 46 x 25 (21)																										
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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 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 GBS Tow/Installation		N/A	146 x 46 x 25 (21)																										
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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 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 3 for GBS Tow/Installation		N/A	146 x 46 x 25 (21)																										
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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 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 4 for GBS Tow/Installation		N/A	146 x 46 x 25 (21)																										
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	65	0	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 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 1 for Ballast Barge		N/A	136 x 36 x 19 (17)																										
-Main Engines	2			2	3,600	Diesel	10,000	3.18	80	18	0	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. Engines	2			1	95	Diesel			80	18	0	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	55.24
Tug 2 for Ballast Barge		N/A	136 x 36 x 19 (17)																										
-Main Engines	2			2	3,600	Diesel	10,000	3.18	80	18	0	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. Engines	2			1	95	Diesel			80	18	0	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	55.24
GBS Ballast Barge 1			400 x 105 x 25																										
	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											
GBS Ballast Barge 2			400 x 105 x 25																										
	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)		N/A	146 x 46 x 25 (21)																										
-Main Engines	2			2	5,440	Diesel	10,000	3.18	16	69	0	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 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	16	69	0	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 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	0	N/A	16	69	0	730	24	17,520	N/A	N/A	N/A	N/A											
Crew Transfer Vessel 1		N/A	65 x 17 x 5																										
-Main Engines	2			1	1,000	Diesel	4,000	3.18	52	9	0	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	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																										
-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	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
																TOTALS	**5,330,727**	**47,605,346**	**44.64**	**982.50**	**326.88**	**41.77**	**40.52**	**12.69**	**4.46**	**60,539**	**5.40**	**2.13**	**61,310**

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:
   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 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 PM 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 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)

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)	Total Emissions (Non-Transit)								
																			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_2O tons	CO_2e 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	0	100%	0%	16,366	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	0	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	0	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	0	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		1	520 x 118 x 44 (31)																								
-Main Generators	3			3	6,032	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	90,172.80
-Aux. Generator	1			2	1,609	Diesel			160	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	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	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	90,172.80
-Aux. Generator	1			2	1,609	Diesel			160	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	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	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 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	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 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	0	N/A	16	69	0	730	24	17,520	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	10	9	0	312	24	7,488	64%	50%	4,717	392,453	1.24	45.00	22.96	1.18	1.15	3.00E-02	1.24E-01	3,168.45	0.41	9.18E-02	3,206.15
-Aux. Generator	1			1	133	Diesel			10	9	0	312	24	7,488	64%	50%			1.10E-01	3.99	2.04	1.05E-01	1.02E-01	2.66E-03	1.10E-02	280.94	3.66E-02	8.14E-03	284.28
-Bow Thruster Engine	1			1	325	Diesel			0	0	0	312	24	7,488	0%	50%			0.27	9.75	4.97	2.57E-01	2.49E-01	6.51E-03	2.70E-02	686.50	8.95E-02	1.99E-02	694.67
-Aux. Engine	1			1	133	Diesel			0	0	0	312	24	7,488	0%	50%			1.10E-01	3.99	2.04	1.05E-01	1.02E-01	2.66E-03	1.10E-02	280.94	3.66E-02	8.14E-03	284.28
Crew Transfer Vessel 1		N/A	65 x 17 x 5																								
-Main Engines	2			1	1,000	Diesel	4,000	3.18	52	9	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 Generators	2			1	27	Diesel			52	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	5,000	3.18	12	9	0	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	27	Diesel			12	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	1,761,021	41,456,918	360.04	9,229.47	1,281.98	180.21	174.80	242.12	32.76	477,527	13.47	21.31	484,212

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:
   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 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 $PM_{2.5}$ 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4, 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)

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)	Total Emissions (Transit) 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_2O tons	CO_2e 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	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	20	6	0	140	24	3,360	37%	37%	78,616	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
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	312	24	7,488	37%	37%	3,931	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
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	0	730	24	17,520	37%	37%	78,616	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
Fall Pipe Vessel - Seabed filter layer		1	520 x 118 x 44 (31)																										
-Main Generators	3			3	6,032	Diesel	50,000	3.18	160	6	0	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			160	6	0	536	24	12,864	72%	72%			0.46	8.94	4.56	0.57	0.55	0.01	0.05	629.72	0.08	1.83E-02	637.21
-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	160	6	0	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			160	6	0	536	24	12,864	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	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	16	69	0	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 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	16	69	0	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 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	0	N/A	16	69	0	730	24	17,520	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	10	9	0	312	24	7,488	64%	50%	4,717	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. Generator	1			1	133	Diesel			10	9	0	312	24	7,488	64%	50%			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
-Bow Thruster Engine	1			1	325	Diesel			0	0	0	312	24	7,488	0%	50%			0	0	0	0	0	0	0	0	0	0	0
-Aux. Engine	1			1	133	Diesel			0	0	0	312	24	7,488	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	4,000	3.18	52	9	0	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	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																										
-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	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
																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

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:
   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 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 $PM_{2.5}$ 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4, 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 (Monopile Design)

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)	Total Emissions (Non-Transit) 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_2O tons	CO_2e 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	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			3	9,651	Diesel	50,000	3.18	40	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)																										
-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	55.79	1472.74	122.73	20.67	20.05	44.27	4.93	72,084.06	0.45	3.46	73,125.91
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	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			32	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	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	32	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			32	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	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	4,000	3.18	14	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	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	24	9,504	0%	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	4,000	3.18	52	9	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 Generators	2			1	27	Diesel			52	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	5,000	3.18	12	9	0	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	27	Diesel			12	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.
   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 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 $PM_{2.5}$ 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4, 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 (Monopile Design)

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)	Total Emissions (Transit)								
																			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_2O tons	CO_2e 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	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	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	Diesel			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	0
Fall Pipe Vessel - Scour protection		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	Diesel			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	0
Bubble Curtain Vessel		N/A	150 x 36 x 10																								
-Main Engines	2			1	750	Diesel	4,000	3.18	14	9	0	396	24	9,504	64%	50%	6,604	498,113	2.67E-02	0.97	0.49	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	Diesel			14	9	0	396	24	9,504	64%	50%			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	Diesel			0	0	0	396	24	9,504	0%	50%			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	Diesel	4,000	3.18	52	9	0	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	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																								
-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	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
																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.
   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 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 $PM_{2.5}$ 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4, and 298 for N_2O.

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 Emissions (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_2O tons**	**CO_2e tons**
Heavy Transport Vessel (transit from TX)		3	484 x 138 x 36																									
-Main Engines	6			3	6,394	Diesel	45,000	3.18	1	200	0	45	24	1,080	33%	33%	117,925	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
Heavy 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	45	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	45	24	1,080	29%	29%			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	0	45	24	1,080	29%	29%			1.91	50.44	4.20	0.71	0.69	1.52	0.17	2,468.63	0.02	0.12	2,504.31
Fall Pipe Vessel - Scour protection		1	520 x 118 x 44 (31)																									
-Main Generators	3			3	6,032	Diesel	50,000	3.18	1	6	0	4	24	96	72%	72%	3,931	62,893	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			1	6	0	4	24	96	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	4,000	3.18	1	9	0	45	24	1,080	64%	50%	472	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	0	45	24	1,080	64%	50%			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	0	45	24	1,080	0%	50%			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	0	45	24	1,080	0%	50%			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
OSS Installation Generator Engine	1	N/A	N/A	255	67	Diesel	235	3.18	0	0	0	15	24	360	0%	100%	0	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
OSS Commissioning Generator Engine	1	N/A	N/A	2	670	Diesel	2,350	3.18	0	0	0	120	24	2,880	0%	91%	0	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	**128,616**	**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**

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:
   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 PM_2or 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 and 298 for N_2O.

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 Emissions (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_2O tons**	**CO_2e tons**
Heavy Transport Vessel (transit from TX)		3	484 x 138 x 36																									
-Main Engines	6			3	6,394	Diesel	45,000	3.18	1	200	0	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	Diesel	80,000	3.18	1	6	0	45	24	1,080	29%	29%	6,289	1,132,075	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	6,032	Diesel			1	6	0	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	Diesel			1	6	0	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	Diesel	50,000	3.18	1	6	0	4	24	96	72%	72%	3,931	62,893	0.03	0.85	0.07	1.19E-02	1.15E-02	0.03	2.83E-03	41.46	2.57E-04	1.99E-03	42.06
-Aux. Generator	1			2	1,609	Diesel			1	6	0	4	24	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	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	4,000	3.18	1	9	0	45	24	1,080	64%	50%	472	56,604	1.91E-03	0.07	0.04	1.82E-03	1.77E-03	4.62E-05	1.92E-04	4.88	6.36E-04	1.41E-04	4.93
-Aux. Generator	1			1	133	Diesel			1	9	0	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	Diesel			0	0	0	45	24	1,080	0%	50%			0	0	0	0	0	0	0	0	0	0	0
-Aux. Engine	1			1	133	Diesel			0	0	0	45	24	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	Diesel	235	3.18	0	0	0	15	24	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	Diesel	2,350	3.18	0	0	0	120	24	2,880	0%	91%	0	88,679	0	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**

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:
   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 PM_{10} 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. 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 and 298 for N_2O.

