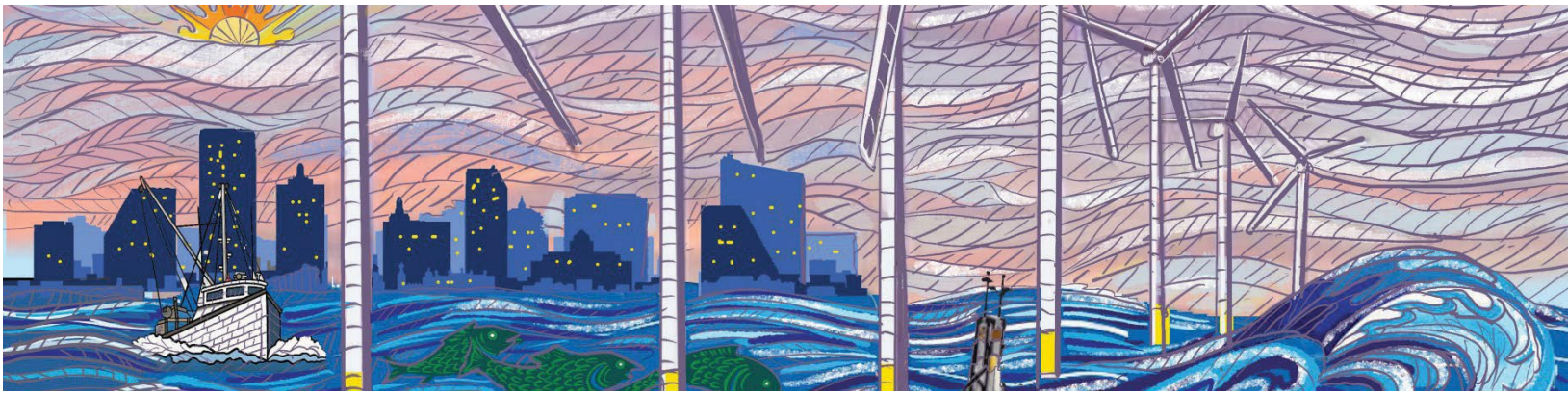

Atlantic Shores Offshore Wind

Outer Continental Shelf Air Permit Application

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Outer Continental Shelf Air Permit Application

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List of Acronyms

ACP	American Clean Power Association
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
AIS	Air insulated switchgear
API	American Petroleum Institute
AQRV	Air Quality Related Values
ARM2	Ambient Ratio Method
BACT	Best Achievable Control Technology
BOEM	Bureau of Ocean Energy Management
CAA	Clean air act
CARB	California Air Resources Board
CER	Certified emissions reductions
CFR	Code of Federal Regulations
CH_4	Methane
CLV	Cable Laying Vessel
CNG	Compressed natural gas
CO	Carbon Monoxide
CO_2E	Carbon dioxide equivalent
COA	Corresponding onshore area
COARE	Coupled Ocean-Atmosphere Response Experiment
COP	Construction and Operations Plan
CTV	crew transfer vessel
DOC	Diesel oxidation catalyst
DP	dynamic positioning
DPF	Diesel particulate filters
DWI	Direct Water Injection
ECC	Export Cable Corridors
EPA	United States Environmental Protection Agency
FAA	Federal aviation administration
FGR	Flue gas recirculation
FID	Final Investment Decision
FLM	Federal Land Manager
GBS	Gravity-base structure
GHG	Greenhouse gas
GIS	Gas insulated switchgear
GWRA	New Jersey Global Warming Response Act
HAP	Hazardous air pollutant
HC	Hydrocarbons
HLV	Heavy lift vessel
HSSE	Health, safety, security, and environmental protection

List of Acronyms (Continued)

HTV	heavy transport vessels
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IEC	International Electrotechnical Commission
IMO	International Maritime Organization
ISO	International Organization for Standardization
kJ	kilojoules
kV	kilovolts
kW	kilowatt
LAER	Lowest Achievable Emissions Rate
LPG	Liquefied petroleum gas
MERP	Modeled Emission Rate Precursor
MMIF	Mesoscale Model Interface
MP	Monopile
N_2O	Nitrous Oxide
NAAQS	National Ambient Air Quality Standard
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NJAAQS	New Jersey Ambient Air Quality Standards
NJAC	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NJWEA	New Jersey Wind Energy Area
NJWP	New Jersey Wind Port
NMHC	Non-methane hydrocarbons
NNSR	Nonattainment New Source Review
NO_2	Nitrogen Dioxide
NOI	Notice of Intent
NO_x	Nitrogen oxides
NSPS	New source performance standards
NSR	New Source Review
NWS	National Weather Service
O&M	Operations and maintenance
O_3	Ozone
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OEM	Original equipment manufacturer
OGV	Ocean-Going Vessels
OLM	Ozone Limiting Method
OREC	Offshore Wind Renewable Energy Certificate

List of Acronyms (Continued)

OSS	Offshore substation
OWEDA	New Jersey Wind Economic Development Act
Pb	Lead
PDE	Project design envelope
PM	Particulate Matter
POI	Point of Interconnection
PRIME	Plume Rise Model Enhancements
PSD	Prevention of Significant Deterioration
PTE	Potential to Emit
PVMRM	Plume Volume Molar Ratio Method
RACT	Reasonably available control technology
RBLC	RACT-BACT-LAER Clearinghouse
RNA	Rotor nacelle assembly
ROV	Remotely operated vessel
SAR	Search and rescue
SATV	Service accommodation and transfer vessel
SCADA	Supervisory control and data acquisition
SCR	Selective Catalytic Reduction
SEEMP	Ship Energy Efficiency Management Plan
SER	Significant Emission Rate
SF_6	Sulfur hexafluoride
SIA	Significant impact area
SIC	Standard Industrial Classification
SIL	Significant impact level
SIP	State implementation plan
SNCR	Selective non-catalytic reduction
SO_2	Sulfur Dioxide
SOTA	State of the Art
SOV	Service operation vessels
SPMT	Self-propelled modular transporters
TOY	Time of year
TP	Transition Piece
TSHD	trailing suction hopper dredge
ULSD	Ultra-low sulfur diesel
UPS	uninterruptible power supply
USCG	United States Coast Guard
VOC	Volatile organic compounds
WRF	Weather research and forecast

List of Acronyms (Continued)

WTA	Wind turbine area
WTG	Wind turbine generator
WTIV	Wind Turbine Installation Vessel

Executive Summary

Purpose of the Application

Atlantic Shores Offshore Wind, LLC ("Atlantic Shores") proposes to construct, operate, and decommission two offshore wind energy generation projects in Lease Area OCS-A 0499. Atlantic Shores accordingly seeks a permit for emissions associated with sources subject to the Outer Continental Shelf (OCS) Air Regulations at 40 Code of Federal Regulation (CFR) Part 55.

Description of the Projects

Atlantic Shores is a 50/50 joint venture between EDF-RE Offshore Development, LLC (a wholly owned subsidiary of EDF Renewables, Inc. [EDF Renewables]) and Shell New Energies US, LLC (Shell). Atlantic Shores is submitting this OCS air permit application to the United States Environmental Protection Agency (EPA) for the development of two offshore wind energy generation projects within Lease Area OCS-A 0499 (the Lease Area). Project 1 and Project 2 are collectively referred to as "the Projects." Atlantic Shores Offshore Wind, LLC is the owner and an affiliate of both the Atlantic Shores Project 1 Company and the Atlantic Shores Project 2 Company.

The purpose of these projects is to develop offshore wind energy generation facilities within the Lease Area to provide clean, renewable energy to the Northeastern U.S. by the mid-to-late 2020s. The projects will help both the U.S. and New Jersey achieve their renewable energy goals, diversify the State's electricity supply, increase electricity reliability, and reduce greenhouse gas (GHG) emissions. The projects will also provide numerous environmental, health, community, and economic benefits, such as the creation of substantial new employment opportunities, including within disadvantaged communities.

Atlantic Shores will develop Lease Area OCS-A 0499 as two projects. Project 1 and Project 2 are collectively referred to as "the Projects." The two Projects will have a combined maximum of 200 wind turbine generators (WTGs) and a maximum of ten offshore substations (OSSs). Both Projects will have associated offshore and onshore cabling, onshore substations, and onshore operations and maintenance (O&M) facilities.

The Projects are in federal waters on the Outer Continental Shelf (OCS), just over 8.7 miles (mi) (14 kilometers [km]) from the New Jersey shoreline. Project 1 is located in the western portion of the Lease Area (also referred to as the Wind Turbine Area [WTA]) and Project 2 is located in the eastern portion of the WTA, with an Overlap Area that could be used by either Project 1 or Project 2. The Overlap Area is included in the event engineering or technical challenges arise at certain locations in the WTA. The WTGs themselves will not emit air pollutants, but there will be air emissions from vessels and engines involved in the construction and operation of the Projects.

Atlantic Shores is requesting the Bureau of Ocean Energy Management's (BOEM's) review and authorization of the Projects in accordance with BOEM's (2018) Project Design Envelope (PDE) guidance. The PDE identifies a reasonable range of designs for the proposed Project components and installation techniques. The PDE articulates the maximum design scenario for key project components, such as the type and number of WTGs, foundation types, OSS types, cable types, and installation techniques. The PDE provides Atlantic Shores with the necessary flexibility to respond to anticipated advancements in industry technologies and techniques, that even under a maximum scenario will not exceed an unreasonable level of environmental effects. Final construction, operation, and maintenance methods will change as the Projects incorporate industry advancements.

Application Applicability

While the WTGs will not generate air emissions, air emissions will occur in connection with construction and operations and maintenance (O&M). Air emissions from these activities are directly associated with internal combustion engines generating power for vessels, vehicles, and tools needed to support the various phases of the Projects.

Under 40 CFR Part 55, EPA regulates the air emissions associated with "OCS sources." OCS sources are defined in part as equipment that can emit air pollutants, including air emissions sources on vessels "[p]ermanently or temporarily attached to the seabed and erected thereon and used for the purpose of exploring, developing or producing resources therefrom . . ." (40 CFR §55.2). The Projects will require an OCS Air Permit under 40 CFR Part 55 for any regulated OCS sources associated with the Projects.

Air quality requirements for OCS sources located within 25 mi of State seaward boundaries are the same as those applicable to sources located in the corresponding onshore area, which has been designated as the State of New Jersey for the Projects. Unlike onshore sources, when comparing project potential emissions to regulatory thresholds, the emissions from vessels servicing an OCS source are included when within 25 nautical miles (nm) of the OCS source.

This application documents compliance with 40 CFR Part 55, relevant federal air quality regulations including the Prevention of Significant Deterioration (PSD) regulations at 40 CFR § 52.21, and relevant New Jersey air quality regulations.

Relevant law and regulations pre-date the development of commercially viable utility-scale offshore wind projects. This application is written based on Atlantic Shores' current understanding of the regulatory interpretations made by EPA, informed through review of recent precedent and through consultations with EPA. In several important particulars, Atlantic Shores requests alternative interpretations of the requirements; these requests are summarized in Appendix A.

Air Emissions Sources

Air emissions from the Projects will be almost exclusively associated with fuel combustion in internal combustion engines. There will be some incidental solvent use associated with touch-up painting and equipment cleaning.

It is important to note that vessel and equipment specifications will change during development and construction of the Projects. Vessel availability at the time of construction or O&M cannot be foreseen with any certainty, given the rapidly changing nature of the offshore wind industry and limitations on vessel use associated with the Jones Act. Vessel data will remain highly speculative throughout the permitting of the Projects. Vessel selection will not be refined until much closer to the start of construction, and vessels may be changed out even after construction begins.

Therefore, this application uses currently best-available information on representative vessel types, with typical or fleet-average emission rates. The number, type, size, and emission rates of vessels could be higher or lower than modeled for any individual activity. Overall, the use of the maximum design scenario associated with the Projects' PDE will serve to ensure a reasonably conservative estimate of emission rates and impacts from the Projects.

Emission Calculation Methods

Emissions are predominantly from internal combustion engines, and are quantified using a three-step process:

1. Detailed plans for each Project activity.
2. Load factors.
3. Emission factors.

Air emissions are broadly calculated as the product of engine rated capacity; hours operating; load factor; and emission factor.

Applicable Requirements

The Clean Air Act at Section 328(a)(1) requires that the EPA establish air pollution control requirements for Outer Continental Shelf (OCS) sources located within 25 mi[1] of states' seaward boundaries that are the same as onshore requirements. EPA's implementing OCS Air Regulations, found at 40 CFR Part 55, apply to all OCS sources in federal waters except those located in certain areas of the Gulf of Mexico.

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[1] Recent precedent has interpreted this requirement to be nautical miles (nm).

OCS sources located within 25 nm of a states' seaward boundaries are subject to the federal requirements set forth in 40 CFR § 55.13 and the federal, state, and local requirements of the Corresponding Onshore Area (COA) set forth in 40 CFR § 55.14. New Jersey has been designated as the COA. Notable federal, state, and local requirements of the COA incorporated by reference into 40 CFR § 55.13 and 55.14 that pertain to the air modeling protocol include New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAPs), Prevention of Significant Deterioration (PSD) review, New Jersey's air permit requirements, and Nonattainment New Source Review (NNSR). This operating permit application documents compliance with applicable air quality requirements incorporated into the OCS permitting program at 40 CFR Part 55.

Control Technology Review

Elements of the Projects are subject to three requirements related to selection of emissions control technology. These are Best Achievable Control Technology (BACT), Lowest Achievable Emissions Rate (LAER), and State Of The Art (SOTA). Following the Vineyard Wind and South Fork precedents, Atlantic Shores proposes to meet applicable control technology requirements by using vessels with the highest-tiered engines that are available at the time of deployment. For stationary engines, Atlantic Shores proposes to use marine diesel engines that meet the highest-tier applicable nonroad or marine diesel EPA standard.

Air Quality Dispersion Modeling

This application documents that the Projects will not cause or significantly contribute to any violation of any National Ambient Air Quality Standard (NAAQS). Atlantic Shores notes that the peak impacts will be entirely over water miles from shore, where there cannot possibly be any residences, and where the public is extremely unlikely to remain for any extended period.

Atlantic Shores requested and received authorization from EPA to use the Coupled Ocean-Atmosphere Response Experiment (COARE) bulk flux algorithm, as implemented within the AERCOARE program for use in the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). The AERCOARE-AERMOD modeling system is an alternative for assessing compliance with air quality standards when emission sources and dispersion occur over water. A separate analysis accounts for secondary formation of particulate matter smaller than 2.5 microns ($PM_{2.5}$), using the View QLIK Modeled Emission Rate Precursor (MERP) methodology stack modeling results to derive a project-specific MERP in accordance with current EPA guidance. Modeled concentrations are added to the appropriate measured background concentration for comparison to the standard.

Separate analyses are included to address Prevention of Significant Deterioration (PSD) increment consumption, and a separate analysis is presented relating to Air Quality Related Values (AQRV) at the Brigantine Wildlife Refuge. Impacts to soils and vegetation are reviewed using a screening procedure, and the general commercial, residential, industrial, and other growth associated with the Projects is reviewed using a qualitative analysis.

Organization of Application

The application is organized into Sections as follows:

1. Introduction and Project Description
2. Emission Calculation Methodology
3. Applicable Regulations
4. Control Technology Review
5. Air Quality Dispersion Modeling

Supplemental information is provided in Appendices.

1.0 Introduction

Atlantic Shores Offshore Wind, LLC ("Atlantic Shores") proposes to construct, operate, and decommission two offshore renewable wind energy projects in Lease Area OCS-A 0499. Collectively, Project 1 and Project 2 are referred to as "the Projects" in this document.

The Projects will be developed and permitted using a Project Design Envelope (PDE). This allows Atlantic Shores to properly define and bracket the characteristics of the Project for purposes of environmental review while maintaining a reasonable degree of flexibility with respect to the selection of key components (e.g., WTGs, foundations, offshore cables, and OSSs).

Air emissions from outer continental shelf (OCS) sources are regulated at the federal level at 40 CFR Part 55. These regulations are different than onshore stationary source air regulations.

The Projects' WTGs themselves will not emit air pollutants, but there will be air emissions from vessels and other equipment involved in the construction and operations and maintenance (O&M) of the Projects. Any air emission source that is "attached to the seabed and erected thereon" within the OCS and is used to develop the Projects is considered an OCS source per 40 CFR Part 55. OCS sources from the Projects will include diesel generators located on the OSSs as well as engines on jack-up vessels (while their legs are attached to the seafloor). Project OCS sources could also include temporary engines on WTGs during construction, and vessels that are doing work while anchored or while attached to an OCS source.

The Projects will include a construction phase (which includes commissioning activities) followed by an O&M phase. The OCS air permit application and this modeling protocol address the construction phase and the O&M phase. If the decommissioning of the Projects is subject to 40 CFR Part 55, Atlantic Shores will apply for a separate permit at the appropriate time.