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

																		Total Emissions (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_2O tons**	**CO_2e tons**
Helicopter - Twin-Engine Heavy		N/A																										
-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	60	0.5	0	0	0	0	100%	0%	9,442	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	Diesel	15,000	3.18	2	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	2,466	Diesel	15,000	3.18	2	9	0	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	1,850	Diesel			2	9	0	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	382	Diesel			0	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	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	2,466	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	1,850	Diesel			2	9	0	106	24	2,544	45%	45%			1.75	34.25	17.48	2.16	2.10	0.02	0.19	2,411.66	0.31	0.07	2,440.35
-Emergency Generator	1			1	382	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	16	6	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	1,609	Diesel			16	6	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	660	Diesel			0	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	7,831	Diesel	15,000	3.18	1	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
-Tugboat Harbor Generator	1			1	979	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Tugboat Emergency Generator	1			1	737	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Dredger Pump Engines	2			3	5,000	Diesel			0	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
-Dredger Harbor Generator	1			2	1,220	Diesel			0	0	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	1,332	Diesel	20,000	3.18	1	18	0	9	24	216	98%	89%	4,717	56,604	0.42	8.22	4.19	0.52	0.50	5.48E-03	0.04	578.81	0.08	0.02	585.70
-Crane Engine	1			1	536	Diesel			0	0	0	9	24	216	0%	89%			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
-Emergency Generator	1			1	361	Diesel			0	0	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	1,260	Diesel	2,500	3.18	1	18	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	449	Diesel			1	18	0	9	24	216	22%	22%			4.71E-03	0.17	0.09	4.50E-03	4.37E-03	1.14E-04	4.73E-04	12.04	1.57E-03	3.49E-04	12.19
-Emergency Generator	1			1	87	Diesel			0	0	0	0	0	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	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	449	Diesel			1	18	0	9	24	216	22%	22%			4.71E-03	0.17	0.09	4.50E-03	4.37E-03	1.14E-04	4.73E-04	12.04	1.57E-03	3.49E-04	12.19
-Emergency Generator	1			1	87	Diesel			0	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	750	Diesel	4,000	3.18	2	9	0	18	24	432	64%	50%	943	22,642	0.07	2.60	1.32	0.07	0.07	1.73E-03	7.18E-03	182.80	0.02	5.30E-03	184.97
-Aux. Generator	1			1	133	Diesel			2	9	0	18	24	432	64%	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
-Bow Thruster Engine	1			1	325	Diesel			0	0	0	18	24	432	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	133	Diesel			0	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	660	Diesel	5,000	3.18	3	9	0	106	24	2,544	95%	95%	1,769	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
-Main Generators	2			1	27	Diesel			3	9	0	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		N/A	65 x 17 x 5																									
-Main Engines	2			1	660	Diesel	5,000	3.18	3	9	0	106	24	2,544	95%	95%	1,769	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
-Main Generators	2			1	27	Diesel			3	9	0	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
																	TOTALS		**98,632**	**7,697,170**	**65.35**	**1,605.78**	**324.98**	**42.41**	**41.14**	**35.11**	**6.15**	**88,207**	**4.46**	**3.63**	**89,401**

Notes:

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)
5. 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 identifed 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 $PM_{2.5}$ 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)
10. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
11. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 and 298 for N_2O.

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

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)	Total Emissions (Transit) 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_2O tons	CO_2e tons
Helicopter - Twin-Engine Heavy		N/A																											
-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	60	0.5	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)																										
-Main Generators	6			3	3,003	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	2,466	Diesel	15,000	3.18	2	9	0	212	24	5,088	45%	45%	3,538	1,000,000	1.65E-02	0.32	0.16	2.04E-02	1.98E-02	2.16E-04	1.75E-03	22.75	2.97E-03	6.59E-04	23.02
-Main Generators	2			2	1,850	Diesel			2	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	382	Diesel			0	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	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	2,466	Diesel	15,000	3.18	2	9	0	106	24	2,544	45%	45%	3,538	500,000	1.65E-02	0.32	0.16	2.04E-02	1.98E-02	2.16E-04	1.75E-03	22.75	2.97E-03	6.59E-04	23.02
-Main Generators	2			2	1,850	Diesel			2	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	382	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	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
Pre-Sweep Dredger/Tug Combination		N/A	480 x 92 x 36 (30)																										
-Tugboat Main Engines	2			3	7,831	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
-Tugboat Harbor Generator	1			1	979	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Tugboat Emergency Generator	1			1	737	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Dredger Pump Engines	2			3	5,000	Diesel			0	0	0	12	24	288	0%	17%			0	0	0	0	0	0	0	0	0	0	0
-Dredger Harbor Generator	1			2	1,220	Diesel			0	0	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	1,332	Diesel	20,000	3.18	1	18	0	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	536	Diesel			0	0	0	9	24	216	0%	89%			0	0	0	0	0	0	0	0	0	0	0
-Emergency Generator	1			1	361	Diesel			0	0	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	1,260	Diesel	2,500	3.18	1	18	0	9	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	449	Diesel			1	18	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	87	Diesel			0	0	0	0	0	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	0	9	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	449	Diesel			1	18	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	87	Diesel			0	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	750	Diesel	4,000	3.18	2	9	0	18	24	432	64%	50%	943	22,642	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	133	Diesel			2	9	0	18	24	432	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	325	Diesel			0	0	0	18	24	432	0%	50%			0	0	0	0	0	0	0	0	0	0	0
-Aux. Engine	1			1	133	Diesel			0	0	0	18	24	432	0%	50%			0	0	0	0	0	0	0	0	0	0	0
Safety Vessel 1		N/A	65 x 17 x 5																										
-Main Engines	2			1	660	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	27	Diesel			3	9	0	106	24	2,544	95%	95%			3.04E-04	1.10E-02	5.63E-03	2.91E-04	2.82E-04	7.36E-06	3.05E-05	0.78	1.01E-04	2.25E-05	0.79
Safety Vessel 2		N/A	65 x 17 x 5																										
-Main Engines	2			1	660	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	27	Diesel			3	9	0	106	24	2,544	95%	95%			3.04E-04	1.10E-02	5.63E-03	2.91E-04	2.82E-04	7.36E-06	3.05E-05	0.78	1.01E-04	2.25E-05	0.79
																	TOTALS		**98,632**	**7,697,170**	**0.80**	**19.58**	**3.41**	**0.46**	**0.45**	**0.48**	**0.07**	**1,124**	**0.05**	**0.05**	**1,139**

Notes:

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)
5. 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 identifed 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 PM 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)
10. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
11. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 and 298 for N_2O.

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

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)	Total Emissions (Non-Transit)								
																			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_2O tons	CO_2e 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	0	100%	0%	5,980	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	Diesel	15,000	3.18	2	9	0	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	2,466	Diesel	15,000	3.18	2	9	0	133	24	3,192	45%	45%	3,538	627,358	2.92	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	1,850	Diesel			2	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	Diesel			0	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	0	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	9	0	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	1,850	Diesel			2	9	0	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	382	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	29	6	0	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	1,609	Diesel			29	6	0	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	0
Pre-Sweep Dredger/Tug Combination		N/A	480 x 92 x 36 (30)																								
-Tugboat Main Engines	2			3	7,831	Diesel	15,000	3.18	1	9	0	22	24	528	27%	17%	1,769	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
-Tugboat Harbor Generator	1			1	979	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Tugboat Emergency Generator	1			1	737	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Dredger Pump Engines	2			3	5,000	Diesel			0	0	0	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
-Dredger Harbor Generator	1			2	1,220	Diesel			0	0	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	1,332	Diesel	20,000	3.18	1	18	0	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			1	536	Diesel			0	0	0	16	24	384	0%	89%			0.04	1.47	0.75	0.04	0.04	9.81E-04	4.07E-03	103.52	1.35E-02	3.00E-03	104.75
-Emergency Generator	1			1	361	Diesel			0	0	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	1,260	Diesel	2,500	3.18	1	18	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	449	Diesel			1	18	0	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	Diesel			0	0	0	0	0	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	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	449	Diesel			1	18	0	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	Diesel			0	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	750	Diesel	4,000	3.18	2	9	0	33	24	792	64%	50%	943	41,509	0.13	4.76	2.43	0.13	0.12	3.18E-03	1.32E-02	335.12	0.04	9.71E-03	339.11
-Aux. Generator	1			1	133	Diesel			2	9	0	33	24	792	64%	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
-Bow Thruster Engine	1			1	325	Diesel			0	0	0	33	24	792	0%	50%			0.03	1.03	0.53	2.71E-02	2.63E-02	6.88E-04	2.85E-03	72.61	9.47E-03	2.10E-03	73.47
-Aux. Engine	1			1	133	Diesel			0	0	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		N/A	65 x 17 x 5																								
-Main Engines	2			1	660	Diesel	5,000	3.18	7	9	0	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	27	Diesel			7	9	0	212	24	5,088	95%	95%			0.06	2.08	1.06	0.05	0.05	1.39E-03	5.75E-03	146.44	1.91E-02	4.24E-03	148.18
Safety Vessel 2		N/A	65 x 17 x 5																								
-Main Engines	2			1	660	Diesel	5,000	3.18	7	9	0	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	27	Diesel			7	9	0	212	24	5,088	95%	95%			0.06	2.08	1.06	0.05	0.05	1.39E-03	5.75E-03	146.44	1.91E-02	4.24E-03	148.18
																	TOTALS		**150,988**	**11,849,686**	**100.13**	**2,485.15**	**489.76**	**63.18**	**61.28**	**55.24**	**9.38**	**135,849**	**6.63**	**5.63**	**137,693**

Notes:

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 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)
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 identifed 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 PM_{10} 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)
11. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
12. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 and 298 for N_2O.

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

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)	Total Emissions (Transit)								
																			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_2O tons	CO_2e 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	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		1	459 x 97 x 36 (24)																								
-Main Generators	6			3	3,003	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	2,466	Diesel	15,000	3.18	2	9	0	133	24	3,192	45%	45%	3,538	627,358	1.65E-02	0.32	0.16	2.04E-02	1.98E-02	2.16E-04	1.75E-03	22.75	2.97E-03	6.59E-04	23.02
-Main Generators	2			2	1,850	Diesel			2	9	0	133	24	3,192	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	382	Diesel			0	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	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	40.29
Installation Support Vessel 2		1	243 x 56 x 26 (21)																								
-Main Generators	2			2	2,466	Diesel	15,000	3.18	2	9	0	212	24	5,088	45%	45%	3,538	1,000,000	1.65E-02	0.32	0.16	2.04E-02	1.98E-02	2.16E-04	1.75E-03	22.75	2.97E-03	6.59E-04	23.02
-Main Generators	2			2	1,850	Diesel			2	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	382	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	29	6	0	487	24	11,688	72%	72%	113,994	7,657,233	0.93	24.56	2.05	0.34	0.33	0.74	0.08	1202.31	7.44E-03	0.06	1,219.69
-Aux. Generator	1			2	1,609	Diesel			29	6	0	487	24	11,688	72%	72%			0.08	1.62	0.83	0.10	0.10	1.08E-03	8.78E-03	114.14	1.49E-02	3.31E-03	115.50
-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
Pre-Sweep Dredger/Tug Combination		N/A	480 x 92 x 36 (30)																								
-Tugboat Main Engines	2			3	7,831	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
-Tugboat Harbor Generator	1			1	979	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Tugboat Emergency Generator	1			1	737	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Dredger Pump Engines	2			3	5,000	Diesel			0	0	0	22	24	528	0%	17%			0	0	0	0	0	0	0	0	0	0	0
-Dredger Harbor Generator	1			2	1,220	Diesel			0	0	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	1,332	Diesel	20,000	3.18	1	18	0	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	536	Diesel			0	0	0	16	24	384	0%	89%			0	0	0	0	0	0	0	0	0	0	0
-Emergency Generator	1			1	361	Diesel			0	0	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	1,260	Diesel	2,500	3.18	1	18	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	449	Diesel			1	18	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	1.02
-Emergency Generator	1			1	87	Diesel			0	0	0	0	0	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	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	449	Diesel			1	18	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	1.02
-Emergency Generator	1			1	87	Diesel			0	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	750	Diesel	4,000	3.18	2	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	133	Diesel			2	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	325	Diesel			0	0	0	33	24	792	0%	50%			0	0	0	0	0	0	0	0	0	0	0
-Aux. Engine	1			1	133	Diesel			0	0	0	33	24	792	0%	50%			0	0	0	0	0	0	0	0	0	0	0
Safety Vessel 1		N/A	65 x 17 x 5																								
-Main Engines	2			1	660	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	27	Diesel			7	9	0	212	24	5,088	95%	95%			7.10E-04	2.58E-02	1.31E-02	6.78E-04	6.58E-04	1.72E-05	7.12E-05	1.81	2.37E-04	5.26E-05	1.83
Safety Vessel 2		N/A	65 x 17 x 5																								
-Main Engines	2			1	660	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	27	Diesel			7	9	0	212	24	5,088	95%	95%			7.10E-04	2.58E-02	1.31E-02	6.78E-04	6.58E-04	1.72E-05	7.12E-05	1.81	2.37E-04	5.26E-05	1.83
																	TOTALS		**150,988**	**11,849,686**	**1.26**	**31.88**	**5.08**	**0.68**	**0.66**	**0.80**	**0.11**	**1,730**	**0.06**	**0.07**	**1,754**

Notes:

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 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)
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 identifed 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 PM_{10} 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)
11. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
12. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 and 298 for N_2O.

LANDFALL MARINE INSTALLATION EQUIPMENT FOR EW 1 (GOWANUS)

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)	Total Emissions (Non-Transit) 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_2O tons	CO_2e tons
Channel Area Dredger/Tug Combination		N/A	480 x 92 x 36 (30)																										
-Tugboat Main Engines	2			3	7,831	Diesel	15,000	3.18	1	3	0	122	24	2,928	27%	17%	590	575,472	3.15	83.07	6.92	1.17	1.13	2.50	0.28	4,066.14	0.03	0.20	4,124.90
-Tugboat Harbor Generator	1			1	979	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Tugboat Emergency Generator	1			1	737	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Dredger Pump Engines	2			3	5,000	Diesel			0	0	0	122	24	2,928	0%	17%			2.01	53.04	4.42	0.74	0.72	1.59	0.18	2,596.18	0.02	0.12	2,633.70
-Dredger Harbor Generator	1			2	1,220	Diesel			0	0	0	0	0	0	0%	0%			0	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 Engines	2			3	7,831	Diesel	15,000	3.18	1	3	0	62	24	1,488	27%	17%	590	292,453	1.60	42.22	3.52	0.59	0.57	1.27	0.14	2,066.40	1.28E-02	0.10	2,096.26
-Tugboat Harbor Generator	1			1	979	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Tugboat Emergency Generator	1			1	737	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Dredger Pump Engines	2			3	5,000	Diesel			0	0	0	62	24	1,488	0%	17%			1.02	26.96	2.25	0.38	0.37	0.81	0.09	1,319.37	8.17E-03	0.06	1,338.44
-Dredger Harbor Generator	1			2	1,220	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
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	0	0	0	90	4	360	0%	79%	0	42,453	0.29	5.76	2.94	0.36	0.35	3.84E-03	0.03	405.52	0.05	1.18E-02	410.35
-Aux. Generator	1			1	449	Diesel			0	0	0	90	4	360	0%	79%			0.03	1.03	0.52	0.03	0.03	6.85E-04	2.84E-03	72.26	9.43E-03	2.09E-03	73.12
-Emergency Generator	2			1	87	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
O&M Base Piling Barge		2	400 x 105 x 25																										
-Station-keeping Engine	1			1	200	Diesel	1,000	3.18	0	0	0	180	12	2,160	0%	56%	0	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	138.13
- Piling Rig Engine	1			1	800	Diesel			0	0	0	90	8	720	0%	56%	0		0.07	2.59	1.32	0.07	0.07	1.72E-03	7.15E-03	182.01	0.02	5.28E-03	184.18
Tug for Cable Landfall and Bulkhead		N/A	98 x 31 x 10 (8)																										
-Main Engines	2			2	1,260	Diesel	1,500	3.18	0	0	0	240	4	960	0%	79%	0	113,208	0.78	15.36	7.84	0.97	0.94	1.02E-02	0.08	1,081.39	0.14	0.03	1,094.26
-Aux. Generator	1			1	449	Diesel			0	0	0	240	4	960	0%	79%			0.08	2.74	1.40	0.07	0.07	1.83E-03	7.57E-03	192.69	0.03	5.59E-03	194.99
-Emergency Generator	2			1	87	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Cable Landfall and Bulkhead Barge		2	400 x 105 x 25																										
-Station-keeping Engine	1			1	200	Diesel	1,000	3.18	0	0	0	210	5	1,050	0%	84%	0	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	101.63
- Piling Rig Engine	1			1	800	Diesel			0	0	0	210	8	1,680	0%	84%	0		0.25	9.13	4.66	0.24	0.23	6.09E-03	0.03	642.78	0.08	0.02	650.43
																	TOTALS FOR EW 1 (GOWANUS)		**9.37**	**245.25**	**37.50**	**4.71**	**4.57**	**6.20**	**0.85**	**12,861.68**	**0.43**	**0.56**	**13,040.39**