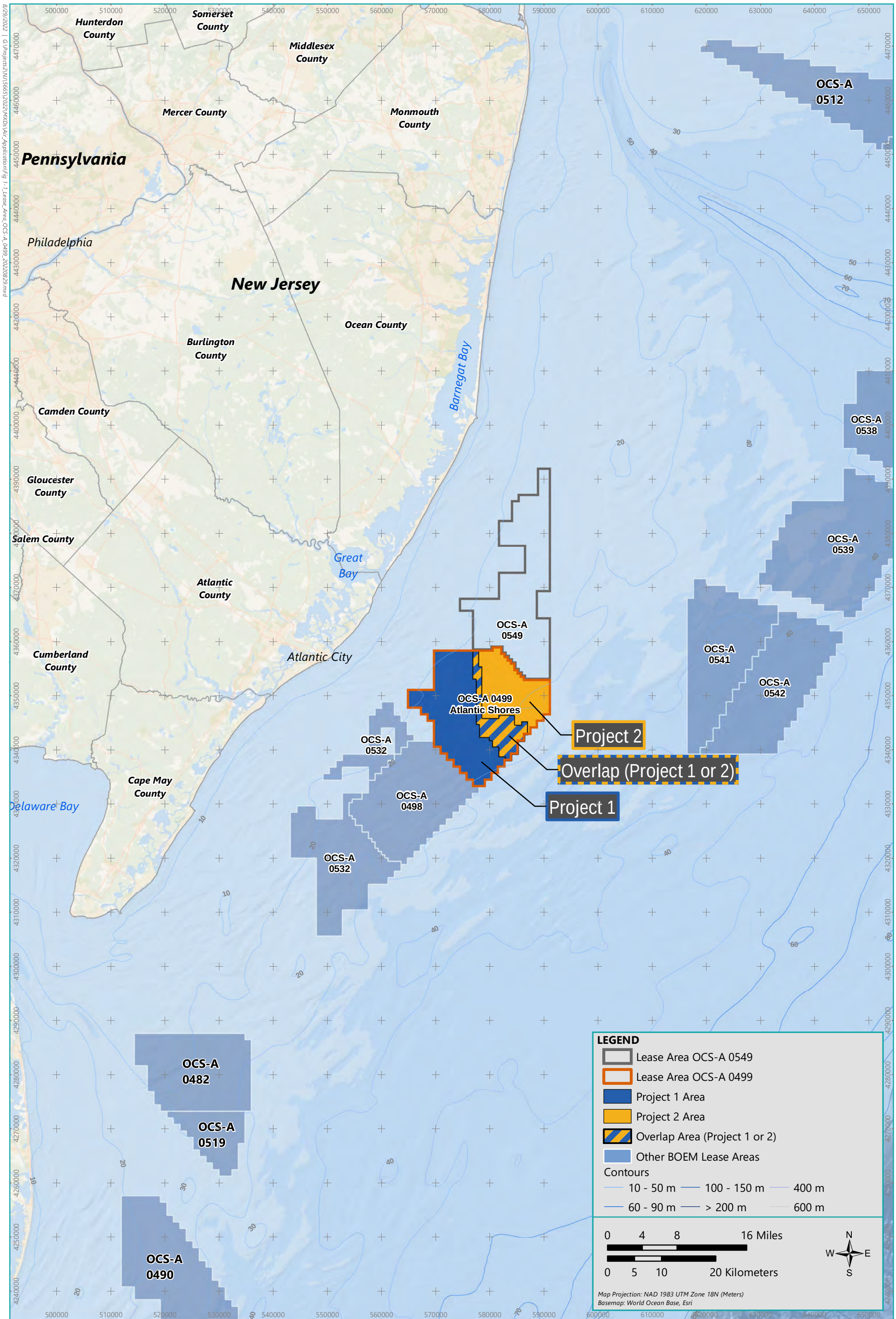
1.1 Projects Description

Atlantic Shores' Lease Area is located on the OCS within the New Jersey Wind Energy Area, which was identified by BOEM as suitable for offshore renewable energy development through a multi-year, public environmental review process. The Projects will be located in the approximately 102,124-acre (413.3-square kilometer [km^2]) BOEM Lease Area OCS-A 0499 (also referred to as the Wind Turbine Area [WTA]) (see Figure 1-1). Project 1 is located in the western portion of the WTA, and Project 2 is located in the eastern portion of the WTA with an Overlap Area that could be used by either Project 1 or Project 2. Figure 1-1 also depicts the boundaries of the Project 1 and Project 2 areas within the WTA.

At its closest point, the WTA is approximately 8.7 miles (mi) (14 kilometers [km]) from the New Jersey shoreline. The WTA will include an array of wind turbine generators (WTGs) and multiple OSSs. The WTA layout is designed to maximize offshore renewable wind energy production while minimizing effects on existing marine uses.

Within the WTA, the WTGs and OSSs for Project 1 and Project 2 will be connected by separate, electrically distinct systems of inter-array cables and/or inter-link cables. Energy from the OSSs will be delivered to shore by export cables that will travel within designed Export Cable Corridors (ECCs) from the WTA through federal and New Jersey state waters to one or two landfall sites on the New Jersey coastline. The Atlantic ECC extends from the western tip of the WTA to the Atlantic Landfall Site in Atlantic City, New Jersey. The Monmouth ECC extends from the eastern corner of the WTA, along the eastern edge of the Lease Area, to the Monmouth Landfall Site in Sea Girt, New Jersey.

From each landfall site, the onshore interconnection cables will travel underground to two new onshore substation and/or converter station sites, and will continue to existing substations where the Projects will be connected into the electrical grid at the Cardiff Substation point of interconnection (POI) in Egg Harbor Township, New Jersey and/or the Larrabee Substation POI in Howell, New Jersey. While both Project 1 and Project 2 will be electrically distinct from each other, both Projects require the ability to interconnect at the two POIs to accommodate the maximum amount of electricity that could be generated by the Projects.



ATLANTIC SHORES offshore wind

Figure 1-1

Atlantic Shores Lease Area OCS-A 0499

Offshore New Jersey

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1.2 Project Design and Construction Activities

This section provides a detailed description of the Projects' facilities (see Figure 1-2), which have been selected for the PDE based on the siting and design evolution process. This section also outlines the Projects' construction sequence and schedule along with a detailed description of the design of each major component of the Projects (e.g., wind turbine generator [WTGs], offshore substations [OSSs], offshore cables, onshore facilities) and the process for construction and installation. This information is summarized from Volume 1 Section 4 of the Construction and Operations Plan (COP), with a focus on elements of the Projects subject to review in the OCS air permit process.

1.2.1 Infrastructure Overview and Schedule

1.2.1.1 Project Design Envelope Overview

The Projects include the following elements:

- Up to 200 WTGs, each with a maximum rotor diameter of approximately 919 feet (ft) (280 meters [m]), will be installed on three main foundation types (piled, suction bucket, and gravity foundations) (see Sections 1.2.2 and 1.2.3).
- A combined maximum of up to 200 wind turbine generators (WTGs) inclusive of the Overlap Area[2]:
  - Project 1: a minimum of 105 WTGs to a maximum of 136 WTGs.
  - Project 2: a minimum of 64 WTGs to a maximum of 95 WTGs.
- Up to 10 small OSSs, up to five medium OSSs, or up to four large OSSs will serve as common collection points for power from the WTGs and also serve as the origin for the export cables that deliver power to shore (see Section 1.2.4).
  - Project 1: up to five small OSSs, two medium OSSs, or two large OSSs.
  - Project 2: up to five small OSSs, three medium OSSs, or two large OSSs.
- Up to 547 miles (mi) (880 kilometers [km]) of High-Voltage Alternating Current (HVAC) inter-array cables will connect strings of WTGs to a shared OSS (see Section 1.2.5).

[2] The number of WTGs in Project 1, Project 2, and the associated Overlap Area will not exceed 200 WTG locations. For example, if Project 1 includes 105 WTGs (the minimum) then the Overlap Area would be incorporated into Project 2 which would include the remaining 95 WTGs; and conversely if the Overlap Area is incorporated into Project 1 such that it includes 136 WTGs, then Project 2 would be limited to 64 WTGs. Each Project may also use only part of the Overlap Area.

    - Project 1: up to 273.5 mi (440 km) of HVAC inter-array cables.
    - Project 2: up to 273.5 mi (440 km) of HVAC inter-array cables.
- Up to 37 mi (60 km) of HVAC inter-link cables may be used to connect OSSs to each other (see Section 1.2.5).
    - Project 1: up to 18.6 mi (30 km) of HVAC inter-link cables connecting to OSSs.
    - Project 2: up to 18.6 mi (30 km) of HVAC inter-link cables connecting to OSSs.
- Up to eight total HVAC and/or High-Voltage Direct Current (HVDC) export cables will be installed in two offshore ECCs, the Atlantic ECC and the Monmouth ECC, that are each approximately 3,300 to 4,200 ft (1,000 to 1,280 m) wide (see Section 1.2.5).
    - The length per cable is approximately 25 mi (40 km) in the Atlantic ECC.
    - The length per cable is approximately 85 mi (138 km) in the Monmouth ECC.
    - Up to one permanent meteorological (met) tower and up to four temporary meteorological and oceanographic (metocean) buoys may be installed within the WTA.
    - Project 1: one permanent met tower and up to three temporary metocean buoys
    - Project 2: up to one temporary metocean buoy
- A proposed new operations and maintenance (O&M) facility in Atlantic City, New Jersey will support the Projects' operations. A communication antenna with a height of up to 120 ft (36.6 m) above ground level may be constructed at the O&M facility, if necessary.
- Existing port facilities in New Jersey, New York, the Mid-Atlantic, New England, the U.S. Gulf Coast, and/or overseas will be used to support the Projects' construction and operations.

1.2.1.2 Project Construction Process and Schedules

The proposed construction schedule is shown in Table 1-1. To maximize construction synergy and efficiency, the construction schedules for Project 1 and Project 2 assumes the same installation teams and equipment (e.g., vessels) will be used to support the construction of both Projects. This strategy will minimize demobilization and remobilization of equipment and crews which will help to reduce construction costs, increase schedule efficiency, and minimize environmental effects (e.g., emissions, vessel transits). This procedure will also provide continuous fabrication in manufacturing facilities to maintain employment and increase productivity. It will also reduce delays in the Federal

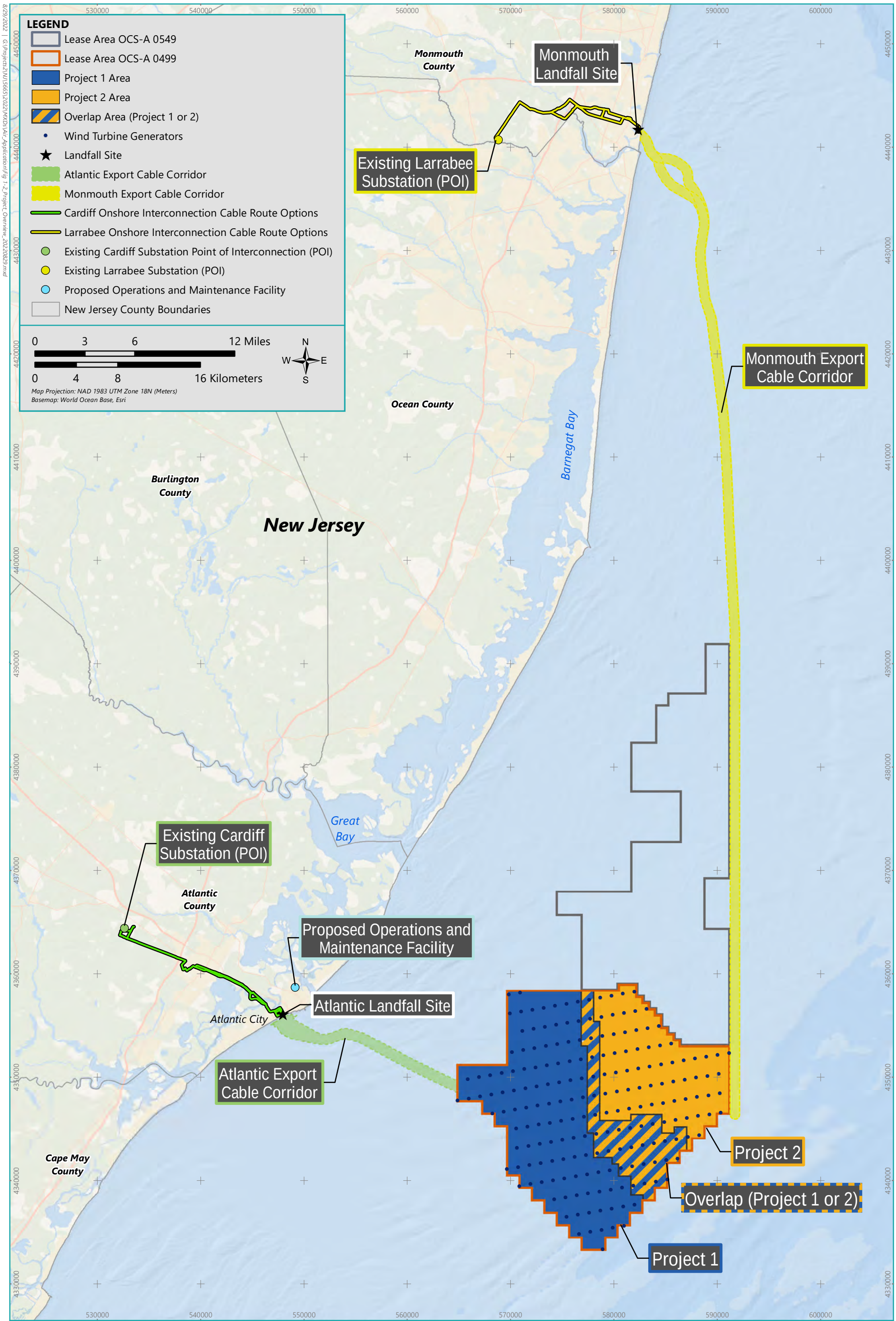

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Figure 1-2
Overview of the Projects

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permitting schedule tied to an individual Project's Final Investment Decision (FID) and allow Atlantic Shores to secure production slots. This strategy would also result in significant benefits to ratepayers, which is a critical component of state Offshore Wind Renewable Energy Certificate (OREC) solicitations.

TABLE 1-1 ANTICIPATED CONSTRUCTION SCHEDULE

ACTIVITY	DURATION[A]	EXPECTED TIMEFRAME[B]	PROJECT 1 START DATE	PROJECT 2 START DATE
ONSHORE INTERCONNECTION CABLE INSTALLATION	9 - 12 MONTHS	2024 - 2025	Q1-2024	Q1-2024
ONSHORE SUBSTATION AND/OR CONVERTER STATION CONSTRUCTION	18 - 24 MONTHS	2024 - 2026	Q1-2025	Q1-2025
EXPORT CABLE INSTALLATION	6-9 MONTHS	2025	Q2-2025	Q3-2025
OSS INSTALLATION AND COMMISSIONING	5-7 MONTHS	2025 - 2026	Q2-2026	Q2-2026
WTG FOUNDATION INSTALLATION[C]	10 MONTHS	2026 – 2027	Q1-2026	Q1-2026[C]
INTER-ARRAY CABLE INSTALLATION	14 MONTHS	2026 - 2027	Q2-2026	Q3-2026[D]
WTG INSTALLATION AND COMMISSIONING	17 MONTHS	2026 - 2027	Q2-2026	Q1-2027[D]

Notes:

a. These durations assume continuous installation without consideration for seasonal pauses or weather delays; anticipated seasonal pauses are reflected in the expected timeframe.

b. The expected timeframe is indicative of the most probable duration for each activity; the timeframe could shift and/or extend depending on the start of fabrication, fabrication methods, and installation methods selected.

c. The expected timeframe depends on the foundation type. If piled foundations are utilized, pile-driving will follow a proposed schedule from May to December to minimize risk to North Atlantic Right Whale. No simultaneous pile driving is proposed.

d. The expected timeframe is dependent on the completion of the preceding Project 1 activities (i.e., Project 1 inter-array cable installation and WTG installation) and the Project 2 foundation installation schedule.

As shown in Figure 1-3, construction of each Project will initiate with the onshore facilities, including the onshore substations and/or converter stations and onshore interconnection cables. The onshore facilities for each Project will be constructed first so that power from the electrical grid can be used to energize, commission, and maintain each Project's offshore facilities (e.g., the OSSs and WTGs) as soon as possible after their installation. Construction of the offshore facilities is expected to begin with installation of the export cables and the WTG and OSS foundations (including scour protection). Once the OSS foundations are installed, the topsides can be installed and commissioned, and the inter-

link cables (if used) can be installed. At each WTG position, after the foundation is installed, the associated inter-array cables and WTGs can be installed (if WTGs are not installed onto gravity-base structure [GBS] foundations at port). Given the number of WTG and OSS positions, there is expected to be overlap in the various equipment installation periods, though the different activities will be spread out across the WTA. Installation of the Projects' onshore and offshore facilities may occur over a period of up to 3 years (to accommodate weather and/or seasonal work restrictions); offshore construction is expected to last approximately 2 years.

Notably, the first establishment of an OCS source in Figure 1-3 is at the fourth step. The OSS topside installation may or may not establish an OCS source (as it may or may not use a jack-up vessel). OSS commissioning will use diesel generators on the OSS, which will establish an OCS source. As discussed in Section 3 of this application, activities that precede the establishment of an OCS source are not subject to OCS permitting.

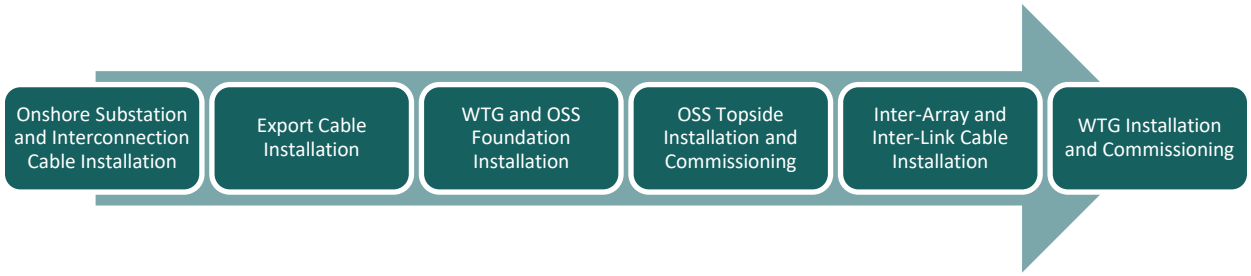


Figure 1-3 General Project Construction Sequence

High resolution geophysical and geotechnical surveys will be conducted to verify site conditions prior to offshore construction and geophysical surveys will be conducted post-construction to ensure proper installation of the components of each Project. Environmental monitoring surveys will be conducted pre-construction, during construction, and post-construction to support the assessment of the Projects' potential effects. The environmental monitoring survey plans are being developed in consultation with federal, state, and local agencies, non-governmental organizations, and other relevant stakeholders and may be conducted as part of regional monitoring initiatives.