LANDFALL MARINE INSTALLATION EQUIPMENT FOR EW 2 (OCEANSIDE)

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)	Total Emissions (Non-Transit) 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_2O tons	CO_2e tons
Tug for Cofferdam Barge		N/A	98 x 31 x 10 (8)																										
-Main Engines	2			2	1,260	Diesel	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	1,823.76
-Aux. Generator	1			1	449	Diesel			4	6	0	120	24	2,880	44%	44%			0.13	4.56	2.33	0.12	0.12	3.04E-03	1.26E-02	321.16	0.04	9.31E-03	324.98
-Emergency Generator	2			1	87	Diesel			0	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 Engine	1			1	200	Diesel	2,000	3.18	1	6	0	120	24	2,880	0%	52%	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	171.90
- Piling Rig Engine	1			1	800	Diesel			1	6	0	120	24	2,880	0%	52%	0		0.27	9.65	4.92	0.25	0.25	6.44E-03	0.03	679.51	0.09	0.02	687.60
																	TOTALS FOR EW 2 (OCEANSIDE)		**1.76**	**42.22**	**21.54**	**2.06**	**1.99**	**0.03**	**0.18**	**2,973**	**0.39**	**0.09**	**3,008**

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: 13.5 nm (only includes portion of transit within the state seaward boundary)
   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 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 PM_{10} 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 and 298 for N_2O.

LANDFALL MARINE INSTALLATION EQUIPMENT FOR EW 1 (GOWANUS)

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)	Total Emissions (Transit) 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_2O tons	CO_2e tons
Channel Area Dredger/Tug Combination		N/A	480 x 92 x 36 (30)																										
-Tugboat Main Engines	2			3	7,831	Diesel	15,000	3.18	1	3	0	122	24	2,928	27%	17%	590	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	6.92
-Tugboat Harbor Generator	1			1	979	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Tugboat Emergency Generator	1			1	737	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Dredger Pump Engines	2			3	5,000	Diesel			0	0	0	122	24	2,928	0%	17%			0	0	0	0	0	0	0	0	0	0	0
-Dredger Harbor Generator	1			2	1,220	Diesel			0	0	0	0	0	0	0%	0%			0	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 Engines	2			3	7,831	Diesel	15,000	3.18	1	3	0	62	24	1,488	27%	17%	590	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	6.92
-Tugboat Harbor Generator	1			1	979	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Tugboat Emergency Generator	1			1	737	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
-Dredger Pump Engines	2			3	5,000	Diesel			0	0	0	62	24	1,488	0%	17%			0	0	0	0	0	0	0	0	0	0	0
-Dredger Harbor Generator	1			2	1,220	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
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	0	0	0	90	4	360	0%	79%	0	42,453	0	0	0	0	0	0	0	0	0	0	0
-Aux. Generator	1			1	449	Diesel			0	0	0	90	4	360	0%	79%			0	0	0	0	0	0	0	0	0	0	0
-Emergency Generator	2			1	87	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
O&M Base Piling Barge		2	400 x 105 x 25																										
-Station-keeping Engine	1			1	200	Diesel	1,000	3.18	0	0	0	180	12	2,160	0%	56%	0	28,302	0	0	0	0	0	0	0	0	0	0	0
- Piling Rig Engine	1			1	800	Diesel			0	0	0	90	8	720	0%	56%	0		0	0	0	0	0	0	0	0	0	0	0
Tug for Cable Landfall and Bulkhead		N/A	98 x 31 x 10 (8)																										
-Main Engines	2			2	1,260	Diesel	1,500	3.18	0	0	0	240	4	960	0%	79%	0	113,208	0	0	0	0	0	0	0	0	0	0	0
-Aux. Generator	1			1	449	Diesel			0	0	0	240	4	960	0%	79%			0	0	0	0	0	0	0	0	0	0	0
-Emergency Generator	2			1	87	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
Cable Landfall and Bulkhead Barge		2	400 x 105 x 25																										
-Station-keeping Engine	1			1	200	Diesel	1,000	3.18	0	0	0	210	5	1,050	0%	84%	0	66,038	0	0	0	0	0	0	0	0	0	0	0
- Piling Rig Engine	1			1	800	Diesel			0	0	0	210	8	1,680	0%	84%	0		0	0	0	0	0	0	0	0	0	0	0
																	TOTALS FOR EW 1 (GOWANUS)		**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**	**13.85**

LANDFALL MARINE INSTALLATION EQUIPMENT FOR EW 2 (OCEANSIDE)

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)	Total Emissions (Transit) 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_2O tons	CO_2e tons
Tug for Cofferdam Barge		N/A	98 x 31 x 10 (8)																										
-Main Engines	2			2	1,260	Diesel	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. Generator	1			1	449	Diesel			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 Generator	2			1	87	Diesel			0	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 Engine	1			1	200	Diesel	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	0
- Piling Rig Engine	1			1	800	Diesel			1	6	0	120	24	2,880	0%	52%	0		0	0	0	0	0	0	0	0	0	0	0
																	TOTALS FOR EW 2 (OCEANSIDE)		**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: 13.5 nm (only includes portion of transit within the state seaward boundary)
   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 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 $PM_{2.5}$ 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)
7. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
8. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 and 298 for N_2O.

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

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)	Total Emissions (Non-Transit)								
																			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_2O tons	CO_2e tons
Helicopter - Twin-Engine Heavy		N/A																									
-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	78	0.5	0	0	0	0	100%	0%	12,275	0	0	0	0	0	0	0	0	0	0	0
Main Installation Vessel		3	484 x 138 x 36																								
-Main Engines	6			3	6,394	Diesel	45,000	3.18	1	6	0	293	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)																								
-Main Generators	2			3	2,880	Diesel	50,000	3.18	27	9	0	98	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			27	9	0	98	24	2,352	98%	98%			7.30	192.62	16.05	2.70	2.62	5.79	0.64	9,427.70	0.06	0.45	9,563.96
-Aux. Generator	1			2	994	Diesel			27	9	0	98	24	2,352	98%	98%			0.94	18.51	9.44	1.17	1.13	1.23E-02	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	0	0	0	0	0	0	0	0	0	0
WTG Installation Generator																											
	1	N/A	N/A	2	1,609	Diesel	6,190	3.18	0	0	0	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																											
	3	N/A	N/A	257	201	Diesel	2,112	3.18	0	0	0	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 SBMT)		N/A	146 x 46 x 25 (21)																								
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	18	0	293	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	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 WTG Blades/Nacelles (from SBMT)		N/A	146 x 46 x 25 (21)																								
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	18	0	293	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	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
Cargo Barge 1 (for WTG Blades/Nacelles)		N/A	400 x 105 x 25																								
							0	N/A	40	18	0	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																								
							0	N/A	40	18	0	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	Diesel	10,000	3.18	27	69	0	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	95	Diesel			27	69	0	293	24	7,032	35%	35%			0.10	3.79	1.93	0.10	0.10	2.53E-03	1.05E-02	266.61	0.03	7.73E-03	269.78
Tug 4 for WTG Towers (from Albany)		N/A	136 x 36 x 19 (17)																								
-Main Engines	2			2	3,600	Diesel	10,000	3.18	27	69	0	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	95	Diesel			27	69	0	293	24	7,032	35%	35%			0.10	3.79	1.93	0.10	0.10	2.53E-03	1.05E-02	266.61	0.03	7.73E-03	269.78
Cargo Barge 2 (for WTG Towers)		N/A	400 x 105 x 25																								
							0	N/A	27	69	0	293	24	7,032	N/A	N/A	N/A	N/A										
																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

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:
   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 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 PM 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. 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 and 298 for N_2O.