1.2.2 Wind Turbine Generator Foundations

The WTG foundations will provide a robust, stable, and level base for the WTG towers. The foundations will also provide personnel access (via boat landings, ladders, and work platforms), contain aids to navigation in accordance with United States Coast Guard (USCG) and the Bureau of Ocean Energy Management (BOEM) requirements, include a

crane for transferring materials and equipment, and house electrical equipment. The PDE includes three categories of WTG foundations that may be affixed to the seabed using piles, suction buckets, or gravity:

1. Piled foundations: monopiles or piled jackets;
2. Suction bucket foundations: mono-buckets, suction bucket jackets, or suction bucket tetrahedron bases; and
3. Gravity foundations: GBS or gravity-pad tetrahedron bases.

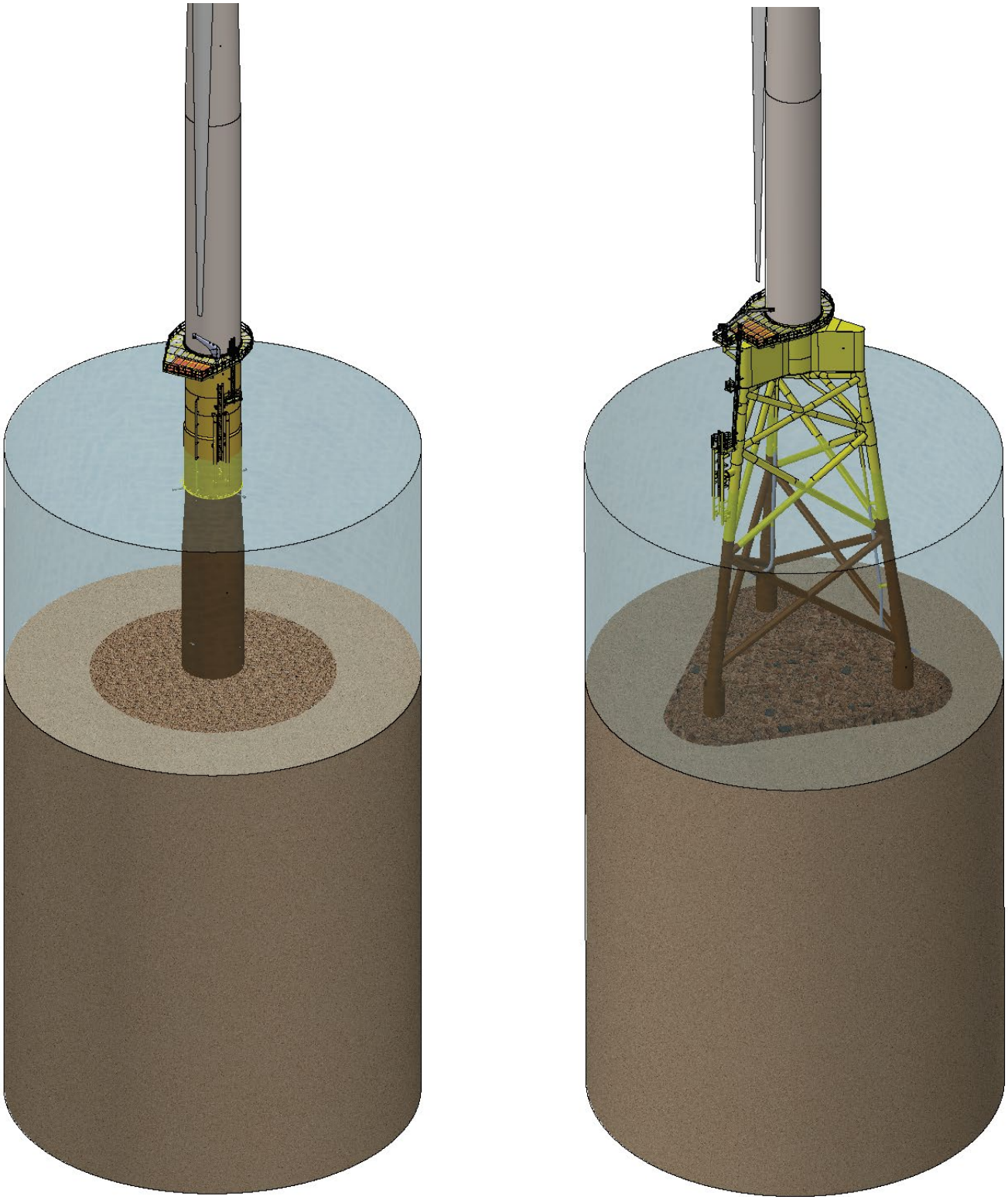
This OCS air application focuses on the use of piled foundations, because those involve the most activity in the WTA and the highest air emissions associated with OCS sources.

1.2.2.1 Piled Foundations

The PDE for the Projects includes two sub-types of piled foundations.

- **Monopiles:** Monopile foundations, which are driven into the seabed, typically consist of a single steel tube composed of several sections of rolled steel plates that are welded together. A transition piece may be mounted on top of the monopile (see Figure 1-4). Alternatively, the monopile length may be extended to the interface with the WTG tower; this is referred to as an "extended monopile." The transition piece or the top of the extended monopile contains a flange for connection to the WTG tower and may include secondary structures such as a boat landing, ladders, a work platform, a crane, and other ancillary components. If a transition piece is used, it will be secured to the monopile via bolts, grout, a slip joint, and/or other mechanical joint connections. The monopile's top diameter and transition piece's bottom diameter are sized based on site-specific environmental and functional loads. The upper outer diameter of the transition piece is identical to the WTG tower's bottom diameter.

- **Piled jackets:** Piled jacket foundations are steel lattice structures comprised of tubular steel members and welded joints that are fixed to the seabed using piles connected to each leg of the jacket (see Figure 1-4). Piled jacket foundations may include three or four legs. Typically, piles are hollow steel cylinders that are driven into the seabed. The top of the jacket foundation contains a flange for connection to the WTG tower as well as secondary structures such as a boat landing, ladders, a work platform, a crane, and other ancillary components.



Monopile **Piled Jacket**

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Figure 1-4
Piled Foundations

The Projects' monopiles or piled jacket components may be fabricated either in the U.S. or overseas and will be delivered either directly to the WTA or to a marshalling port for final assembly and staging. If storage at a marshalling port is required, equipment such as crawler cranes or self-propelled modular transporters (SPMTs) will be used to unload and transport foundations within the marshalling port. Depending on the location of fabrication and any subsequent staging activities, foundation components may be transported to the marshalling port or WTA by heavy transport vessels (HTVs), ocean-going barges, jack-up feeder vessels, or smaller feeder barges towed by local tugboats.

Monopile and piled jacket design and installation methods may require seabed preparation prior to installation (see Section 1.2.2.2). Scour protection may be required and would be installed at the base of the monopiles or piled jackets (see Section 1.2.2.3).

At the WTA, piled foundations will be installed using one or two jack-up vessels or heavy-lift vessels (HLVs) using dynamic positioning (DP) or anchoring. At each foundation location, a crane on the installation vessel will lift the monopile or each piled jacket component from the transportation vessel into a vertical position and lower it to the seabed (see Figure 1-5).

Jacket foundations may have either pre-installed piles or post-installed piles. If pre-installed, a template will be used to properly position the piles so they can be driven into the seabed before the jacket arrives at the WTA. The jacket will then be lifted by a vessel crane and set directly onto the installed piles. If post-installed, a vessel crane will lift the jacket foundation and place it on the seabed, after which pin piles will be driven through the jacket's pile sleeves to secure it in place. Mud mats may be used for piled jackets during installation to support the jacket during piling.

Once the monopile or jacket pin pile is lowered to the seabed, the weight of the pile itself will cause the pile to sink a distance into the seabed (but not to target penetration depth). With the pile resting on the seabed, the crane will release the pile and place a hydraulic hammer atop the pile in preparation for pile-driving. The maximum expected hammer size for installation of monopiles is up to 4,400 kilojoules (kJ) whereas the maximum expected hammer size for jacket pin piles is 2,500 kJ. It is anticipated that it will take a maximum of 7 to 9 hours to drive one monopile and that a maximum of 2 monopiles could be driven per day per vessel. For jackets, it is expected that the maximum installation rate will enable installation of all pin piles for a single jacket foundation (i.e., three or four piles) per day.

During pile driving, a gripper frame may be used to stabilize the foundation for piling. A vibratory pile driver may also be used at the beginning of pile driving to support embedment of the pile until it is stable enough for pile driving.

Pile Driving of a Monopile

Transition Piece Installation from a Jack-Up Vessel

Monopile Transport via Tugboat and Barge

Pile Driving of a Jacket Pile

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Figure 1-5

Piled Foundation Transportation and Installation

Following installation of a monopile, a vessels' crane will lift the transition piece (if used) onto the monopile, and the joint will be secured with grout, bolts, a slip joint, other mechanical joint, or a combination of these methods. If used, grout will be mixed onboard a vessel and pumped into the transition piece above a high-strength rubber grout seal to avoid leakage.

For jacket foundations, once the pin piles are driven to their target depths, the installation vessel will ensure the foundation is level and the piles will be fixed in place with grout. Grout will fill each pile sleeve, but the procedure will be monitored to ensure that grout does not spill over the sleeve. For both monopile and jacket foundations, proper grouting procedures will be utilized to minimize any overflow.

1.2.2.2 Seabed Preparation

In general, foundations will be positioned or sized to avoid or reduce seabed preparation where possible. Seabed preparation involves removing the uppermost sediment layer to establish a level surface, remove any surficial sediments that are too weak to support the planned structure, and enable full contact between the foundation's base and the seafloor. This is necessary to ensure that the foundation remains vertical, and its weight is uniformly distributed.

1.2.2.3 Scour Protection

Scour protection may be installed at the base of each foundation to protect it from sediment transport/erosion caused by water currents. The presence of foundations can create locally higher currents around the structures, which scour protection can withstand.

The PDE includes six types of scour protection: Rock placement; Rock bags; Grout- or sand-filled bags; Concrete mattresses; Ballast-filled mattresses; and mattresses with fronds (which are designed to replicate how natural seaweed reduces water velocity locally. Scour protection with rock is used in the air emissions calculations and modeling, as the most likely type.

Scour protection consisting of freely-laid rock will likely be installed by a fallpipe vessel, which uses a pipe that extends to just above the seafloor to deposit rock contained in the vessel's hopper in a controlled manner. Concrete mattresses, rock bags, grout- or sand-filled bags, and frond mattresses will likely be deployed by a vessel's crane.

All scour protection options considered for the Projects were screened for technical and economic suitability. The need for and selected type(s) of scour protection will be determined by the final design of the foundations and ongoing agency consultations.

1.2.3 Wind Turbine Generators

1.2.3.1 WTG Design

The Projects' WTGs are expected to follow the traditional offshore WTG design comprised of a three-bladed rotor nacelle assembly (RNA) mounted on a tower structure affixed to a foundation. The rotor will drive a variable speed electric generator. The WTG will sense the direction of the wind using integrated sensors and will automatically turn into the wind by activating the yaw system. The WTG will also adjust the blades continuously during operation to maximize power production and maintain safe operating limits. The drivetrain, electric generator, yaw system, control system, and power electronics are enclosed in a nacelle, which provides protection from the weather as well as lightning protection.

The WTG power system (i.e., the power converter, transformers, and switchgear) converts the voltage and frequency of the power produced by the WTG's generator to the inter-array cables' voltage (66 to 150 kilovolts [kV]) and electrical grid's frequency, reduces harmonics, and provides reactive power control.

The WTG control and protection system monitors environmental and operational parameters to keep equipment within design limits. Heating and cooling systems regulate the temperature of each component and lubrication systems keep components corrosion-free and rotating smoothly. The control and protection system monitors the WTG and protects equipment and personnel by providing automatic shutdown and alarms. The system also includes fire detection, overheating, overpower, and overspeed protection.

All WTGs in the Projects will be connected to the central supervisory control and data acquisition (SCADA) system for remote monitoring and control. The SCADA system allows remote operators to track the operation and performance of all Project assets from a single system, to store long-term data, and to access short-term high-resolution data for fault troubleshooting. It also allows functions such as remote testing, software updates, parameter updates, and WTG shut down for maintenance or at the request of grid operators, regulators, or search and rescue (SAR) teams. Individual WTGs can be controlled manually from within the nacelle or tower base for commissioning and maintenance activities.

The WTG can be accessed for commissioning and maintenance from the platform on the WTG foundation via a locked door in the tower base. WTGs are equipped with an elevator, ladders, and other access routes that enable the movement of maintenance personnel, small equipment, and small spare parts inside the tower and RNA. A helihoist platform on top of the nacelle can be used for technician access and for evacuation. To facilitate maintenance, the WTGs will be equipped with auxiliary cranes in the nacelle and on the external working platform.

An uninterruptible power supply (UPS) will power the control and protection system in case of a grid outage to enable safe shut down of the WTG and saving operational data. Additional back-up power systems (e.g., WTG self-power feature, portable generators, and/or battery systems) may be utilized to provide power for commissioning or for storm protection in the event of a longer-term grid outage.

All WTG components will be designed to comply with relevant health, safety, security, and environmental protection (HSSE) standards and regulations. During construction and operation, the WTGs (and their foundations) will be lit and marked in accordance with Federal Aviation Administration (FAA), USCG, and BOEM guidelines to aid safe navigation within the WTA.

The PDE of WTG dimensions is illustrated in Figure 1-6. The WTG dimensions are indicative of the maximum dimensions of WTGs anticipated to be commercially available within the Projects' expected development schedule. The PDE of WTG dimensions provides Atlantic Shores with flexibility in WTG choice, which is necessary to ensure that anticipated advancements in available WTG technology can be incorporated into the Projects' final design.

The WTGs will be designed according to site-specific conditions, including winter storms, hurricanes, and tropical storms, based on industry standards such as American Clean Power Association (ACP), International Electrotechnical Commission (IEC), American Petroleum Institute (API), and International Organization for Standardization (ISO) standards. The WTGs are expected to produce power at wind speeds between approximately 9.8 and 101 feet per second (ft/s) (3 and 31 m/s), although the WTGs' exact environmental operating conditions will depend on vendor and WTG model. WTGs will automatically shut down in wind speeds above the WTGs' maximum operational limit.

1.2.3.2 WTG Installation

WTG components are expected to be manufactured in the U.S. or overseas and shipped, if needed, to a U.S. marshalling port. At the marshalling port, WTG components will be offloaded, stored, pre-assembled, and prepared for load-out. The WTG components (i.e., blades, nacelles, and towers) will be delivered in suitable transport and lifting frames to facilitate loading, offloading, storage, and installation. The components will be offloaded using shore-based equipment (e.g., cranes and SPMTs) and will be inspected for damage before being transported from quayside to storage. Storage will ensure a constant supply of WTGs to the assembly location or the WTA.

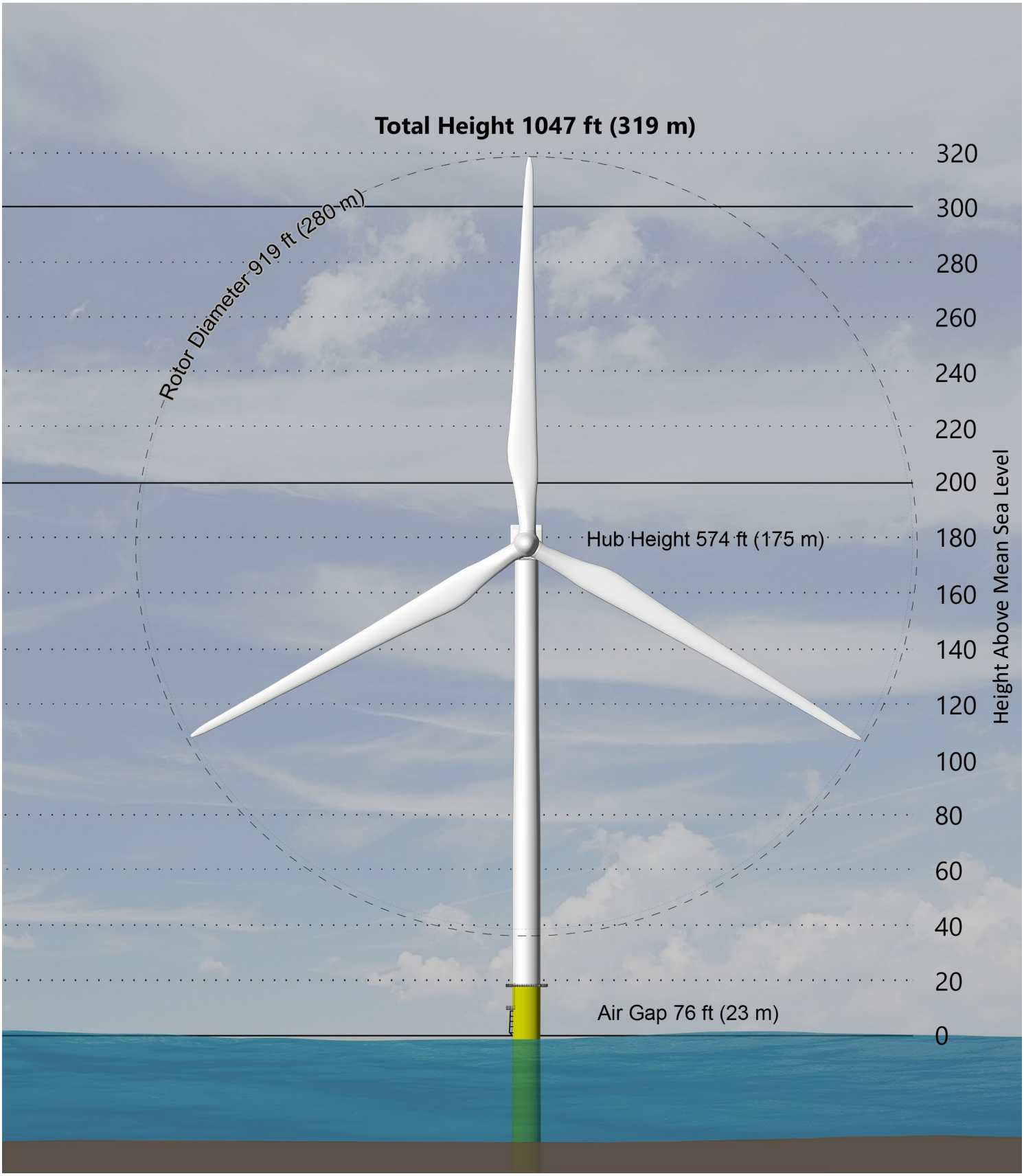

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Figure 1-6
Wind Turbine Generator PDE

The WTG components may be pre-assembled at the marshaling port. Blades are typically transported and stored in racks and minimal pre-assembly is required.

Offshore installation of WTGs is expected to involve a jack-up WTG installation vessel assisted by feeder barges or jack-up feeder vessels. The jack-up WTG installation vessel will be equipped with a crane to lift WTG components from the feeder barges/vessel onto the foundation (see Figure 1-7).

1.2.3.3 WTG Commissioning

Following installation, the WTGs will be energized from the grid through the inter-array cables or with a temporary power supply. Then, the commissioning process will prepare WTGs for operation. The purpose of commissioning is to test electrical connections, safety and control functions of the WTG (e.g., emergency stop, auto restart, etc.), and the communication between the WTG and the SCADA system. It is likely that installed WTGs will undergo commissioning and testing while other WTGs are still being installed. Once commissioning is completed, a test run (i.e., trial operation) is carried out (typically for 240 hours) to demonstrate that the WTG performs as expected and is reliable. During commissioning and testing, personnel may be transported to and from WTGs via service operation vessels (SOVs), crew transfer vessels (CTVs), and/or helicopters.

1.2.4 Offshore Substations

The Projects will include one or more OSSs that serve as common collection points for power from the WTGs and also serve as the origin for the export cables that deliver power to shore. Atlantic Shores is considering three sizes of OSS. Depending on the final OSS design, there will be up to 10 small OSSs, up to five medium OSSs, or up to four large OSSs in the Projects combined. There will be up to five small OSSs, two medium OSSs, or two large OSSs for Project 1; and up to five small OSSs, three medium OSSs, or two large OSSs for Project 2.

OSSs will be located along the same east-northeast to west-southwest rows as the WTGs; small OSSs will be located no closer than 12 miles (mi) (19.3 km) from shore whereas medium and large OSSs will be located at least 13.5 mi (21.7 km) from shore. Potential OSS locations for both Projects are shown on Figure 1-8.

Transport of WTG Components via Jack-Up Vessel

Installation of WTG Component using Jack-Up Vessel Crane

Figure 1-7
Representative WTG Transportation and Installation

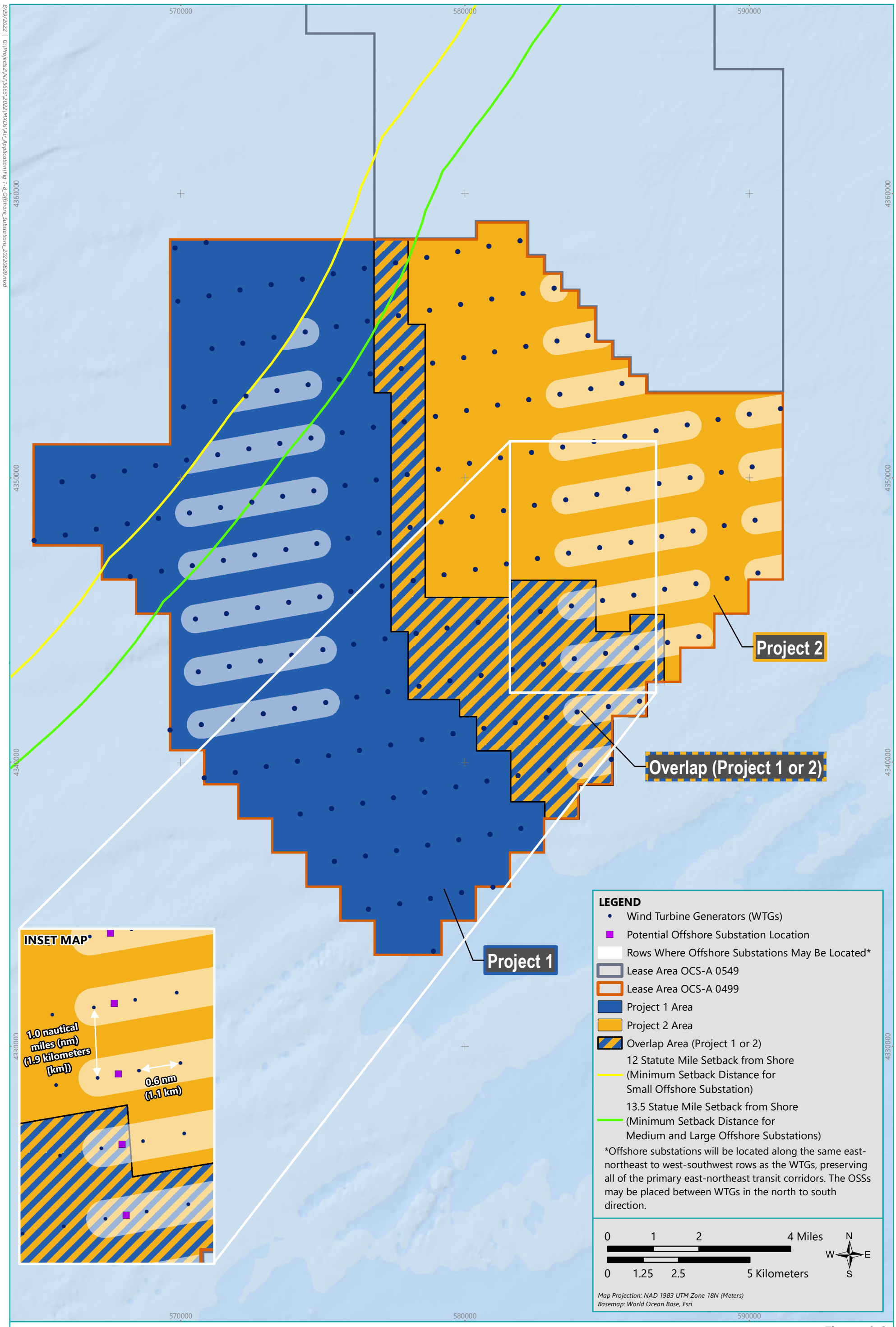

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Figure 1-8

Offshore Substation Locations

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1.2.4.1 OSS Foundation Design and Installation

Similar to the WTG foundations, the PDE includes three categories of OSS foundations that may be affixed to the seabed using piles, suction buckets, or gravity. The type of OSS foundation used depends on the size of the OSS itself (see Table 1-2).

TABLE 1-2 OSS FOUNDATION TYPES

FOUNDATION TYPES		SMALL OSS	MEDIUM OSS	LARGE OSS
PILED	MONOPILE	●		
	PILED JACKET	●	●	●
SUCTION BUCKET	MONO-BUCKET	●		
	SUCTION BUCKET JACKET	●	●	●
GRAVITY	GBS	●	●	●

These foundation types are similar to those under consideration for the WTGs, although tetrahedron base foundations are not included in the OSS foundation PDE. There could be up to 10 small OSSs, which would have foundations similar to WTGs. The air emissions estimates and modeling analyses in this OCS application use the piled foundation case, as having the most local air quality impacts.

1.2.4.2 Topside Design, Installation, and Commissioning

Power generated by the WTGs will be transmitted to the OSSs via 66 kV to 150 kV inter-array cables, which will connect to circuit breakers and transformers located within the OSS topsides. These transformers will increase the voltage level to the export cable voltage (230 kV to 525 kV). From the OSSs, the export cables will transmit electricity to shore. .

The PDE of OSS topside parameters is provided in Table 1-3.

TABLE 1-3 PDE OF OSS TOPSIDE DIMENSIONS

TOPSIDE PARAMETER	SMALL OSS	MEDIUM OSS	LARGE OSS
MAX. # OF OSSS	10	5	4
MAX. WIDTH	114.8 FT (35.0 M)	147.6 FT (45.0 M)	164.0 FT (50.0 M)
MAX. LENGTH	131.2 FT (40.0 M)	213.3 FT (65.0 M)	295.3 FT (90.0 M)
MAX. HEIGHT ABOVE FOUNDATION INTERFACE	98.4 FT (30.0 M)	114.8 FT (35.0 M)	131.2 FT (40.0 M)
MAX. HEIGHT OF TOPSIDE ABOVE MLLW	174.8 FT (53.3 M)	191.2 FT (58.3 M)	207.6 FT (63.3 M)

The OSSs will be designed according to site-specific conditions, including winter storms, hurricanes, and tropical storms, based on industry standards such as ACP, IEC, API, and ISO standards.

Although the precise electrical equipment contained in the OSS topsides will be determined as the engineering design advances, each OSS will contain power transformers, which will vary in size depending on the type of OSS (HVAC or HVAC/HVDC) and electrical capacity. The OSS topsides are also expected to include:

- switchgear
- transformers
- control and communications equipment
- shunt reactors
- fire detection and firefighting equipment (e.g., inert gas and/or water/foam systems)
- cranes
- safety equipment (e.g., life rafts or boats, lifejackets)
- freshwater storage
- clean water wash system
- UPS system and associated batteries
- backup diesel generator
- diesel fuel storage
- utility pumps for systems such as freshwater, diesel fuel, and cooling.
- oil containment

Lightning masts or air terminals will be installed on OSS topsides to protect electrical equipment and personnel. Heating, ventilation, and air conditioning systems will be installed in the OSS to regulate equipment temperatures.

During construction and operation, the OSSs will be lighted and marked in accordance with FAA, USCG, and BOEM guidelines to aid safe navigation within the WTA.

The OSS topsides are expected to be fabricated outside of the U.S. and transported directly to the WTA on the installation vessel, a HTV, or ocean-going barge. Although unlikely, if an OSS is staged at a U.S. port prior to installation, shore-based equipment such as crawler cranes and SPMTs would unload the OSS topside and transport it to port storage. Then, the OSS topside would be loaded onto a vessel to be transported to the WTA for installation. Once at the WTA, the OSS topsides are expected to be lifted from the transport vessel onto the OSS foundation using a crane on a jack-up vessel or HLV using either dynamic positioning (DP) or anchors.

Alternatively, the OSS topsides may be pulled by tugboats and floated to the WTA, after which the topsides would be ballasted down over an installed OSS foundation or jack-up legs integrated into the topside would lower to the seabed and raise the topside to its target elevation.

The emissions calculations and modeling analysis in this OCS air application are based on topside installation using an HLV using DP.

After the OSS topside is secured to its foundation, the OSS will be commissioned. During commissioning, the electrical and safety systems on the OSS will be tested and the OSS will be energized. A jack-up vessel or floating vessel may be used to provide accommodations for the personnel commissioning the OSSs.

1.2.4.3 Seabed Preparation and Scour Protection

As with WTG foundations, OSS foundations (particularly gravity foundations), may require seabed preparation (i.e., removing the uppermost sediment layer beneath the foundation). Scour protection may be installed at the base of each OSS foundation to protect it from sediment transport/erosion caused by water currents.

1.2.5 Offshore Cables

Each Project will include offshore export, inter-array, and possibly inter-link cables (the "offshore cables"). The export cables will deliver electricity from the Project OSSs to the landfall sites. The inter-array cables will connect strings of WTGs to an OSS and interlink cables could be used to connect OSSs to each other. As each Project will be electrically distinct none of the offshore cables will be shared between Projects. The export cables from each Project will however have the potential to utilize either ECC or be co-located in the same ECC.

1.2.5.1 Pre-Installation Activities

Activities that will be conducted prior to cable installation include sand bedform clearing, relocation of boulders if needed, a pre-lay grapnel run, and a pre-lay survey.

1.2.5.1.1 Sand Bedform Removal

The expected presence of mobile sand bedforms (i.e., ripples, megaripples, and sand waves) within the ECCs and WTA may necessitate the removal of the tops of some sand bedforms prior to offshore cable installation to ensure the cables can be installed within stable seabed. Sand bedform removal will be limited only to the extent required to achieve adequate cable burial depth. Project engineers estimate that up to 20% of the export cable routes, 10% of the inter-array cable routes, and 20% of the inter-link cable routes may require sand bedform removal.

Sand bedform removal is expected to be completed with trailing suction hopper dredge (TSHD), controlled flow excavation, route clearance plow, cutterhead dredging, or backhoe dredging.

1.2.5.1.2 Pre-lay Grapnel Run

Within approximately two months prior to cable installation, Atlantic Shores will perform a pre-lay grapnel run to clear the final cable alignments of human-made obstructions/debris such as discarded fishing wires, nets, or ropes. To complete the pre-lay grapnel run, a vessel will tow an approximately 3.3 ft-wide (1 m-wide) grapnel train consisting of a series of hooks designed to snag debris. Measuring tension on the grapnel train towing rope will indicate whether debris is caught on the hooks. Atlantic Shores expects to make three passes with the grapnel train along each cable alignment. The first pass will likely be placed on the centerline of the cable alignment and the remaining two passes will occur parallel to and slightly offset from the centerline (within approximately 25 ft [7.5 m] to each side). The pre-lay grapnel runs will impact the seafloor to a maximum depth of 1.6 ft (0.5 m), subject to prevailing sediment conditions.

1.2.5.2 Cable Installation

The export cables, the inter-array cables, and any inter-link cables will be transported to the WTA or ECCs via one of two methods: direct or marshalled. Since the cables will likely be manufactured outside the U.S., the direct method of delivery is expected to involve a cable installation vessel being loaded at the factory or port and sailing to the Offshore Project Area to complete the cable installation. In this scenario, it is possible that the same vessel will sail back to its origin, obtain the next load of cable, and return to the WTA or ECC to complete the installation; alternatively, a second cable installation vessel could sail from the origin.

The marshalled method would have a similar first step consisting of a cable installation vessel sailing from its origin to the Offshore Project Area to install the first batch of cable. Meanwhile, a subsequent batch of cable would be loaded onto a freighter that would sail to a U.S. port where the cable would be spooled onto a carousel located onshore and stored quayside. Alternatively, the cables can be transported on pre-wound drums that are unloaded and transported into quayside storage using heavy lift cranes or SPMTs. After the first batch of cable is installed, the installation vessel would load the remaining batches from the U.S. port and install them in the Offshore Project Area. Inter-array and inter-link cables are lighter and easier to handle than the export cables, making staging at a U.S. port prior to installation more likely.

Three common methods may be used to lay and bury the export cables, inter-array cables, and/or inter-link cables:

- **Simultaneous lay and burial:** This is a combined process where the cable will be directly guided from the cable installation vessel through the burial tool and laid into the seabed. This approach will provide immediate protection of the cable following installation but is slower than laying cable with other methods depending on the tool employed (see the description of each tool below for installation speeds). Atlantic Shores expects to use simultaneous lay and burial to install the export cables.
- **Post-lay burial:** This process involves temporarily laying the cable onto the seabed followed by a subsequent, separate burial operation. With post-lay burial, the cables lie unprotected on the seabed between the laying and post-lay burial campaigns. Post-lay burial is especially appropriate for inter-array cables where the cables are buried close to WTG or OSS foundations and are relatively short lengths. Cable-laying without simultaneous burial could proceed at a rate of 985 to 1,970 ft per hour (300 to 600 m per hour). Post-lay burial can proceed at a faster burial rate than simultaneous lay and burial (see the description of each tool below for installation speeds) and is appropriate for the sediment types in the WTA. In particular, post-lay burial is expected to be used for the inter-array and inter-link cables because it allows them to be buried to their target depth closer to the foundations and facilitates performing multiple passes with the burial tool (where needed), hence minimizing the need for cable protection. Post-lay burial also results in a shorter duration of burial, thus minimizing the duration of cable installation impacts. Post-lay burial is not proposed as a primary installation technique for the export cables due to the longer lengths of export cables compared to the inter-array cables that would remain exposed, which would temporarily preclude other marine uses from the ECCs.
- **Pre-lay trenching:** This process involves excavating a trench prior to cable installation. The trench must remain clear before the cable is laid into the trench. Once the cable is laid, the trench is backfilled with spoils from the previous excavation. For the offshore cables, this technique is only expected to be used in

limited circumstances where deeper cable burial (greater than the target depth of 5 to 6.6 ft [1.5 to 2 m]) may be required or firmer ground (such as clays or dense sands) is encountered.