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

																		Total Emissions (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_2O tons**	**CO_2e tons**
Helicopter - Twin-Engine Heavy		N/A																										
-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	78	0.5	0	0	0	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		3	484 x 138 x 36																									
-Main Engines	6			3	6,394	Diesel	45,000	3.18	1	6	0	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)		1	568 x 138 x 39 (18)																									
-Main Generators	2			3	2,880	Diesel	50,000	3.18	27	9	0	98	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	Diesel			27	9	0	98	24	2,352	98%	98%			0.75	19.90	1.66	0.28	0.27	0.60	0.07	974.03	6.03E-03	0.05	988.11
-Aux. Generator	1			2	994	Diesel			27	9	0	98	24	2,352	98%	98%			0.10	1.91	0.98	0.12	0.12	1.28E-03	1.04E-02	134.64	0.02	3.90E-03	136.24
-Emergency Generator	1			2	601	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
WTG Installation Generator																												
	1	N/A	N/A	2	1,609	Diesel	6,190	3.18	0	0	0	30	24	720	0%	100.0%	0	58,396	0	0	0	0	0	0	0	0	0	0	0
WTG Commissioning Generators																												
	3	N/A	N/A	257	201	Diesel	2,112	3.18	0	0	0	80	24	1,920	0%	100.0%	0	53,132	0	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	40	18	0	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	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 WTG Blades/Nacelles (from SBMT)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	40	18	0	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	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
Cargo Barge 1 (for WTG Blades/Nacelles)		N/A	400 x 105 x 25																									
							0	N/A	40	18	0	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																									
							0	N/A	40	18	0	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	Diesel	10,000	3.18	27	69	0	293	24	7,032	35%	35%	244,104	921,384	1.94	38.02	19.40	2.40	2.33	2.54E-02	0.21	2676.61	0.35	0.08	2,708.46
-Aux. Engines	2			1	95	Diesel			27	69	0	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
Tug 4 for WTG Towers (from Albany)		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	27	69	0	293	24	7,032	35%	35%	244,104	921,384	1.94	38.02	19.40	2.40	2.33	2.54E-02	0.21	2676.61	0.35	0.08	2,708.46
-Aux. Engines	2			1	95	Diesel			27	69	0	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
Cargo Barge 2 (for WTG Towers)		N/A	400 x 105 x 25																									
							0	N/A	27	69	0	293	24	7,032	N/A	N/A	N/A	N/A											
																TOTALS	**851,898**	**9,484,170**	**6.97**	**146.45**	**59.17**	**7.40**	**7.18**	**1.19**	**0.71**	**9,627.60**	**1.03**	**0.31**	**9,746.45**

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:
   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 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 $PM_{2.5}$ 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. 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 and 298 for N_2O.

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

																		Total Emissions (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_2O tons	CO_2e tons
Helicopter - Twin-Engine Heavy		N/A																										
-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	91	0.5	0	0	0	0	100%	0%	14,321	0	0	0	0	0	0	0	0	0	0	0	0
Main Installation Vessel		3	484 x 138 x 36																									
-Main Engines	6			3	6,394	Diesel	45,000	3.18	1	6	0	586	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	54	9	0	196	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			54	9	0	196	24	4,704	98%	98%			14.59	385.23	32.10	5.41	5.25	11.58	1.29	18,855.39	0.12	0.90	19,127.92
-Aux. Generator	1			2	994	Diesel			54	9	0	196	24	4,704	98%	98%			1.89	37.02	18.89	2.34	2.27	2.47E-02	0.20	2,606.29	0.34	0.08	2,637.31
-Emergency Generator	1			2	601	Diesel			0	0	0	0	0	0	0%	0%			0	0	0	0	0	0	0	0	0	0	0
WTG Installation Generator																												
	1	N/A	N/A	2	1,609	Diesel	6,190	3.18	0	0	0	60	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	0	0	160	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 SBMT)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	18	0	586	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	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 WTG Blades/Nacelles (from SBMT)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	18	0	586	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	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
Cargo Barge 1 (for WTG Blades/Nacelles)		N/A	400 x 105 x 25																									
							0	N/A	80	18	0	586	24	14,064	N/A	N/A	N/A	N/A											
Cargo Barge 2 (for WTG Blades/Nacelles)		N/A	400 x 105 x 25																									
							0	N/A	80	18	0	586	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)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	54	69	0	586	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	95	Diesel			54	69	0	586	24	14,064	35%	35%			0.21	7.57	3.86	0.20	0.19	5.05E-03	2.09E-02	533.22	0.07	1.55E-02	539.56
Tug 4 for WTG Towers (from Albany)		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	54	69	0	586	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	95	Diesel			54	69	0	586	24	14,064	35%	35%			0.21	7.57	3.86	0.20	0.19	5.05E-03	2.09E-02	533.22	0.07	1.55E-02	539.56
Cargo Barge 2 (for WTG Towers)		N/A	400 x 105 x 25																									
							0	N/A	54	69	0	586	24	14,064	N/A	N/A	N/A	N/A											
																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

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:
   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 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 PM 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. 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 and 298 for N_2O.

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

																		Total Emissions (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_2O tons**	**CO_2e tons**
Helicopter - Twin-Engine Heavy		N/A																										
-Main Engines	2			164	1,400	Jet fuel	N/A	N/A	91	0.5	0	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																									
-Main Engines	6			3	6,394	Diesel	45,000	3.18	1	6	0	586	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	0	196	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	9	0	196	24	4,704	98%	98%			1.51	39.80	3.32	0.56	0.54	1.20	0.13	1948.07	1.21E-02	0.09	1,976.23
-Aux. Generator	1			2	994	Diesel			54	9	0	196	24	4,704	98%	98%			0.20	3.82	1.95	0.24	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	0	0
WTG Installation Generator																												
	1	N/A	N/A	2	1,609	Diesel	6,190	3.18	0	0	0	60	24	1,440	0%	100.0%	0	116,792	0	0	0	0	0	0	0	0	0	0	0
WTG Commissioning Generators																												
	3	N/A	N/A	257	201	Diesel	2,112	3.18	0	0	0	160	24	3,840	0%	100.0%	0	106,264	0	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	80	18	0	586	24	14,064	24%	24%	188,679	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	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 WTG Blades/Nacelles (from SBMT)		N/A	146 x 46 x 25 (21)																									
-Main Engines	2			2	5,440	Diesel	10,000	3.18	80	18	0	586	24	14,064	24%	24%	188,679	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	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
Cargo Barge 1 (for WTG Blades/Nacelles)		N/A	400 x 105 x 25																									
							0	N/A	80	18	0	586	24	14,064	N/A	N/A	N/A	N/A											
Cargo Barge 2 (for WTG Blades/Nacelles)		N/A	400 x 105 x 25																									
							0	N/A	80	18	0	586	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)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	54	69	0	586	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	95	Diesel			54	69	0	586	24	14,064	35%	35%			5.53E-02	2.01	1.02	5.28E-02	5.12E-02	1.34E-03	5.55E-03	141.27	1.84E-02	4.09E-03	142.95
Tug 4 for WTG Towers (from Albany)		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	54	69	0	586	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	95	Diesel			54	69	0	586	24	14,064	35%	35%			5.53E-02	2.01	1.02	5.28E-02	5.12E-02	1.34E-03	5.55E-03	141.27	1.84E-02	4.09E-03	142.95
Cargo Barge 2 (for WTG Towers)		N/A	400 x 105 x 25																									
							0	N/A	54	69	0	586	24	14,064	N/A	N/A	N/A	N/A											
																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**

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:
   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 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 PM 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. 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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 and 298 for N_2O.

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

																		Total Emissions (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_2O tons	CO_2e tons
Service Operations Vessel 1																													
-Main Generators	4	1	275 x 58 x 21	2	2212	Diesel	4,000	3.18	7	9	0	219	24	5,256	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	275 x 58 x 21	2	2212	Diesel	4,000	3.18	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		N/A	65 x 17 x 5																										
-Main Engines	2			1	1000	Diesel	3,000	3.18	31	9	0	219	24	5,256	38%	38%	10,967	206,604	0.89	32.16	16.41	0.85	0.82	0.02	0.09	2,264.49	0.30	0.07	2,291.44
-Main Generators	2			1	27	Diesel			31	9	0	219	24	5,256	38%	38%			0.02	0.86	0.44	0.02	0.02	5.75E-04	2.38E-03	60.71	7.92E-03	1.76E-03	61.43
Crew Transfer Vessel 2		N/A	65 x 17 x 5																										
-Main Engines	2			1	1000	Diesel	3,000	3.18	4	9	0	30	24	720	38%	38%	1,415	28,302	0.12	4.41	2.25	0.12	0.11	2.94E-03	1.22E-02	310.20	0.04	8.99E-03	313.90
-Main Generators	2			1	27	Diesel			4	9	0	30	24	720	38%	38%			3.25E-03	0.12	0.06	3.11E-03	3.02E-03	7.88E-05	3.27E-04	8.32	1.08E-03	2.41E-04	8.42
Inter-array Cable Pulling Engine (at each WTG)	1	N/A	N/A	254	20	Diesel	70	3.18	0	0	0	167	24	4,008	0%	99.4%	0	3,676	0.06	0.43	0.43	0.03	0.03	9.88E-05	9.69E-04	10.74	4.36E-04	8.71E-05	10.78
Inter-array Cable Pulling Engine (at OSS)	1	N/A	N/A	254	20	Diesel	70	3.18	0	0	0	4	24	96	0%	99.4%	0	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 Pulling Engine (at OSS)	1	N/A	N/A	255	34	Diesel	117	3.18	0	0	0	4	24	96	0%	99.7%	0	147	1.53E-03	1.09E-02	1.32E-02	7.91E-05	7.67E-05	3.96E-06	3.88E-05	0.43	1.74E-05	3.49E-06	0.43
																TOTALS	**16,156**	**552,025**	**3.65**	**88.07**	**45.16**	**4.18**	**4.05**	**0.06**	**0.38**	**6,180.12**	**0.81**	**0.18**	**6,253.56**

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.
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 PM 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. 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).
8. Inter-array 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).
9. 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).
10. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
11. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 and 298 for N_2O.