An anchored cable laying vessel may be used in shallow portions of the ECCs; no anchoring is expected in the WTA.

To install an inter-array cable, a cable-laying vessel will first pull the end of an inter-array cable into a WTG or OSS foundation, then lay the cable along the route to the next WTG, where the second cable end will be pulled into the WTG or OSS foundation. The vessel will repeat the process until all WTGs in a string are connected to a single OSS. If post-lay burial is used, a cable burial vessel will then progress along the laid strings of inter-array cables, burying them to target depth. If simultaneous lay and burial is used, the cables will be installed to the target depth in a single operation. If inter-link cables are included in the Projects' final design, the same process will apply to inter-link cables, except these cables will connect OSSs to one another rather than to strings of WTGs.

1.2.5.3 Cable Protection

Cable protection may be necessary if sufficient burial depth cannot be achieved (e.g., due to sediment properties or a cable joint). While Atlantic Shores will work to minimize the amount of cable protection required, it is conservatively assumed that up to 10% of the export cables, inter-array cables, and inter-link cables may require cable protection where sufficient burial depth is not achieved.

Atlantic Shores is considering the use of five types of cable protection: Rock placement; Concrete mattresses; Rock bags; Grout-filled bags; and Half-shell pipes. One or more of these types of cable protection may be used. Cable protection consisting of freely-laid rock can be installed by a fallpipe vessel, a vessel's crane, or side dumping from a vessel. If freely-laid rock is used, the fallpipe installation method, which is the most accurate technique, will be used wherever possible. Concrete mattresses, rock bags, and grout-filled bags will likely be deployed by a vessel's crane. Hall-shell pipes are expected to be installed around the cable on board the cable laying vessel prior to installing the cable.

The emission calculations and modeling evaluation in this OCS application assume the use of rock placement.

1.2.6 Proposed Construction Vessels

The following discussion summarizes the vessels expected to be used during offshore construction. Vessels intended for use in O&M activities are described in Section 1.3.3. Construction of the offshore portion of the Projects will require use of many different types of vessels. Some of these vessels are typical ocean-going vessels, while others are purpose-built to perform specific tasks related to construction of offshore wind and/or buried cable installation. Alongside these vessels, helicopters are sometimes used for crew transfer operations and may also be used for visual inspection of equipment while vessels continue with installation activities. Atlantic Shores may also use fixed-wing aircraft to support environmental monitoring and mitigation.

Offshore construction will be divided into different campaigns including foundation installation, scour protection installation, OSS installation, WTG installation, inter-array cable installation, inter-link cable installation (if needed), and export cable installation. While performing construction tasks, vessels may anchor, jack-up, or maintain their position using DP systems. DP systems use a continually-adjusting propulsion system to keep the vessel steady in a single location. Jack-up vessels have legs that lower into the seabed and brace the vessel as it elevates above sea level, where it can safely perform operations in a stable, elevated position.

Atlantic Shores has not yet selected the specific vessels that will carry out construction activities. For the purposes of this OCS air application, representative vessel types are presented rather than specific vessels, and vessel specifications such as length, width, and speed are based on typical ranges for each type of vessel. Because the number of vessels and the number of vessel trips depend on the specific vessels used, estimates were generated using sample vessels and preliminary Project plans. Currently anticipated vessel types are shown in Table 1-4.

TABLE 1-4 REPRESENTATIVE OFFSHORE CONSTRUCTION VESSELS

ROLE	VESSEL TYPE	APPROX. LENGTH	APPROX. WIDTH
Foundation Installation			
FOUNDATION INSTALLATION	BULK CARRIER	722-755 FT (220-230 M)	66-82 FT (20-25 M)
	MEDIUM HEAVY LIFT VESSEL	591-722 FT (180-220 M)	131-164 FT (40-50 M)
	JACK-UP VESSEL	591-607 FT (180 – 185 M)	197 FT (60 M)

TABLE 1-4 REPRESENTATIVE OFFSHORE CONSTRUCTION VESSELS (CONTINUED)

ROLE	VESSEL TYPE	APPROX. LENGTH	APPROX. WIDTH
Foundation Installation			
BUBBLE CURTAIN SUPPORT VESSEL	TUGBOAT	230-246 FT (70 – 75 M)	49-66 FT (15 – 20 M)
TRANSPORT BARGE	BARGE	394-410 FT (120 – 125 M)	98-115 FT (30 – 35 M)
TOWING TUGBOAT	TUGBOAT	98-115 FT (30 – 35 M)	33-49 FT (10 – 15 M)
SUPPORT VESSEL	SERVICE OPERATION VESSEL	295-344 FT (90 – 105 M)	49-66 FT (15 – 20 M)
CREW TRANSFER AND NOISE MONITORING	CTV	82-98 FT (25 – 30 M)	30-33 FT (9 – 10 M)
OSS Installation			
OSS INSTALLATION	LARGE HEAVY LIFT VESSEL	640-656 FT (195 – 200 M)	279-295 FT (85 – 90 M)
	MEDIUM HEAVY LIFT VESSEL	591-722 FT (180 – 220 M)	131-164 FT (40-50 M)
BUBBLE CURTAIN SUPPORT VESSEL	TUGBOAT	230-246 FT (70 – 75 M)	49-66 FT (15 – 20 M)
TRANSPORT BARGE	BARGE	394-410 FT (120 – 125 M)	98-115 FT (30 – 35 M)
TOWING TUGBOAT	TUGBOAT	98-115 FT (30 – 35 M)	33-49 FT (10 – 15 M)
ASSISTANCE TUGBOAT	TUGBOAT	230-246 FT (70 – 75 M)	49-66 FT (15 – 20 M)
CREW TRANSFER AND NOISE MONITORING	CTV	82-98 FT (25 – 30 M)	30-33 FT (9 – 10 M)
Scour Protection			
SCOUR PROTECTION INSTALLATION	FALL PIPE VESSEL	623-640 FT (190 – 195 M)	131-148 FT (40 – 45 M)
DREDGING	DREDGER	640-656 FT (195 – 200 M)	131-148 FT (40 – 45 M)

TABLE 1-4 REPRESENTATIVE OFFSHORE CONSTRUCTION VESSELS (CONTINUED)

ROLE	VESSEL TYPE	APPROX. LENGTH	APPROX. WIDTH
WTG Installation			
WTG INSTALLATION	JACK-UP VESSEL	591-607 FT (180 – 185 M)	197 FT (60 M)
TOWING TUGBOAT	TOWING TUGBOAT	98-115 FT (30 – 35 M)	33-49 FT (10 – 15 M)
FEEDER VESSEL	JACK-UP FEEDER	407-410 FT (124-125 M)	128-131 FT (39-40 M)
	BARGE	394-410 FT (120 – 125 M)	98-115 FT (30 – 35 M)
	HARBOR TUGBOAT	98-115 FT (30 – 35 M)	33-49 FT (10 – 15 M)
WTG COMMISSIONING AND CREW TRANSFER	SERVICE OPERATION VESSEL	295-344 FT (90 – 105 M)	49-66 FT (15 – 20 M)
	CTV	82-98 FT (25 – 30 M)	30-33 FT (9 – 10 M)
Inter-Array Cable Installation			
CABLE INSTALLATION	CABLE INSTALLATION VESSEL	246-541 FT (75 – 165 M)	82-115 FT (25 – 35 M)
SUPPORT VESSEL	SERVICE OPERATION VESSEL	295-344 FT (90 – 105 M)	49-66 FT (15 – 20 M)
CABLE BURIAL VESSEL	CABLE INSTALLATION VESSEL	246-541 FT (75 – 165 M)	55-115 FT (17 – 35 M)
DREDGING	DREDGER	640-656 FT (195 – 200 M)	131-148 FT (40 – 45 M)
ANCHOR HANDLING TUG SUPPLY (AHTS) VESSEL	AHTS	246-262 FT (75 – 80 M)	49-66 FT (15 – 20 M)
ROCK DUMPING VESSEL	FALL PIPE VESSEL	623-640 FT (190 – 195 M)	131-148 FT (40 – 45 M)

TABLE 1-4 REPRESENTATIVE OFFSHORE CONSTRUCTION VESSELS (CONTINUED)

ROLE	VESSEL TYPE	APPROX. LENGTH	APPROX. WIDTH
Export Cable Installation			
CABLE INSTALLATION	CABLE INSTALLATION VESSEL	246-541 FT (75 – 165 M)	82-115 FT (25 – 35 M)
SUPPORT & JOINTING VESSEL	SUPPORT VESSEL	312-328 FT (95 – 100 M)	66 FT (20 M)
DREDGING	DREDGER	640-656 FT (195 – 200 M)	131-148 FT (40 – 45 M)
AHTS VESSEL	AHTS	246-262 FT (75 – 80 M)	49-66 FT (15 – 20 M)
ROCK DUMPING VESSEL	FALL PIPE VESSEL	640-656 FT (195 – 200 M)	131-148 FT (40 – 45 M)
Fuel Bunkering			
TOWING TUGBOAT	TOWING TUGBOAT	98-115 FT (30 – 35 M)	33-49 FT (10 – 15 M)
TRANSPORT BARGE	BARGE	394-410 FT (120 – 125 M)	98-115 FT (30 – 35 M)

1.3 Operations and Maintenance

Once commissioned, the Projects are designed to operate for up to 30 years.[3] Operations and maintenance (O&M) activities will ensure the Projects function safely and efficiently. To minimize equipment downtime and maximize energy generation, the Projects will conduct O&M activities through scheduled, predictive, and remotely-controlled activities. O&M activities will be performed by experienced, well-trained personnel.

The health and safety of people and the environment are at the forefront of planning and execution for all O&M activities. The Atlantic Shores Project Companies will reinforce this priority by ensuring that personnel comply with all applicable health, safety, security, and

[3] Atlantic Shores' Lease Agreement OCS-A 0499 includes a 25-year operating term, which may be extended or otherwise modified in accordance with applicable regulations in 30 CFR Part 585.

environmental (HSSE) laws and regulations and by developing and refining O&M procedures through an iterative process that incorporates knowledge gained throughout the Projects' operations and from other offshore wind projects.

The Projects' O&M strategy builds upon the following guiding principles:

- health and safety;
- environmental protection;
- compliance with regulations;
- maximum availability and energy output of wind farm;
- efficiency of resources and personnel to minimize costs; and
- continuous improvement of operational processes.

The Projects incorporate these guiding principles into all aspects of its operational planning and execution. In addition, Atlantic Shores requires its subcontractors to follow these guiding principles.

1.3.1 Monitoring and Control Systems

All facilities associated with both Projects, including the WTGs and offshore substations (OSSs), are designed to operate autonomously without on-site attendance by technicians. The Projects will be equipped with a SCADA system to interface between the WTG controllers, OSSs, onshore substations and/or converter stations, and all environmental and condition monitoring sensors and to provide detailed performance and system information. The SCADA system is configured to provide notifications of any alarms or warnings from Project components.

The SCADA system is remotely accessible to the Projects' operator through a remote control center. The operator will continuously monitor the status, production, and health of the Projects 24 hours per day. In addition to the SCADA system, the Projects will likely utilize a number of additional communication systems to manage overall operations.

1.3.2 Operations, Maintenance, and Inspections

A comprehensive O&M Plan for the Projects will be developed, which will include plans for scheduled and un-scheduled inspections and maintenance activities to keep the Projects operating with optimum reliability and performance throughout the design life. A risk-based maintenance approach will be used to balance long-term operating costs with the Projects' performance.

Scheduled maintenance is performed on a fixed, predetermined schedule (e.g., annually) and may consist of remote monitoring, inspections, testing, replacement of consumables, and preventive maintenance. Scheduled maintenance of offshore facilities will be performed during non-winter months when accessibility is highest. The frequency of inspections, tests, and maintenance will be based on industry standards and best practices.

Unscheduled maintenance is performed in response to a sensor alarm or fault indicating a component malfunction or to an event that causes accidental damage. Unscheduled maintenance may involve inspections, troubleshooting, and corrective maintenance, and may occur at any time of the year. Atlantic Shores will conduct a post-event inspection after an event that causes damage to a structure (e.g., a ship allision) or after a storm during which measured environmental conditions exceeded specified conditions (e.g., a hurricane or significant storm event).

All maintenance activities will follow the procedures outlined in each Project's Safety Management System (SMS). Maintenance activities will only be performed after appropriate preparatory actions have been taken according to the O&M Plan, including risk assessment and method statement development, marine traffic coordination, and checking that communication and remote monitoring and control systems are functional.

1.3.2.1 WTGs

<u>Scheduled Maintenance</u>

Scheduled maintenance of WTGs includes regularly scheduled inspections and routine maintenance of mechanical and electrical components. Most scheduled maintenance and associated crew transfer will be performed using CTVs, service operation vessels (SOVs), and/or helicopters. The types and frequency of inspections and maintenance activities are based on detailed original equipment manufacturer (OEM) specifications. Annual maintenance campaigns are dedicated to general upkeep (e.g., bolt tensioning, crack and coating inspection, safety equipment inspection, cleaning, high-voltage component service, and blade inspection) and replacement of consumable components (e.g., lubrication, oil changes).

Preventative maintenance (e.g., planned replacement of components such as motors and brakes) occurs less frequently (every 5 to 10 years) but is also regularly scheduled.

<u>Unscheduled Maintenance</u>

Unscheduled inspections and minor repairs, such as replacement of small components, can be performed via the regular maintenance vessels. Replacement of large components (e.g., blades, generators, gearboxes, and large bearings) or structural repair may require support vessels, such as jack-up vessels with cranes, as well as larger teams of technicians.

1.3.2.2 OSS Topsides

Scheduled Maintenance

OSSs undergo annual maintenance to both medium-voltage and high-voltage systems, auxiliary systems, and safety systems as well as topside structural inspections. Portions of the topsides may require the reapplication of corrosion-resistant coating. Diesel generators located on the OSSs will also require routine maintenance and refueling.

Unscheduled Maintenance

Corrective maintenance for OSS topside infrastructure includes minor structural repairs discovered during inspections, electrical repairs discovered either during inspections or through operational faults, and relatively rare movable part overhauls. Replacement of major components (e.g., transformers) is expected to occur infrequently and will likely require support vessels similar to those required for WTG major component replacement activities.

1.3.2.3 Representative Inspection and Maintenance Schedule

A representative schedule of the Projects' inspection and maintenance activities is presented in Table 1-5. This schedule provides an overview of the estimated frequency of inspection and maintenance activities; it is expected that this schedule will be updated during the detailed design process.

TABLE 1-5 SCHEDULE OF PLANNED PREVENTIVE MAINTENANCE ACTIVITIES

PROJECT COMPONENT	ACTIVITY	FREQUENCY
WTG	INSPECTIONS	ANNUAL
	MAINTENANCE OF MECHANICAL, ELECTRICAL, STRUCTURAL, AND SAFETY SYSTEMS	ANNUAL
	RETROFITS/UPGRADE	AS NEEDED
	GEARBOX OIL CHANGE	2-3 TIMES OVER LIFESPAN, AS NEEDED
OSS	INSPECTIONS	ANNUAL
	MAINTENANCE OF MEDIUM-VOLTAGE AND HIGH-VOLTAGE SYSTEMS, AUXILIARY SYSTEMS, AND SAFETY SYSTEMS	ANNUAL
	DIESEL GENERATOR REFUELING	AS NEEDED

TABLE 1-5 SCHEDULE OF PLANNED PREVENTIVE MAINTENANCE ACTIVITIES (CONTINUED)

PROJECT COMPONENT	ACTIVITY	FREQUENCY
FOUNDATION	ABOVE WATER INSPECTION	ANNUAL
	BELOW WATER INSPECTION	20% OF POSITIONS PER YEAR (MAY BE MODIFIED BASED ON SITE AND DESIGN RISK ASSESSMENT)
	MAINTENANCE OF STRUCTURAL, AUXILIARY, AND SAFETY SYSTEMS	ANNUAL
OFFSHORE CABLES (EXPORT, INTER-ARRAY, AND INTER-LINK)	SURVEY	ANNUALLY DURING THE FIRST FEW YEARS OF OPERATIONS AND AT LESS FREQUENT INTERVALS THEREAFTER (MAY BE MODIFIED BASED ON SITE AND DESIGN RISK ASSESSMENT)
	ELECTRICAL TESTS	EVERY 5 YEARS

1.3.3 Proposed Vessels

A combination of CTVs, SOVs, other smaller vessels, and helicopters may be used to access infrastructure in the WTA. The vessels are likely to be dispatched from the quayside at the O&M facility or other supporting O&M ports. The logistical approach will aim to share facilities and vessels, where possible, to maximize efficiency and minimize the environmental impact of transporting personnel, materials, and tools. In addition to CTVs, SOVs, and smaller vessels, the Projects may also use jack-up, heavy-lift, or other larger support vessels on an infrequent basis for large component replacement. If the characteristics of the O&M facility's port are unsuitable for the types of vessels required to complete the repair or for the quayside logistics required to manage larger components, a nearby port will be used. In addition, Atlantic Shores may use fixed-wing aircraft to support environmental monitoring and mitigation.

Atlantic Shores may utilize a CTV-based logistical approach due to the proximity of the WTA to the O&M facility in Atlantic City and the O&M facility's port characteristics (e.g., water depths). CTVs enable faster, more practical transport of personnel and equipment to the Projects' offshore facilities than SOVs when the transit distance is relatively short (see Figure 1-9 for a representative photo of a CTV). CTVs may transit daily between the CTV base and WTA. Helicopters can be used when rapid-response O&M activities are needed or when poor weather limits the use of CTVs. Helicopters would be based within reasonable distance of the Projects at a general aviation airport.

SOVs are relatively large vessels that offer considerable capacity for personnel and spare parts, allowing for service trips that are several weeks in duration (see Figure 1-9). SOVs include sleeping quarters for technicians and may include workshop space. SOVs are capable of transferring technicians to WTGs and OSSs through use of gangways. Typically, an SOV is equipped with a dynamic positioning (DP) system, lifting and winch capacity, and may support a helipad. SOVs are only limited by the need to return to port to restock fuel, food, and spare parts but are typically used in conjunction with smaller daughter crafts/workboats or CTVs to enable quick transport of personnel or supplies between the vessel and port or offshore assets. An SOV-based O&M strategy may also rely upon helicopters to shuttle technicians and equipment within the WTA.

In addition to CTVs, SOVs, and helicopters, other vessels and vehicles may be used to support O&M activities over the lifetime of the Projects:

- Although CTVs and SOVs are the most common vessels around which O&M logistical approaches are designed, an alternative approach employs a service accommodation and transfer vessel (SATV), which is larger than a CTV and supports week-long service campaigns.
- Larger support vessels (e.g., jack-up vessels) may be used infrequently to perform some routine maintenance activities, periodic corrective maintenance, and significant repairs (if needed). These vessels are similar to vessels used during construction.
- Survey vessels may be required for subsea inspection campaigns.
- Cable laying vessels may support cable repair campaigns.
- Other monitoring and inspection needs may be met by unmanned aerial vehicles, remotely-operated vehicles (ROVs), or underwater drones.

Approximately 5 to 11 vessels are expected to operate in the Offshore Project Area at any given time during normal O&M activities in support of both Projects, though additional vessels (a maximum of up to 22 vessels) may be required in other maintenance or repair scenarios. Depending on whether SOVs or CTVs are primarily used, Atlantic Shores estimates that approximately 550 to 2,050 vessel round trips to the Offshore Project Area will occur annually during the Projects' operations, which is an average of two to six vessel trips per day in support of both Projects. These vessel trips may be supplemented by helicopters to assist in personnel transport. The actual level of vessel activity during O&M will depend on the specific maintenance needs that develop as well as the final design of the offshore facilities.

Example Crew Transfer Vessel (CTV)

Example Service Operation Vessel (SOV)

Figure 1-9
Crew Transfer Vessel (CTV) and Service Operation Vessel (SOV) Examples

2.0 Project Emissions

Unlike traditional fossil-fuel based energy generation, the Projects' WTGs will not generate any air pollutant emissions. Instead, the electricity generated by the WTGs has the potential to significantly reduce emissions from the regional electric power grid over the life of the Projects by displacing electricity generated from pollution-emitting fossil fuel-fired power plants that otherwise would be required to serve the projected increase in electric demand within regional electric markets.

While the WTGs will not generate air emissions, air emissions will occur in connection with construction and operations and maintenance (O&M). Air emissions from these activities are directly associated with internal combustion engines generating power for vessels, vehicles, and tools needed to support the various phases of the Projects.

The Clean Air Act (CAA) (42 U.S.C. §§ 7401 et seq., amended 1990) and implementing Federal and State regulations, requires the EPA to established NAAQS for pollutants that are considered harmful to public health and welfare and the environment. These pollutants come from a diverse set of sources, including cars and trucks, electric power plants, factories, office buildings, and homes. EPA has established NAAQS for six air contaminants, known as criteria pollutants. These criteria pollutants are sulfur dioxide (SO_2), particulate matter (with a diameter smaller than 10 microns as PM_{10} and a diameter smaller than 2.5 microns as ($PM_{2.5}$), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), and lead (Pb).

In addition to these criteria pollutants, the Projects also generate greenhouse gas (GHG) emissions and hazardous air pollutant (HAPs) emissions. A GHG is an atmospheric gas that slows the rate at which heat radiates from earth into space, thus having a warming effect on the atmosphere. Carbon dioxide (CO_2) is the most common GHG, but the Projects also have the potential to emit other GHGs such as methane (CH_4), nitrous oxide (N_2O), and sulfur hexafluoride (SF_6). GHG emissions are presented as carbon dioxide equivalent (CO_2e). Each GHG has an associated Global Warming Potential (GWP) that correlates the global warming effects of the compound to that of CO_2, which has a base value of one (for example, methane has a GWP of 25, which means each ton of methane has the equivalent greenhouse effect of 25 tons of CO_2). GHGs are typically multiplied by their GWP values to express the total as CO_2e. Global Warming Potentials for GHG compounds are from Table A-1 of 40 CFR Part 98, Subpart A.

HAPs are compounds that at varying exposure levels are known or suspected to cause serious health effects (e.g., certain forms of cancer or birth defects) or can result in serious adverse environmental effects. Some examples of HAPs are acrolein, formaldehyde, and cadmium. HAPs may be emitted from fossil fuel combustion (due to the presence of impurities or products of incomplete combustion) and from industrial processes that

involve the use of toxic chemicals. HAPs are a subclassification of PM and volatile organic compound (VOC) emissions where a small portion of VOC or PM emitted are also classified as HAP emissions.

The pollutants that are included in the emissions estimates for the Projects are as follows:

- Nitrogen Oxides (NOx)
- VOC
- CO
- PM
- PM10
- PM2.5
- SO2
- H2SO4
- Pb
- Total HAPs
- GHGs (CO2, CH4, N_2O, and SF_6)

The emissions estimates are calculated based on approximations of representative vessels, engine sizes, and hours of operation that reflect the current state of the design of the Projects at the time of the submission of this application. Atlantic Shores is still in the process of designing and contracting and as such the base information used to generate these emissions estimates may change after the submission of this application. It is not possible for Atlantic Shores to know the exact vessel that will be used or operation time that will be necessary until a short time before construction begins as there are limited vessels capable of performing the actions necessary to construct and operate an offshore wind farm and demand for these vessels is increasing. As such, the air emission estimates presented in this application are subject to change.

2.1 Calculation Methodology

Emissions are predominantly from internal combustion engines from marine vessels and offshore generators and are quantified using a three-step process:

- Detailed plans for each activity.
- Load factors.
- Emission factors.

Emissions of air pollutants can also result from fugitive emissions from processes such as marine paint evaporation, fuel oil evaporation, and switchgear insulating gas leaks. Air emissions are broadly calculated as the product of engine rated capacity; hours operating; load factor; and emission factor.

The construction strategy presented is based on the worst case between monopile and transition piece (MP/TP) and GBS installation, with heavy vessels using the New Jersey Wind Port (NJWP) and Paulsboro. CTVs will use the port of Atlantic City, and (weather permitting) some crew transfers will use helicopters. Helicopter use is conservatively not included in the emissions totals because any helicopter trip would avoid a marine vessel trip, and on-the-whole would reduce air emissions. Offshore construction also includes fuel bunkering which involves a tug and barge combination making trips to port twice a month to load up on fuel for the offshore vessels rather than having each individual vessel make a trip into port for refueling as needed. Offshore construction also includes stationary generators on the OSS for commissioning activities with engine emissions based on Tier 4 nonroad engine standards. Miscellaneous activities during offshore construction include emissions of VOCs from the evaporation of marine paint and fuel.

Operation & Maintenance (O&M) activities include all vessels, helicopters, generators, and construction equipment that are expected to be used during the Projects' operation. The presented logistical concepts are based on use of a dedicated Service Operations Vessel (SOV), supported by CTVs. Again, helicopters could be used but would decrease total air emissions so are conservatively excluded from the calculations. Lighter vessels would use the port of Atlantic City, and heavier support and repair vessels would use the NJWP.

2.1.1 Marine Vessels

Emissions from the engines on the marine vessels were calculated according to the methodology described in BOEM's Offshore Wind Energy Facilities Emission Estimating Tool Technical Documentation, referred to as the "BOEM Wind Tool". These estimates are based on Version 1 of the BOEM Wind Tool. BOEM recently released an updated version (Version 2.0) of the BOEM Wind Tool in 2021, however this tool makes the assumption that all vessel engines are Category 2 EPA Tier 1 marine engines and applies the same emission factors to all marine vessel types and engines. Atlantic Shores believes that using Version 1 of the BOEM Wind Tool which has marine engine emission factors based on fleet-weighted averages for each vessel type is more appropriate and accurate for an estimate of air emissions, especially given the wide range of vessel types and engine sizes expected to be used during construction and operation of the Projects.

Emissions estimates from vessel engines are calculated for two different modes of operation. The first is when the engines are operating in transit mode to represent when the vessel is traveling at speed between the port and the Project Area. The other is when

the vessel engines are in maneuvering mode to represent when the vessel is operating in the Project Area. The general formula used for estimating emissions from these two engine modes is as follows:

$$E = \text{Engine Power} * \text{Operating Time} * LF * EF * 1.10231 \times 10^{-6}$$

Where:

- E = total emissions (US tons)
- Engine Power = total engine size (kilowatt [kW])
- Operating Time = duration of each activity (hours)
- LF = engine load factor (unitless)
- EF = emission factor (g/kW-hr)
- 1.10231×10^{-6} = grams to ton conversion factor

Vessel Engine sizes are based on engine sizes from specification sheets for actual vessels that are representative of the type and size of vessel that may be used during the construction or operation of the Projects. Some vessel specification sheets do not specify the size of auxiliary engines or differentiate between auxiliary engines and main engines. In these instances, the smallest engine was assumed to be the auxiliary engine. If all engines were the same size, one engine was assumed as an auxiliary engine while the others were assumed to be main engines.

The hours of operation for each vessel are determined based on modeling of the necessary time needed to construct or operate the Projects. For transit hours, the number of trips to port, the assumed vessel speed, and the distance to the port for each vessel were used to calculate the number of hours spent traveling between port and the Project Area. For maneuvering, the number of hours of operation necessary were estimated based on the modeled number of days required to complete the action the vessel is performing.

The load factors for vessel main engines are derived from the BOEM Wind Tool. The auxiliary engine load factors are based on several different sources. Load factors for auxiliary engines on vessels w/ category 1 or 2 main engines were derived from Table 4 Auxiliary and Boiler Power Surrogates of the Eastern Research Group 2019 document that was used as supporting documentation in the 2017 National Emissions Inventory (NEI). For vessels with category 3 main engines, the load factors are derived from Table 4-17 of the 2014 NEI for Commercial Marine Vessels. The SOV load factors were provided by PEAK Wind based on experience with prior projects. Vessels are conservatively assumed as operating on the maneuvering load factor for 24 hours per day for operating days spent in Project Area.

As described above, emission factors were pulled from Version 1 of the BOEM Wind Tool where available. For HAP emissions, the HAP speciation for marine vessels was pulled from the 2017 NEI supporting document titled "NEI Development Documentation - Methodology Documentation for EPA's Commercial Marine Emissions Estimates." This document provides the fraction of PM2.5 and VOC that corresponds to each HAP and was used to generate a total ratio of HAP to VOC and PM that is applied to calculate the HAP emission factor for each vessel category.

Fuel use factors are from "Current Methodologies and Best Practices in Preparing Port Emission Inventories" April 2009, Table 2-9: Emission Factors for Ocean-Going Vessels (OGV) Main Engines, Table 2-16: Auxiliary Engine Emission Factors. Category 1&2 marine engines are calculated based on the BOEM CO_2 emission rate and fuel information such as Marine Diesel Fuel Density of 7.10 lb/gal, higher heating value of 0.138 MMBtu/gal, and CO_2 emission factor in kg/MMBtu from 40 CFR Part 98, Subpart C, Table C-1.

All vessels are assumed to be transiting at 10 knots except CTVs which are estimated at a higher speed of 29 knots and certain foundation install vessels which have case specific speeds from the base model runs of 3 and 7 knots. All vessel engines are assumed as Category 1&2 except jack-up vessels which are assumed to use Category 3 engines. Ports assumed for each vessel are provided in the main calculation tables found in Appendix B.

2.1.2 Offshore Generators

Offshore generators are used in both construction and operation. Generators are used for commissioning of the WTGs and offshore substations (OSSs) during construction as well as for powering construction equipment such as air compressors and hydraulic hammers. During O&M, offshore generators are used on the OSS platforms for regular testing and in case of the need for emergency power if the connection to the grid is lost. Offshore generators are assumed to operate at full load for activities such as air compressors and hydraulic hammers. For the external power generation for the WTG and OSS commissioning generators, a 50% load factor is assumed for commissioning. During O&M, the OSS generators are assumed to have a 75% load factor.

Emission factors for the generators are based on the assumption that the engines used meet the requirements of the highest available tier from 40 CFR Part 1042 regulations. Emission factors for the hydraulic hammer and air compressors, are based on the Tier 3 engine factors, while for the commissioning generators, it is assumed Tier 4 generators will be used. NO_x emissions are conservatively assumed as 100% of NMHC (non-methane hydrocarbons) + NOx factors where not provided separately while VOC emissions are assumed as 12% of NMHC + NOx based on ratio of HC (hydrocarbons) to NOX+HC for engine tiers that have both values split out separately. HAP emission factors for the generators are based on EPA AP-42 emission factors for HAP emissions from internal combustion engines as found in AP-42 Chapters 3.3 (Engines <600 HP) and 3.4 (Engines >600 HP).

2.1.3 Miscellaneous

Miscellaneous emissions come from fugitive emissions from different processes across construction and operation. These processes include fuel evaporation, marine paint use, and switchgear insulating gas leaks.

Fuel evaporation is based on a fuel evaporation factor of 0.014 lb/Mgal of fuel consumed per AP-42 Chapter 5.2 Table 5.2-5.

Marine paint evaporation is assumed as a paint with a density of 5 lb/gal of marine paint with 300 gallons of marine paint used per year.

The loss of SF_6 from the switchgears located around the Project Area is conservatively based on 0.5% loss of the initial charge of SF_6 every year of operation. The 0.5% leakage rate is obtained from an EPA document titled "SF6 Leak Rates from High Voltage Circuit Breakers - U.S. EPA Investigates Potential Greenhouse Gas Emissions Source." The OSS platforms will have an initial charge of 1,500 kg of SF_6 to each of the OSS switchgears while the WTGs are estimated as having a maximum charge of 110 kg of SF_6 each.

2.2 Exhaust Parameters

Information is not broadly available to estimate the stack parameters to be used for the various construction vessel types. Atlantic Shores has prepared a best-efforts basis set of exhaust parameters based on the following sources:

- a review of available specification sheets for identified representative vessels and engines, supported and checked with an evaluation of available vessel imagery;
- stack parameters provided in the Source Guide attachment that accompanied the Vineyard Wind, LLC OCS Air Permit application (EPA OCS-R1-03);
- stack parameters provided in the South Fork Wind, LLC OCS air permit application (EPA OCS-R1-04); and
- California EPA Air Resources Board's (2005) Appendix G: Draft Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach.

The range of stack parameters will serve to estimate the different sizes of vessels and engines that will be used in the Projects, and different heights from which engine emissions will be emitted. Actual stack parameters will not be known until vessels are retained for the Project (and vessels may be changed mid-project to meet changing needs).

Vessels will be in motion while operating, so emissions from vessels will not come from a fixed point in space. When using the AERCOARE-AERMOD modeling system, emissions from moving vessels may be represented as volume sources, where the volume represents a conservatively small estimate of the locations over which the vessel would move during the course of an hour. Emissions during transits (moving at-speed from one location to another) may be included as line volume sources. Downwash will only be addressed for stationary structures (such as jack-up vessels and platforms). Atlantic Shores does not currently intend to address the effect of waves on stack heights and angles (which would generally serve to increase dispersion).

During both construction and O&M, vessel emissions will only exist for a few hours or days at any one location, before moving to the next location.

2.3 Emissions Estimates

Emissions estimates are split into the two main phases of the Projects, Construction and Operation and Maintenance. The emissions shown in Table 2-1 are representative of emissions that are subject to OCS Air Permitting under 40 CFR Part 55 only. The full detailed calculations can be found in Appendix B.

Emissions during construction result from marine vessels, offshore generators and equipment, and miscellaneous sources such as paint or fuel evaporation. The emissions presented in the tables below are split into these three categories as well as separated into total emissions from construction and peak year emissions.

Similarly, emissions during operation and maintenance result from marine vessels, offshore generators and equipment, and miscellaneous sources. The emissions presented in the tables below are split into these three categories and represent a conservative case for O&M emissions because all unplanned/infrequent events such as retrofit campaigns, major repairs, etc. happen in a single year.

TABLE 2-1 TOTAL EMISSIONS DURING CONSTRUCTION (TONS)

Pollutant	Emissions									
Vessels	NO_x	VOC	CO	PM_{10}	$PM_{2.5}$	SO_2	Pb	HAPs	H_2SO_4	CO_2e
CONSTRUCTION TOTAL OCS EMISSIONS (TONS)	2,725.6	61.5	712.9	88.7	86.1	7.3	0.01	5.6	0.3	191,742.9
CONSTRUCTION PEAK YEAR OCS EMISSIONS (TONS/YEAR)	1,704.1	39.2	452.2	55.0	53.4	4.1	0.01	3.5	0.2	120,729.1
O&M OCS EMISSIONS (TONS/YEAR)	408.1	7.0	96.0	13.2	12.8	1.2	0.00	0.8	0.1	30,386.4

3.0 Regulatory Requirements

As a result of the air quality and emissions standards set by the EPA and State of New Jersey, the Project activities which generate emissions will be subject to various Federal and State regulation. These regulations provide the basis for how Atlantic Shores has assessed and will manage emissions sources. This section reviews those regulations, focusing on those that will be reviewed through the OCS air permitting process.