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

																		Total Emissions (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_2O tons**	**CO_2e tons**
Service Operations Vessel 1		1	275 x 58 x 21																									
-Main Generators	4			2	2212	Diesel	4,000	3.18	7	9	0	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		1	275 x 58 x 21																									
-Main Generators	4			2	2212	Diesel	4,000	3.18	1	9	0	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		N/A	65 x 17 x 5																									
-Main Engines	2			1	1000	Diesel	3,000	3.18	31	9	0	219	24	5,256	38%	38%	10,967	206,604	0.05	1.71	0.87	0.04	0.04	1.14E-03	4.72E-03	120.20	0.02	3.48E-03	121.63
-Main Generators	2			1	27	Diesel			31	9	0	219	24	5,256	38%	38%			1.26E-03	0.05	0.02	1.20E-03	1.17E-03	3.05E-05	1.27E-04	3.22	4.20E-04	9.34E-05	3.26
Crew Transfer Vessel 2		N/A	65 x 17 x 5																									
-Main Engines	2			1	1000	Diesel	3,000	3.18	4	9	0	30	24	720	38%	38%	1,415	28,302	6.07E-03	0.22	0.11	5.80E-03	5.63E-03	1.47E-04	6.09E-04	15.51	2.02E-03	4.50E-04	15.69
-Main Generators	2			1	27	Diesel			4	9	0	30	24	720	38%	38%			1.63E-04	5.91E-03	3.01E-03	1.55E-04	1.51E-04	3.94E-06	1.63E-05	0.42	5.42E-05	1.21E-05	0.42
Inter-array Cable Pulling Engine (at each WTG)																												
	1	N/A	N/A	254	20	Diesel	70	3.18	0	0	0	167	24	4,008	0%	99.4%	0	3,676	0	0	0	0	0	0	0	0	0	0	0
Inter-array Cable Pulling Engine (at OSS)																												
	1	N/A	N/A	254	20	Diesel	70	3.18	0	0	0	4	24	96	0%	99.4%	0	88	0	0	0	0	0	0	0	0	0	0	0
Export Cable Pulling Engine (at OSS)																												
	1	N/A	N/A	255	34	Diesel	117	3.18	0	0	0	4	24	96	0%	99.7%	0	147	0	0	0	0	0	0	0	0	0	0	0
																TOTALS	**16,156**	**552,025**	**0.09**	**2.58**	**1.32**	**0.09**	**0.09**	**0.00**	**0.01**	**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.
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 PM 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. 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).
8. Inter-array 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).
9. 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).
10. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
11. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 and 298 for N_2O.

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

																		Total Emissions (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_2O tons**	**CO_2e tons**
Service Operations Vessel 1																												
-Main Generators	4	1	275 x 58 x 21	2	2212	Diesel	4,000	3.18	14	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	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		N/A	65 x 17 x 5																									
-Main Engines	2			1	1000	Diesel	3,000	3.18	62	9	0	438	24	10,512	38%	38%	21,934	413,208	1.77	64.32	32.82	1.69	1.64	0.04	0.18	4,528.99	0.59	0.13	4,582.87
-Main Generators	2			1	27	Diesel			62	9	0	438	24	10,512	38%	38%			0.05	1.72	0.88	0.05	0.04	1.15E-03	4.77E-03	121.42	1.58E-02	3.52E-03	122.87
Crew Transfer Vessel 2		N/A	65 x 17 x 5																									
-Main Engines	2			1	1000	Diesel	3,000	3.18	8	9	0	60	24	1,440	38%	38%	2,830	56,604	0.24	8.81	4.50	0.23	0.23	5.88E-03	2.44E-02	620.41	0.08	1.80E-02	627.79
-Main Generators	2			1	27	Diesel			8	9	0	60	24	1,440	38%	38%			6.51E-03	0.24	0.12	6.22E-03	6.03E-03	1.58E-04	6.53E-04	16.63	2.17E-03	4.82E-04	16.83
Inter-array Cable Pulling Engine (at each WTG)	1	N/A	N/A	254	20	Diesel	70	3.18	0	0	0	334	24	8,016	0%	99.4%	0	7,352	0.12	0.87	0.87	0.05	0.05	1.98E-04	1.94E-03	21.48	8.71E-04	1.74E-04	21.55
Inter-array Cable Pulling Engine (at OSS)	1	N/A	N/A	254	20	Diesel	70	3.18	0	0	0	4	24	96	0%	99.4%	0	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 Pulling Engine (at OSS)	1	N/A	N/A	255	34	Diesel	117	3.18	0	0	0	4	24	96	0%	99.7%	0	147	1.53E-03	1.09E-02	1.32E-02	7.91E-05	7.67E-05	3.96E-06	3.88E-05	0.43	1.74E-05	3.49E-06	0.43
																TOTALS	**32,311**	**1,103,814**	**7.30**	**176.11**	**90.29**	**8.36**	**8.11**	**0.12**	**0.75**	**12,359.55**	**1.61**	**0.36**	**12,506.42**

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.
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 PM 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. 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).
8. Inter-array 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).
9. 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).
10. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
11. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 and 298 for N_2O.

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

																		Total Emissions (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_2O tons**	**CO_2e tons**
Service Operations Vessel 1		1	275 x 58 x 21																									
-Main Generators	4			2	2212	Diesel	4,000	3.18	14	9	0	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		1	275 x 58 x 21																									
-Main Generators	4			2	2212	Diesel	4,000	3.18	2	9	0	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		N/A	65 x 17 x 5																									
-Main Engines	2			1	1000	Diesel	3,000	3.18	62	9	0	438	24	10,512	38%	38%	21,934	413,208	0.09	3.41	1.74	0.09	0.09	2.28E-03	9.44E-03	240.41	0.03	6.97E-03	243.27
-Main Generators	2			1	27	Diesel			62	9	0	438	24	10,512	38%	38%			2.52E-03	0.09	0.05	2.41E-03	2.34E-03	6.11E-05	2.53E-04	6.45	8.41E-04	1.87E-04	6.52
Crew Transfer Vessel 2		N/A	65 x 17 x 5																									
-Main Engines	2			1	1000	Diesel	3,000	3.18	8	9	0	60	24	1,440	38%	38%	2,830	56,604	1.21E-02	0.44	0.22	1.16E-02	1.13E-02	2.94E-04	1.22E-03	31.02	4.05E-03	8.99E-04	31.39
-Main Generators	2			1	27	Diesel			8	9	0	60	24	1,440	38%	38%			3.25E-04	1.18E-02	6.03E-03	3.11E-04	3.02E-04	7.88E-06	3.27E-05	0.83	1.08E-04	2.41E-05	0.84
Inter-array Cable Pulling Engine (at each WTG)																												
	1	N/A	N/A	254	20	Diesel	70	3.18	0	0	0	334	24	8,016	0%	99.4%	0	7,352	0	0	0	0	0	0	0	0	0	0	0
Inter-array Cable Pulling Engine (at OSS)																												
	1	N/A	N/A	254	20	Diesel	70	3.18	0	0	0	4	24	96	0%	99.4%	0	88	0	0	0	0	0	0	0	0	0	0	0
Export Cable Pulling Engine (at OSS)																												
	1	N/A	N/A	255	34	Diesel	117	3.18	0	0	0	4	24	96	0%	99.7%	0	147	0	0	0	0	0	0	0	0	0	0	0
																TOTALS	**32,311**	**1,103,814**	**0.17**	**5.16**	**2.64**	**0.18**	**0.18**	**0.00**	**0.02**	**363.64**	**0.05**	**0.01**	**367.97**

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.
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 PM 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. 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).
8. Inter-array 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).
9. 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).
10. Average load factors for vessel engines were estimated based on typical daily fuel use rates provided by the project.
11. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4 and 298 for N_2O.

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											
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**	**CH_4 tons**	**N_2O tons**	**CO_2e 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	265.88
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																				
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	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	4.13E-04	5.84E-03	79.12	2.00E-03	2.01E-03	79.77
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	4.30E-03	4.17E-03	1.56E-04	2.37E-03	30.33	8.08E-04	7.72E-04	30.58
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	87.90	2.34E-03	2.24E-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	118.17
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	168.99	4.34E-03	4.30E-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	5.39	3.34E-04	1.37E-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	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	1.56E-04	2.37E-03	30.33	8.08E-04	7.72E-04	30.58
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	3.19E-03	9.45E-05	15.76
Refuse Truck		-	diesel	132	-	-	9	2,387	2.28E-03	0.03	1.18E-02	9.76E-04	8.98E-04	2.24E-04	3.41E-04	26.87	1.49E-03	7.37E-05	26.93
Dump Truck		-	diesel	131	-	-	68	14,191	0.04	0.27	0.13	1.03E-02	9.45E-03	1.34E-03	4.66E-03	159.71	1.53E-02	6.14E-04	160.27
Concrete 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
Worker Commute																				
Light Commercial Truck		-	diesel	134	-	-	60	4,274	1.21E-02	0.05	0.10	1.35E-03	1.25E-03	4.02E-04	2.17E-03	48.10	9.68E-03	2.97E-04	48.43
Passenger Truck		-	gasoline	135	-	-	36	2,020	9.69E-03	8.27E-03	0.15	3.92E-04	3.46E-04	2.80E-04	9.24E-04	19.55	5.02E-04	4.79E-04	19.70
							Total	**206,768**	**1.04**	**7.46**	**2.56**	**0.33**	**0.32**	**0.02**	**0.24**	**3,008.82**	**0.11**	**0.07**	**3,032.48**

Notes:

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 I - 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											
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**	**CH_4 tons**	**N_2O tons**	**CO_2e 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**

Notes:

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 I - 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 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

								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 tons**	**CH_4 tons**	**N_2O tons**	**CO_2e 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	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	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**

Notes:

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 I - 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											
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**	**CH_4 tons**	**N_2O tons**	**CO_2e 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	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	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**

Notes:

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 I - 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 Emissions (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 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	N_2O tons	CO_2e tons
Service Operations Vessel 1		1	275 x 58 x 21																									
-Main Generators	4			2	2212	Diesel	4,000	3.18	26	9	0	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																									
-Main Engines	2			1	1000	Diesel	4,000	3.18	120	9	0	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			120	9	0	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																									
-Main Engines	2			1	1000	Diesel	4,000	3.18	120	9	0	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			120	9	0	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																									
-Main Engines	2			1	1000	Diesel	4,000	3.18	120	9	0	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			120	9	0	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																									
-Main Engines	2			1	1000	Diesel	4,000	3.18	120	9	0	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			120	9	0	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	3,000	3.18	1	9	0	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	468.01
-Main Generators	2			1	402	Diesel			1	9	0	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**	**1,681,887**	**9.11**	**268.84**	**137.16**	**9.75**	**9.46**	**0.18**	**0.94**	**18,928.64**	**2.47**	**0.55**	**19,153.87**

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
   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 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 200
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 $PM_{2.5}$ 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
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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4, and 298 for N_2O.

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

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 otal Operatin Hours (hrs)	Transit Average load (%)	Non-Transit Average load (%)	Transit Fuel Usage Gallons (per vessel)	Non-Transit Fuel Usage Gallons (per vessel)	Total Emissions (Transit) 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_2O tons	CO_2e tons
Service Operations Vessel 1		1	275 x 58 x 21																										
-Main Generators	4			2	2212	Diesel	4,000	3.18	26	9	0	328.5	24	7,884	12%	12%	12,264	413,208	0.10	1.96	1.00	0.12	0.12	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	4,000	3.18	120	9	0	240.9	24	5,782	51%	51%	56,604	303,019	0.24	8.81	4.50	0.23	0.23	5.88E-03	2.44E-02	620.41	0.08	1.80E-02	627.79
-Main Generators	2			1	27	Diesel			120	9	0	240.9	24	5,782	51%	51%			6.51E-03	0.24	0.12	6.22E-03	6.03E-03	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	4,000	3.18	120	9	0	240.9	24	5,782	51%	51%	56,604	303,019	0.24	8.81	4.50	0.23	0.23	5.88E-03	2.44E-02	620.41	0.08	1.80E-02	627.79
-Main Generators	2			1	27	Diesel			120	9	0	240.9	24	5,782	51%	51%			6.51E-03	0.24	0.12	6.22E-03	6.03E-03	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	4,000	3.18	120	9	0	240.9	24	5,782	51%	51%	56,604	303,019	0.24	8.81	4.50	0.23	0.23	5.88E-03	2.44E-02	620.41	0.08	1.80E-02	627.79
-Main Generators	2			1	27	Diesel			120	9	0	240.9	24	5,782	51%	51%			6.51E-03	0.24	0.12	6.22E-03	6.03E-03	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	4,000	3.18	120	9	0	240.9	24	5,782	51%	51%	56,604	303,019	0.24	8.81	4.50	0.23	0.23	5.88E-03	2.44E-02	620.41	0.08	1.80E-02	627.79
-Main Generators	2			1	27	Diesel			120	9	0	240.9	24	5,782	51%	51%			6.51E-03	0.24	0.12	6.22E-03	6.03E-03	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	3,000	3.18	1	9	0	60	24	1,440	27%	27%	354	56,604	0.00	0.04	0.02	0.00	0.00	2.74E-05	2.22E-04	2.89	0.00	8.38E-05	2.93
-Main Generators	2			1	402	Diesel			1	9	0	60	24	1,440	27%	27%			4.27E-04	0.02	0.01	4.08E-04	3.96E-04	1.03E-05	4.28E-05	1.09	1.42E-04	3.16E-05	1.10
																TOTALS	**239,033**	**1,681,887**	**1.10**	**38.21**	**19.49**	**1.08**	**1.05**	**0.03**	**0.11**	**2,690.18**	**0.35**	**0.08**	**2,722.18**

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
   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 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 200
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 $PM_{2.5}$ 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
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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4, and 298 for N_2O.

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

																		Total Emissions (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 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**	**N_2O tons**	**CO_2e tons**
Heavy Lift Vessel (every year)																												
-Main Engines	6	3	484 x 138 x 36	3	6,394	Diesel	45,000	3.18	1	6	0	30	24	720	33%	33%	3,538	424,528	3.80	100.41	8.37	1.41	1.37	3.02	0.34	4,914.82	0.03	0.24	4,985.86
Tug 1 (every year)																												
-Main Engines	2	N/A	136 x 36 x 19 (17)	2	3,600	Diesel	10,000	3.18	1	18	0	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. Engines	2			1	95	Diesel			1	18	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
Tug 2 (every year)																												
-Main Engines	2	N/A	136 x 36 x 19 (17)	2	3,600	Diesel	10,000	3.18	1	18	0	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. Engines	2			1	95	Diesel			1	18	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	18	0	30	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 Generators	4			2	2,606	Diesel	15,000	3.18	1	9	0	14	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)		1	459 x 97 x 36 (24)																									
-Main Generators	6			3	3,003	Diesel	15,000	3.18	1	9	0	14	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)																												
	16	N/A	N/A	257	201	Diesel	11,270	3.18	0	0	0	6	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	**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**

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
   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 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 200
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 $PM_{2.5}$ 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
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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4, and 298 for 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	**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 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**	**N_2O tons**	**CO_2e tons**
Heavy Lift Vessel (every year)																												
-Main Engines	6	3	484 x 138 x 36	3	6,394	Diesel	45,000	3.18	1	6	0	30	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)																												
-Main Engines	2	N/A	136 x 36 x 19 (17)	2	3,600	Diesel	10,000	3.18	1	18	0	30	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. Engines	2			1	95	Diesel			1	18	0	30	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)																												
-Main Engines	2	N/A	136 x 36 x 19 (17)	2	3,600	Diesel	10,000	3.18	1	18	0	30	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. Engines	2			1	95	Diesel			1	18	0	30	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				0	N/A	1	18	0	30	24	720	N/A	N/A	N/A	N/A											
Inter-Array Cable Lay Vessel (every year)																												
-Main Generators	4	1	313 x 71 x 29 (24)	2	2,606	Diesel	15,000	3.18	1	9	0	14	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)																												
-Main Generators	6	1	459 x 97 x 36 (24)	3	3,003	Diesel	15,000	3.18	1	9	0	14	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	201	Diesel	11,270	3.18	0	0	0	6	24	144	0%	100.0%	0	21,264	0	0	0	0	0	0	0	0	0	0	0
																TOTALS	**11,792**	**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**

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
   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 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 200
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 $PM_{2.5}$ 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
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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4, and 298 for N_2O.