Atlantic Shores has prepared and submitted this OCS air permit application based on a best-efforts understanding of current agency regulatory interpretations, policy, and precedent. However, Atlantic Shores believes there are alternative interpretations that EPA could take that would significantly simplify the review process for the Projects and other OSW projects. These alternative interpretations would still comply with all applicable laws and regulations, continue to meet the intent of those laws and regulations, and continue to protect public health and the environment. Appendix A requests specific regulatory interpretations.

OCS Air Permitting

Under 40 CFR Part 55, EPA regulates the air emissions associated with "OCS sources." OCS sources are defined in part as air emissions sources on vessels "permanently or temporarily attached to the seabed and erected thereon and used for the purpose of exploring, developing or producing resources therefrom . . . " (40 CFR §55.2). The Project will require an OCS Air Permit under 40 CFR Part 55 for any regulated OCS sources associated with the Projects.

Authority to issue the OCS air permit currently lies with EPA Region 2, but the State of New Jersey is in the process of obtaining delegated authority to issue and enforce OCS air permits. Per 40 CFR § 55.11(b), that delegation can occur when New Jersey has demonstrated that the State has adopted the appropriate portions of the regulation into State law, and has adequate authority, resources, and administrative procedures to implement the regulation. New Jersey incorporated 40 CFR Part 55 into the New Jersey Department of Environmental Protection (NJDEP) regulations (at New Jersey Administrative Code (NJAC) 7:27-30) effective May 4, 2020. There are two other key differences in air permitting requirements for operations in the OCS versus onshore operations:

- Under EPA regulations, air quality requirements for OCS sources located within 25 mi of State seaward boundaries are the same as those applicable to sources located in the corresponding onshore area. The State of New Jersey has been designated as the corresponding onshore area, and the WTA is within 25 mi (40 km) of New Jersey's seaward boundary (which in turn is 3 nm [5.6 km] from the coastline). Therefore, the OCS air permit will address compliance with NJDEP regulations at NJAC 7:27.

- A facility's Potential to Emit (PTE) is used in onshore and offshore permitting to determine whether certain major source permitting requirements are triggered. For onshore air permits, the PTE is calculated based on the emissions from stationary sources at the facility, and generally exclude temporary sources associated with construction. For OCS facilities, 40 CFR Part 55 mandates that emissions from vessels that are servicing or associated with the operation of OCS sources must be counted as direct emissions from the OCS source, while those vessels are at the OCS source or en route to or from the OCS source within 25 mi (40 km) of the source. EPA has previously determined for offshore wind projects that the PTE includes temporary operations associated with construction. Under this definition of PTE, the construction and operation of OCS sources in the WTA will trigger major source permitting requirements under the Prevention of Significant Deterioration (PSD) rules at 40 CFR § 52.21, and the nonattainment New Source Review (NSR) rules at NJAC 7:27-18.

Through this OCS air permitting process, Atlantic Shores will document compliance with all applicable Federal and New Jersey air quality requirements. This will include documentation of compliance with ambient air standards, documentation of SOTA emission controls and obtaining emissions offsets to the extent required.

Other Regulatory Requirements

Project activities offshore can be subject to other Federal and State air quality requirements. Those can include:

- Federal New Source Performance Standards (NSPS): Per Section 111 of the CAA, the EPA has developed technology-based standards which apply to specific categories of stationary sources. Potentially applicable NSPS include standards for Stationary Compression Ignition Internal Combustion Engines (40 CFR Part 60, Subpart IIII).
- Federal National Emissions Standards for Hazardous Air Pollutants (NESHAPs): EPA has developed NESHAPs for stationary sources of HAPs. Potentially applicable NESHAPs include standards for Stationary Reciprocating Internal Combustion Engines (40 CFR Part 63, Subpart ZZZZ).
- New Jersey stationary source preconstruction permit requirements: Individual stationary sources onshore could be subject to preconstruction permit requirements.

While not subject to review as part of this OCS air permit application, nonroad diesel engines and marine diesel engines installed on U.S. vessels are subject to regulations at 40 CFR Part 89, 40 CFR Part 94, and 40 CFR Part 1042. Air pollution from both domestic and foreign vessels is addressed through Annex VI of the International Maritime Organization's (IMO's) MARPOL treaty. Annex VI establishes global limits on the sulfur

content of marine fuels and NOx emissions limits for engines exceeding 130 kW on vessels built after 2000 (other than engines used solely for emergencies). The IMO has also adopted legally binding energy efficiency measures as amendments to MARPOL Annex VI.

While not a regulatory requirement applicable to Project activities, the New Jersey Global Warming Response Act (GWRA) (P.L. 2007 c.112; P.L. 2018 c.197) requires the NJDEP and other State agencies to develop plans for reducing emissions of CO_2e to 80% below 2006 levels by 2050. NJDEP's plans include "the rapid adoption of three key strategies: (1) replacing internal combustion vehicles with electric vehicles, (2) converting space and water heating in the residential and commercial buildings to electric heat, and (3) replacing fossil fuels in the electric generation sector with renewable energy sources" (NJDEP 2020b). The plans include offshore wind as a key component, and the Projects would serve to support implementation of NJDEP's plans.

The remainder of this section focuses on specific regulatory programs applicable to this OCS air permit application.

3.1 Significant Sources Subject to OCS Air Permitting

EPA's implementing OCS Air Regulations at 40 CFR Part 55 adopt the statutory definition of an OCS source from Section 328(a)(4)(c) of the Clean Air Act (CAA): *"any equipment, activity, or facility which—(i) emits or has the potential to emit any air pollutant, (ii) is regulated or authorized under the Outer Continental Shelf Lands Act [43 U.S.C. 1331 et seq.], and (iii) is located on the Outer Continental Shelf or in or on waters above the Outer Continental Shelf."* The regulations at 40 CFR Part 55 state that vessels are only considered OCS sources when they are: *"(1) Permanently or temporarily attached to the seabed and erected thereon and used for the purpose of exploring, developing or producing resources therefrom, within the meaning of section 4(a)(1) of OCSLA (43 U.S.C. § 1331 et seq.); or (2) Physically attached to an OCS facility, in which case only the stationary sources aspects of the vessels will be regulated."*

This section describes which of the Project's activities and equipment that meet the definition of an OCS source.

3.1.1 Equipment and Activities that are OCS Sources

Any engines and other emitting equipment located on the WTGs, OSSs, and their foundations will meet the statutory definition of an OCS source because they:

1. **Emit or Have the Potential to Emit Any Air Pollutant:** Engines and other equipment located on the WTGs, OSSs, and foundations, have the potential to emit air pollutants during the construction and/or operation of the Project. Atlantic Shores will not install meteorological (met) tower or meteorological and oceanographic (metocean) buoys that contain air emissions sources.
2. **Are Regulated or Authorized under the Outer Continental Shelf Lands Act:** BOEM is reviewing the project consistent with the regulations implementing the National Environmental Policy Act (NEPA), and EPA will review this OCS Air Permit application for the Projects. Therefore, per Section 388 of the Energy Policy Act of 2005 amended Sections 4(a) and 8 of the OCSLA, the Projects are regulated or authorized under the OCSLA.
3. **Are located on the Outer Continental Shelf:** The OCS is all submerged lands lying seaward of a state's territorial boundary that are under US jurisdiction, which typically extends 200 NM out to sea (BOEM 2018). The Project's WTGs and ESP(s) are located on the OCS.

In addition to meeting the three criteria above, to meet the definition of OCS source, a vessel must be:

1. **Permanently or temporarily attached to the seabed or an existing OCS source:** As described in the South Fork Wind Fact Sheet, "attachment" for the purposes of being an OCS source does not mean "any physical connection." Rather, the purpose of the "attachment" must be to "prevent or minimize relative movement" between the vessel and the seabed.
2. **Erected on the seabed:** In the South Fork Wind Fact Sheet, EPA also found that in order for a vessel to be "erected" on the seabed, it must remain stationary while it conducts its OCS activity and be located where the OCS activity (i.e., generation of power) is reasonably expected to occur. Atlantic Shores will generate power in the WTA; vessels outside the WTA would not be considered OCS sources.
3. **Used for the purpose of exploring, developing, or producing resources, within the meaning of Section 4(a)(1) of OCSLA:** In the South Fork Wind Fact Sheet, EPA also explained that the terms "exploring," "developing," and "producing," as defined in OCSLA, do not include construction other than platform construction. Therefore, vessels used must contribute to platform construction (i.e., construction of the WTGs, ESPs, and/or foundations) to meet the definition of OCS source.

A connection to the seabed or another OCS source, does not make a vessel an OCS source if the vessel does not use that connection to remain stationary (relative to the seabed). As examples:

- A CTV that uses its engines to push against a boat landing on WTG or OSS foundation is not an OCS source because the CTV is using its engines to remain stationary.
- A service operations vessel (SOV) that uses a gangplank to transfer crew a WTG or OSS foundation is not an OCS source, because the gangplank is not used to "prevent or minimize relative movement" between the vessel and seabed (it merely rests on the foundation).
- A foundation installation vessel conducting pile driving may be indirectly connected to the seabed via the pile, but the vessel is not an OCS source because it is not connected to the pile to "prevent or minimize relative movement" between the vessel and the seabed.
- A bubble curtain support vessel may extend bubble curtains (i.e., a type of noise mitigation device) to lay on the seabed, but because the hose would not be used to restrict the movement of the vessel, the vessel would not be considered an OCS source.
- A cable laying vessel (CLV) that uses a pull-ahead anchor does not satisfy the requirement of being "erected" on the seabed because, as stated in the South Fork Wind Fact Sheet, "the phrase 'erected thereon' for the purposes of an OCS source definition requires a more secure, stationary activity than cable laying." The customary meaning of the verb "to erect" is "to construct' or "to build." As described in the Fact Sheet, "pull-ahead anchor CLVs are neither constructed nor built on the seabed but are instead pulled along an anchor line." Also, because the CLV may operate a significant distance from the WTA, it would not contribute to platform construction. In the South Fork Fact Sheet, EPA found that pull-ahead anchor CLVs are not "used for the purpose of exploring, developing or producing resources therefrom, within the meaning of section 4(a)(1) of OCSLA."
- A vessel anchored for safety or convenience in the WTA is not an OCS source if the vessel is not performing work to support OSS or WTG construction (e.g., a vessel that is idle).

OCS sources associated with the Projects are expected to include:

- Engines on the WTGs and their foundations: Any engines placed on the WTGs or their foundations are considered OCS sources. No permanent engines will be used; instead a UPS will power the control and protection system in case of a grid outage to enable safe shut down of the WTG and saving operational data. Additional backup power systems (e.g., WTG self-power feature, portable generators, and/or battery systems) may be utilized to provide power for commissioning or for storm protection in the event of a longer-term grid outage. Portable generators used in this manner would be OCS sources while operating on the WTGs.

- Engines on the OSSs (topside or foundation): Any engines placed on or in the OSSs are considered OCS sources. Atlantic Shores will install permanent generators on the OSSs to provide backup power to critical systems; these will operate for emergencies and reliability testing during O&M. Emergencies include unplanned loss of grid power or a failure of the offshore cable system that requires an OSS to be disconnected from external power (either from onshore or the WTGs). During construction, these generators will likely be used to provide power for installation and commissioning activities on the OSSs until they can be connected to the electrical grid (although this power could come from other generators of similar size). Additional generators may be used temporarily on the OSSs during construction.
- Jack-up vessels while jacked-up at the WTA to support OSS or WTG construction: Jack-up vessels are self-propelled or non-self-propelled vessels with legs that extend to the ocean floor and a hull that elevates to provide a safe, stable working platform. As stated in the Vineyard Wind 1 Statement of Basis and Fact Sheet, "*The EPA has determined that a jack-up vessel is included in the definition of an OCS source once three of the jack-up vessel's legs have attached to the seafloor, because the jack-up unit has become stationary and is no longer operating as a vessel or a barge. Once that occurs, the jack-up vessel is considered to be erected on the seabed since the vessel will not be using its engines to maneuver itself at that time.*" Any air emissions source on the jack-up vessel that operates while the vessel is attached to the seabed are an OCS source. These could include the vessel's auxiliary engines, and engines powering specific equipment such as pile driving hammers and air compressors. Once fewer than three jack-up legs are attached to the seafloor, the jack-up vessel and any other engines/equipment on the vessel cease to be OCS sources. Atlantic Shores will use a main WTG installation vessel that will be a jack-up vessel, and may use smaller "feeder" jack-up vessels to transport WTG components from port to the main installation vessel.

Atlantic Shores does not generally expect any vessels to become OCS sources by placing one or more anchors on the seabed and producing air emissions while performing any activity that supports the construction or operation of the Project. Similarly, Atlantic Shores does not expect any vessels to become OCS sources by tethering, mooring, or otherwise attaching to an OCS source such as a WTG, ESP, or jack-up vessel, producing air emissions, and performing work that supports the construction or operation of the Project. In the event that a vessel becomes an OCS source in such a manner, the stationary source aspects of the air emissions sources would be OCS sources.

3.1.2 Vessels at or enroute to OCS Sources

Potential emissions are defined in 40 CFR §55.2 and include emissions from vessels 'servicing or associated with an OCS source' while at the source and while enroute to or from the source when within 25 miles of the source. That does not include vessel emissions from activities that precede the establishment of an OCS source. Atlantic Shores expects the first OCS source could be established as early as part of OSS topside installation, or as late as part of the WTG installation. The first OCS source will likely be a generator used for OSS commissioning, which occurs after OSS topside installation. All or nearly all export cable installation activities will precede establishment of any OCS source. This application conservatively assumes other activities in the WTA could occur after establishment of an OCS source. As the schedule is refined, Atlantic Shores may identify and exclude additional activities that will occur before any OCS source is established. Similarly, onshore emissions are not counted because they are not vessel emissions, and vessel emissions in-harbor or hoteling are not counted because they are not enroute to any OCS source.

Consistent with recent precedent, Atlantic Shores interprets "within 25 miles of the source" to mean nautical miles. Also consistent with recent precedent, the distance is counted from the centroid of the WTA. The use of the WTA centroid is appropriate when calculating potential emissions because calculating the distance traveled to any specific OCS source would not result in a total calculated emission rate substantively different than calculating based on the centroid. The Projects' activities are evenly spaced across the WTA, and longer and shorter distances will tend to even out in the overall calculation. Calculating distances to the WTA boundary would be unnecessarily conservative and complex, and calculating distances to each individual OCS source would be unnecessarily complex. To the extent that vessels will be required to document emissions and other operating parameters while operating within 25 miles of the OCS source, the requirement to recalculate that distance each trip would become cumbersome (and possibly infeasible as vessels' destinations could change mid-trip due to changing weather or other circumstances).

3.2 OCS Air Permitting Process

3.2.1 Notice Of Intent

On December 21, 2021, Atlantic Shores and the Project Companies submitted a Notice of Intent (NOI) for Atlantic Shores Projects 1 and 2, as required per the Outer Continental Shelf (OCS) Air Regulations at 40 CFR §55.4. These regulations require that the NOI be submitted no more than 18 months prior to the submittal of an application for a preconstruction permit. The NOI addressed the applicable requirements of the regulation with a discussion of the necessary information to document compliance.

Atlantic Shores will has submitted this application for an OCS Air Permit within 18 months of this NOI per 40 CFR §55.4(a). The Nearest Onshore Area (NOA) is New Jersey. A copy of the NOI was being submitted to NJDEP. The other onshore areas that are adjacent to the NOA are Delaware, New York, and Pennsylvania. As such, a copy of this NOI was submitted to the state air pollution control agencies of Delaware (Delaware Department of Natural Resources and Environmental Control), New York (New York Department of Environmental Conservation), and Pennsylvania (Pennsylvania Department of Environmental Protection).

The NOI included general company information, including company name and address, owner's name and agent, and facility site contact. It described the Projects, and noted that during operation Projects will fall under Standard Industrial Classification (SIC) Code 4911 for electric services, which is defined as establishments that generate, transmit, and/or distribute electricity for sale[4]. The NOI provided preliminary air emissions estimates and fuel use estimates for construction and for O&M, as well as estimates of avoided air emissions. The estimates submitted with the NOI are updated and replaced by the estimates in this OCS air permit application. Similarly, the information in this OCS application updates and replaces the information provided in the NOI relating to: the description of emissions points, associated vessels, and air pollution control equipment; proposed limitations on source operations; proposed work practice standards affecting emissions; other information affecting emissions; other information to determine the applicability of onshore requirements; and other to determine the Projects' impact in onshore areas.

Per 40 C.F.R. Part 55, an NOI submittal for a new OCS source located within 25 miles of a state seaward boundary triggers a Corresponding Onshore Area (COA) designation. An email from EPA (Viorica Petriman, March 9, 2022) noted that Part 55 provides the air pollution control agencies of states, which are not the Nearest Onshore Area (NOA), with the opportunity to apply to be designated the COA for a given project. The deadline for states to request COA designation for the Projects was February 22, 2022. EPA did not receive any such requests, and thus the COA for the Projects is the NOA, which is the State of New Jersey.

An NOI submittal for a new OCS source located within 25 miles of a state seaward boundary also triggers a consistency review. The deadline for EPA to propose any necessary consistency update rule for this project in the Federal Register was March 9, 2022. On March 3, 2022, EPA published a final New Jersey consistency update rule in the

[4] During construction the Projects will fall under SIC Code 1639.

Federal Register[5], and on March 9 EPA determined that New Jersey's current state rules remained consistent with the versions incorporated by reference by that March 3 final rule. EPA therefore determined that no further consistency update is needed for New Jersey's rules.