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

																		Total Emissions (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 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**	**N_2O tons**	**CO_2e tons**
Heavy Lift Vessel (every year)																												
-Main Engines	6	3	484 x 138 x 36	3	6,394	Diesel	45,000	3.18	2	6	0	60	24	1,440	33%	33%	7,075	849,057	7.61	200.83	16.74	2.82	2.73	6.04	0.67	9,829.64	0.06	0.47	9,971.72
Tug 1 (every year)		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	2	18	0	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
-Aux. Engines	2			1	95	Diesel			2	18	0	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
Tug 2 (every year)		N/A	136 x 36 x 19 (17)																									
-Main Engines	2			2	3,600	Diesel	10,000	3.18	2	18	0	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
-Aux. Engines	2			1	95	Diesel			2	18	0	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	18	0	60	24	1,440	N/A	N/A	N/A	N/A											
Inter-Array Cable Lay Vessel (every year)		1	313 x 71 x 29 (24)																									
-Main Generators	4			2	2,606	Diesel	15,000	3.18	2	9	0	28	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)		1	459 x 97 x 36 (24)																									
-Main Generators	6			3	3,003	Diesel	15,000	3.18	1	9	0	14	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)																												
	16	N/A	N/A	257	201	Diesel	11,270	3.18	0	0	0	6	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**

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
   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 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 200
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 $PM_{2.5}$ 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
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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4, and 298 for 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	**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 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**	**N_2O tons**	**CO_2e tons**
Heavy Lift Vessel (every year)																												
-Main Engines	6	3	484 x 138 x 36	3	6,394	Diesel	45,000	3.18	2	6	0	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 Engines	2	N/A	136 x 36 x 19 (17)	2	3,600	Diesel	10,000	3.18	2	18	0	60	24	1,440	35%	35%	4,717	188,679	0.04	0.73	0.37	0.05	0.05	4.90E-04	0.00	51.72	0.01	0.00	52.34
-Aux. Engines	2			1	95	Diesel			2	18	0	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
Tug 2 (every year)																												
-Main Engines	2	N/A	136 x 36 x 19 (17)	2	3,600	Diesel	10,000	3.18	2	18	0	60	24	1,440	35%	35%	4,717	188,679	0.04	0.73	0.37	0.05	0.05	4.90E-04	0.00	51.72	0.01	0.00	52.34
-Aux. Engines	2			1	95	Diesel			2	18	0	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	0	60	24	1,440	N/A	N/A	N/A	N/A											
Inter-Array Cable Lay Vessel (every year)		1	313 x 71 x 29 (24)																									
-Main Generators	4			2	2,606	Diesel	15,000	3.18	2	9	0	28	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)																									
-Main Generators	6			3	3,003	Diesel	15,000	3.18	1	9	0	14	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	201	Diesel	11,270	3.18	0	0	0	6	24	144	0%	100.0%	0	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**

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
   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 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 200
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 $PM_{2.5}$ 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
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. CO_2e emission rates use the following carbon equivalence factors: 25 for CH_4, and 298 for N_2O.

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 tons**	**CH_4 tons**	**N_2O tons**	**CO_2e 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**

Notes:

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 I - 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)	18,360
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

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
CO	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

Notes:

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)	18,360
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

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	7.4	1.85
CO	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

Notes:

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 Emissions		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_2e) [4]	tons/year	314.16	502.65	1306.89	2613.77	552.91	829.37

1. SF_6 = 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. CO_2e 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.

Commercial Marine Vessels (CMVs)

		Commercial Marine Vessel Emission Factors (g/hp-hr) /a									Fuel Cons.
	Engine Type	VOC	NO_x	CO	PM/ PM_{10} /b, /c	$PM_{2.5}$ /b	SO_2 /d	CO_2	CH_4	N_2O	(gal/hp-hr) /e
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 PM_{10} emission factor. $PM_{2.5}$ is estimated to be 97 % of PM_{10} per EPA guidance in "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition," EPA420-R-10-018/NR-009d, July 2010.

/c PM_{10} 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 CO_2 emission factor (g/hp-hr) and the emission factor for the mass of CO_2 generated per gallon of fuel (10.21 kg CO_2/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)

				NONROAD Emission Factors (g/hp-hr) /a								Climate Leaders (g/kWh) /b		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_2O	gal/kWh /c	Load Factor
	Construction & 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 Equipment 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 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 N_2O 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 CO_2/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.

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

	NONROAD Source Category			NONROAD Emission Factors (g/hp-hr) /a								Climate Leaders (g/kWh) /b	Fuel Consumption	NONROAD
	SCC	Description	Engine Size (hp)	Exhaust+ Crankcase VOC	Exhaust NO_x	Exhaust CO	Exhaust PM_{10}	Exhaust $PM_{2.5}$	Exhaust SO_2	Exhaust CO_2	Exhaust CH_4	Exhaust N_2O	gal/kWh /c	Default 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%
	Industrial Equipment 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 Equipment 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.
/b Emission factors for N_2O 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 CO_2/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.

On-road Vehicles (Kings County, NY)

			MOVES2014b Emission factors in lb/VMT /a											
			VOC	NO_x	CO	PM_{10}	PM2.5	SO_2	HAP	CO_2	CH_4	N_2O	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)

			MOVES2014b Emission factors in lb/VMT /a											
			VOC	NO_x	CO	PM_{10}	PM2.5	SO_2	HAP	CO_2	CH_4	N_2O	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.

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

Helicopters

			Emission Factors (lb/hr) /a									
	Helicopter Type	Default Speed (mph	VOC	NO_x	CO	PM/PM10	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O	Fuel Use (gal/hr)
161	Single	157.5	1.89	2.32	0.07	0.07	0.07	0.3	956.92	0.03	0.03	45.36
162	Twin Light	177	4.3	3.1	0.10	0.09	0.09	0.5	1589.69	0.04	0.05	75.35
163	Twin Medium	182.6	3.5	7.2	0.20	0.20	0.20	0.78	2459.92	0.1	0.1	116.59
164	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)

			Subpart IIII standards (g/kWh) /a				(g/kWh) /b	Other Emission Factors (lb/MMBtu) /c, /d				Fuel Cons.
	Stationary Source Category	Engine Size (kW)	VOC	NO_x	CO	PM/ PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O	(gal/kWh) /e
254	Non-Emergency Engines Subject to Tier 4 Standards (2015 model year and later)	kW < 19	0.93	6.57	6.6	0.40	0.39	0.0015	163.1	0.007	0.001	0.067
255		19 <= kW < 56	0.58	4.12	5.0	0.03	0.03	0.0015	163.1	0.007	0.001	0.067
256		56 <= kW < 130	0.19	0.40	5.0	0.02	0.02	0.0015	163.1	0.007	0.001	0.067
257		130 <= kW <= 560	0.19	0.4	3.5	0.02	0.02	0.0015	163.1	0.007	0.001	0.067
258	Gensets	kW > 560	0.19	0.67	3.5	0.03	0.03	0.0015	163.1	0.007	0.001	0.067
259	All except gensets		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 PM_{10} emission factor. $PM_{2.5}$ is estimated to be 97 % of PM_{10} per EPA guidance in "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition," EPA420-R-10-018/NR-009d, July 2010.
/c SO2 emission factor based on typical mass balance for 0.0015% by weight ULSD, assuming 100% conversion of fuel sulfur to SO2.
/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 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													
Input Year	Fuel	Vehicle Type	Emission Factor lbs/VMT										
			VOC	NOx	CO	PM10	PM2.5	SO2	HAPS	CO2	CH4	N2O	CO2e
2022	Diesel	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
		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
		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
		Passenger Car	0.00042	0.00023	0.00448	0.00001	0.00001	0.00001	0.00007	0.88278	0.00033	0.00000	0.88534
	Gasoline	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
		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
		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										
			VOC	NOx	CO	PM10	PM2.5	SO2	HAPS	CO2	CH4	N2O	CO2e
2022	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
		Passenger Truck	0.00059	0.00184	0.00398	0.00005	0.00005	0.00001	0.00009	1.38976	0.00032	0.00001	1.39405
		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 HAP (ratioed 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 HAP (ratioed 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.

Reference: 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

Pollutant	Emission Factor (lb/MMBtu)[a]	Emission Factor Rating	Source (AP-42 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

Pollutant	Emission Factor (lb/MMBtu)[a]	Emission Factor Rating	Source (AP-42 Table)
Organic Compounds			
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	E	3.4-3
PAH			
Naphthalene[b]	1.30E-04	E	3.4-4
Acenaphthylene[b]	9.23E-06	E	3.4-4
Acenaphthene[b]	4.68E-06	E	3.4-4
Fluorene[b]	1.28E-05	E	3.4-4
Phenanthrene[b]	4.08E-05	E	3.4-4
Anthracene[b]	1.23E-06	E	3.4-4
Fluoranthene[b]	4.03E-06	E	3.4-4
Pyrene[b]	3.71E-06	E	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	E	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

[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 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	0.000000079
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 HAP (ratioed to PM10)		**0.001034792**
chromium	ug/bhp-hr	0.03
manganese	ug/bhp-hr	1.37
nickel	ug/bhp-hr	2.035
Total HAP (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.