3.2.2 Subject Regulations

The OCS air regulations at 40 CFR § 55.13 specify which federal requirements apply to OCS sources, and the OCS air regulations at 40 CFR § 55.14 specify which federal requirements apply to OCS sources. Federal requirements include PSD (40 CFR § 52.21), NSPS (40 CFR Part 60), and NESHAPS (40 CFR Part 63). The operating permit requirements have been delegated to New Jersey (and therefore apply through NJAC 7:27 Subchapter 22), and none of the regulations cited in 40 CFR § 55.13(g) are in-effect in New Jersey (so none of them apply to OCS sources).

The March 3, 2022 final New Jersey consistency update rule identified specific portions of NJAC Title 27 and 27B as applying to OCS sources within 25 miles.

3.3 PSD Review

The PSD regulations are found at 40 CFR § 52.21. These regulations are in-turn incorporated into the OCS Air Regulations at 40 CFR § 55.13(d)(1) for:

- OCS sources;
- located within 25 miles of a state's seaward boundary;
- if the PSD regulations are in effect in the COA.

The provisions of 40 CFR § 52.21, except paragraph (a)(1), are incorporated and made a part of the applicable state implementation plan (SIP) for the State of New Jersey, per 40 CFR § 52.1603. Therefore, 40 CFR § 52.21 is applicable to the Project.

Under the PSD regulations, a stationary source that is not on a list of 28 specific source categories is considered a major source for PSD purposes if it emits or has the potential to emit (PTE) 250 tons per year (tpy) or more of a regulated New Source Review (NSR) pollutant. The Project is not on that list of 28 source types, and therefore, the 250 tpy threshold applies to the Project. Potential emissions are defined in 40 CFR §55.2 and include emissions from vessels 'servicing or associated with an OCS source' while at the source and while enroute to or from the source when within 25 nm of the source.

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[5] 87 FR 11961, EPA-R02-OAR-2021-0747, FRL-9241-02-R2, available at https://www.federalregister.gov/documents/2022/03/03/2022-04271/outer-continental-shelf-air-regulations-update-to-include-new-jersey-state-requirements

Potential emissions during the construction phase of the Projects will exceed the 250 tpy threshold for one or more pollutants; therefore during the construction phase the Projects are considered major for PSD. The applicability of the PSD rules to specific pollutants therefore depends on a comparison against the Significant Emission Rate (SER) in 40 CFR § 52.21(b)(23)(i). Construction-phase emissions, total for both Projects, are compared to the SERs in Table 3-1.

TABLE 3-1 CONSTRUCTION EMISSIONS COMPARED TO PSD SER THRESHOLDS

POLLUTANT	OCS-APPLICABLE EMISSIONS DURING CONSTRUCTION, BOTH PROJECTS, TONS IN THE WORST-CASE YEAR	PSD SER, TPY	PSD REVIEW REQUIRED?
CO	459	100	YES
NOX	1,839	40	YES
PM	60	25	YES
PM10	60	15	YES
PM2.5	58	10	YES
SO2	5.2	40	NO
VOC	39.8	40	NO
SULFURIC ACID (H2SO4)	0.24	7	NO
LEAD (PB)	0.01	0.6	NO
GHG (AS CO2E)	123,001	75,000	YES

Notes regarding PSD applicability:

- This application bases PSD applicability on the worst-case 12-month period during construction or O&M.
- Per 40 CFR § 52.21(i)(2), the substantive requirements of the PSD regulation (paragraphs (j) through (r)) do not apply to ozone and its precursors (NOx and VOC) because ozone is designated as nonattainment in the COA. NOx is still subject to paragraphs (j) through (r) for the purposes of regulating NO_2 emissions under PSD.

- PM and PM_{10} are treated together for the purposes of regulatory applicability and compliance in this application.
- The SER for GHG applies only to sources subject to PSD for another pollutant.
- No emissions of fluorides, hydrogen sulfide, total reduced sulfur, or reduced sulfur compounds are expected

The substantive requirements of the PSD regulation are in paragraphs (j) through (r), summarized below:

- Control technology review: 40 CFR § 52.21(j) requires major modifications to meet applicable emissions limits under the SIP, to meet applicable emissions standards at 40 CFR Parts 60, 61, and 63 (NSPS and NESHAPS), and to apply BACT for each regulated NSR pollutant that exceeds the significant emission rate.
- Source impact analysis, air quality analysis, and additional impact analyses: 40 CFR § 52.21(k) requires a demonstration that the Projects will not cause or contribute to air pollution in excess of any NAAQS or applicable maximum allowable increase over the baseline concentration in any area. 40 CFR § 52.21(m) requires an analysis of the ambient air quality in the area affected by the Projects for each pollutant resulting in a significant net emissions increase. 40 CFR § 52.21(o) requires the an analysis of the Projects' direct and indirect impacts to visibility, soils, and vegetation as well as air quality impacts resulting from general commercial, residential, industrial, and other growth associated with the Projects.

3.4 New Source Performance Standards

NSPS are a set of technology-based federal standards that apply to specific categories of stationary sources of air pollution. The only NSPS category under 40 CFR Part 60 that applies to the Project's OCS sources is Subpart IIII —Standards of Performance for Stationary Compression Ignition Internal Combustion Engines. A review of other NSPS finds none that apply. As examples, Atlantic Shores expects no fired steam generating units subject to Subparts Db or Dc, no tanks holding organic liquids volatile enough to be subject to Subpart Kb, and no spark-ignition engines subject to Subpart JJJJ.

The specific requirement of 40 CFR 60 Subpart IIII depend on the engine's model year, size, and displacement in liters per cylinder. Limits and requirements are found within Subpart IIII itself (40 CFR 60.4200 *et. seq.*, but also incorporated by reference in the nonroad engine standards at 40 CFR Part 1039 and the marine engine standards at 40 CFR Part 1042. The EPA recognizes in its NSPS that an owner of a stationary source in a marine environment can certify its engine based on the marine engine requirements rather than the nonroad engine requirements.

3.5 National Emissions Standards for Hazardous Air Pollutants

Per 40 CFR § 52.13(e), NESHAPs apply to OCS sources if rationally related to the attainment and maintenance of Federal or State ambient air quality standards or the requirements of Part C of Title I of the Act. The only NESHAPs category under 40 CFR Part 63 that applies to the Project's OCS sources is Subpart ZZZZ, the NESHAP for Reciprocating Internal Combustion Engines (RICE). A review of other NESHAPs finds none that apply. For Example, Atlantic Shores expects no fired steam generating units subject to Subpart JJJJJ, no tanks holding organic liquids volatile enough to be subject to Subpart Kb, and no spark-ignition engines subject to Subpart JJJJ.

For engine models 2006 and newer, compliance with the relevant NSPS Subpart IIII standards (above) constitute compliance with NESHAP Subpart ZZZZ at an area source (the Projects are an area source of HAPs). Engines models older than 2006 at OCS sources are exempt from numerical emissions limits but have maintenance and fuel requirements per 40 CFR § 63.6603 and 40 CFR § 63.6604.

3.6 New Jersey Regulatory Requirements

Certain New Jersey regulations from NJAC 7:27 and NJAC 7:27B are incorporated into 40 CFR Part 55 by reference and listed in Appendix A of Part 55. Each regulation is briefly described below, followed by a description of its relevance to OCS Sources associated with the Atlantic Shores Projects.

NJAC 7:27 Subchapter 2 - Control and Prohibition of Open Burning (Effective 6/20/1994)

Prohibits open burning without obtaining requisite permit(s). Since there will be no open burning or aggregated storage of combustible material, this regulation will not apply.

NJAC 7:27 Subchapter 3 - Control and Prohibition of Smoke From Combustion of Fuel (Effective 2/4/2002)

Prohibits smoke from stationary indirect heat exchangers, indirect heat exchangers at marine installations, internal combustion engines and stationary turbine engines. The specific limits for the various types of equipment vary depending on the type of equipment. Atlantic Shores will comply by using of good combustion practices and use of good operating and maintenance standards.

NJAC 7:27 Subchapter 4 - Control and Prohibition of Particles From Combustion of Fuel (Effective 4/20/2009)

Prohibits the emission of particulate emissions above limits established in Table 7:27-4.2 or determined by interpolation. This subchapter applies fuel combustion at OCS sources. Atlantic Shores will comply by using of good combustion practices and use of good operating and maintenance standards.

NJAC 7:27 Subchapter 5 - Prohibition of Air Pollution (Effective 10/12/1977)

Prohibits emissions into the atmosphere of substances that result in air contaminants in such quantities and duration that are injurious to human health, welfare, animal or plant life or property, or would unreasonably interfere with the enjoyment of life or property within New Jersey or its territories. This subchapter applies to OCS sources. Compliance with other air permit conditions and good operating practices will ensure compliance with this general standard.

NJAC 7:27 Subchapter 6 - Control and Prohibition of Particles From Manufacturing Processes (Effective 6/12/1998)

Prohibits the emission of particulate emissions and opacity from listed processes. Since none of the listed processes will be part of the Projects, this regulation will not apply.

NJAC 7:27 Subchapter 7 - Sulfur (Effective 11/6/2017)

Limits emission of sulfur compounds, excluding compounds resulting from the combustion of commercial fuel. Since the only sulfur-related emissions from the Projects will be from commercial fuel, this regulation will not apply.

NJAC 7:27 Subchapter 8 - Permits and Certificates for Minor Facilities (and Major Facilities Without an Operating Permit) (Effective 1/16/2018)

Subchapters 8 and 22 contain the key air permit submittal, review, and approval requirements with apply to the Projects. These requirements are discussed in detail in Section 3.6, below.

NJAC 7:27 Subchapter 9 - Sulfur in Fuels (Effective 9/20/2010)

Limits sulfur in fuels used and stored in New Jersey, and establishes sulfur dioxide emissions limits. Fuel used by ocean-going vessels is excluded per NJAC 7:27-9.3; other limits will apply to fuel used by stationary engines (generators).

NJAC 7:27 Subchapter 10 - Sulfur in Solid Fuels (Effective 9/6/2011)

Limits sulfur in solid fuels. Since the Projects will use no solid fuels, this regulation will not apply.

NJAC 7:27 Subchapter 11 - Incinerators (Effective 5/4/1998)

Establishes requirements for incinerators. Since the Projects will use no incinerators, this regulation will not apply. Note that electric toilets do not meet the definition of incinerator under this regulation.

NJAC 7:27 Subchapter 12 - Prevention and Control of Air Pollution Emergencies (Effective 5/20/1974)

Establishes when and how the Governor of New Jersey can declare an air pollution emergency. Consistent with the requirements, Ocean Wind will prepare standby plans to establish the appropriate response during periods of a declared air pollution emergency.

NJAC 7:27 Subchapter 16 - Control and Prohibition of Air Pollution by VOCs (Effective 1/16/2018)

Establishes requirements and procedures to limit air pollution by VOC and CO emissions. Requires that any stationary source operation use reasonably available control technology (RACT) to control VOC emissions where applicability thresholds are met. The provisions of NJAC 7:27-16.2 apply to stationary storage tank that stores applicable VOC; vessel fuel bunkers and tanks will not be subject because they are not stationary, and fuel tanks servicing stationary engines will be smaller than the appliable thresholds (2000 gallons).

The provisions of NJAC 7:27-16.10 apply to any stationary reciprocating engine that is subject to the provisions of NJAC 7:27-19 except emergency generators. Stationary engines on the OSSs during O&M are therefore subject to Subchapter 16 (because conditions can occur when they are used that do not meet the definition of emergency).

NJAC 7:27 Subchapter 18 - Control and Prohibition of Air Pollution From New or Altered Sources Affecting Ambient Air Quality (Emission Offset Rules) (Effective 11/6/2017)

Subchapter 18 contains the NSR requirements with apply to the Projects. These requirements are discussed in detail in Section 3.7, below.

NJAC 7:27 Subchapter 19 - Control and Prohibition of Air Pollution From Oxides of Nitrogen (Effective 1/16/2018)

Establishes requirements and procedures to limit air pollution by NO_x emissions. This regulation applies to stationary engines on the OSSs during O&M. It does not apply to vessel engines because they are not stationary, and it does not apply to engines used for commissioning because (NJAC 7:27-19.2(g)) those engines are not connected to the electric power distribution grid, not replacing power from the electric grid, and are portable.

NJAC 7:27 Subchapter 21 - Emission Statements (Effective 1/16/2018)

Requires the submittal of annual emission statements for facilities that have the PTE any air contaminant greater than the thresholds in Subchapter 21 Table 1. Atlantic Shores will submit the required emission statements.

NJAC 7:27 Subchapter 22 - Operating Permits (Effective 1/16/2018)

Subchapters 8 and 22 contain the key air permit submittal, review, and approval requirements with apply to the Projects. These requirements are discussed in detail in Section 3.6, below.

NJAC 7:27B Subchapters 1, 2, and 3

NJAC Chapter 27B Subchapters 1, 2, and 3 specify testing procedures for particles, opacity, and VOC. Atlantic Shores will use these procedures if specified in any air permit condition or related requirement.

3.7 New Jersey Permitting Requirements

NJAC Chapter 27, Subchapters 8 and 22 establish the procedures to apply for, and obtain, air preconstruction and operating permits. "Major facility" is defined at NJAC 7:27-8.1 and 7:27-22.1 as "a facility that constitutes a major source, as defined by EPA at 40 CFR § 70.2 or any subsequent amendments thereto, and that has the potential to emit any of the air contaminants listed below in an amount that is equal to or exceeds the applicable major facility threshold level." Table 3-2 summarizes the major source thresholds, compared to construction emissions.

TABLE 3-2 CONSTRUCTION EMISSIONS COMPARED TO MAJOR FACILITY THRESHOLDS

POLLUTANT	OCS-APPLICABLE EMISSIONS DURING CONSTRUCTION, BOTH PROJECTS, TONS IN THE WORST-CASE YEAR	MAJOR FACILITY THRESHOLD LEVEL, TPY
CO	452.2	100
PM_{10}	55.0	100
$PM_{2.5}$	53.4	100
TOTAL SUSPENDED PARTICLES (TSP)	55.0	100
SO_2	4.1	100
SO_2 (AS $PM_{2.5}$ PRECURSOR)	4.1	100
NO_X	1,704.1	25
NO_X (AS $PM_{2.5}$ PRECURSOR)	1,704.1	100
VOC	39.2	25
LEAD	0.007	10
ANY HAP	< 3.5	10
ALL HAPS, COLLECTIVELY	3.5	25
ANY OTHER AIR CONTAMINANT, EXCEPT CO_2	NONE IDENTIFIED	100

The regulations separately define "preconstruction permit," "operating certificate approval," and "operating permit approval." Per 7:27-22.5(g):

> *A new facility subject to this subchapter may either obtain preconstruction permit and operating certificate approval pursuant to NJAC 7:27-8 or such facility may elect to obtain both preconstruction and operating permit approval simultaneously by the submittal and approval of a consolidated preconstruction and operating permit application pursuant to this subchapter and NJAC 7:27-8 prior to construction of the facility.*

Atlantic Shores is currently submitting an application for preconstruction permit and operating certificate approval pursuant to NJAC 7:27-8, only. Based on a review of the application content requirements in Subchapter 22, the additional requirements for a consolidated preconstruction and operating permit application would include information

on insignificant sources, and a compliance plan addressing the requirements described in this regulatory applicability section. Atlantic Shores may revise this application and elect to obtain both preconstruction and operating permit approval simultaneously.

3.8 Application Requirements

This OCS Application meets the substantive submittal requirements from NJAC 7:27-8.4, as described below:

- NJAC 7:27 8.4(d): Sections 2 and 3 of this application contain details regarding the equipment or control apparatus as necessary to determine that the equipment or control apparatus is designed to operate without causing a violation of any relevant State or Federal laws or regulations.
- NJAC 7:27 8.4(d): Section 4 of this application provides information necessary to determine compliance with the SOTA requirement in accordance with NJAC 7:27-8.12, State of the art.
- NJAC 7:27 8.4(d): Section 2 and Appendix B of this application contain descriptions of processes, raw materials used, operating procedures, physical and chemical natures of any air contaminant, and volumes of gas discharged.
- NJAC 7:27 8.4(e): Atlantic Shores is not claiming any information submitted as part of an application as confidential information.
- NJAC 7:27 8.4(g): This application provides information about significant sources.
- NJAC 7:27 8.4(h): Atlantic Shores proposes that the logical grouping of processes would be into Construction and O&M phases. During technical review of this application, Atlantic Shores looks forward to discussing options to logically group processes to allow issuance of separate approvals for Project 1 and Project 2.
- NJAC 7:27 8.4(i): Sections 3.4 and 3.5 of this application provide the NSPS and NESHAP applicability and compliance demonstration.
- NJAC 7:27 8.4(j): The protocol for conducting an air quality impact analysis was submitted on May 31, 2022, and comment responses were submitted on July 13, 2022. Notably, New Jersey regulations require submittal of a protocol only with the air permit application, not the air quality impact analysis itself.
- NJAC 7:27 8.4(k): The air contaminants that the source operation's potential to emit is above the applicable reporting threshold per NJAC 7:27 Subchapter 8 Appendix 1 Table A are as follows: Total VOC; TSP; PM_{10}; $PM_{2.5}$; NO_X; CO; SO_2. Atlantic Shores expects no emissions of any 112 (r) contaminant; any stratospheric ozone depleting substance, or any greenhouse gas except carbon dioxide (CO2) in amounts above the reporting threshold (0.05 lbs/hour). No source operation may under normal operations, emit the air contaminant in an amount which may result in noncompliance with the air pollution odor provisions at NJAC 7:27-8.3(j) and NJAC 7:27-5.

- NJAC 7:27 8.4(l): Atlantic Shores will use engine fuels as described in Section 4, and may use an incidental amount of paint for touch-up painting of OCS sources. Such fuels and paints will comply with specified maximum emission rates and applicable requirements as described in this Section.
- NJAC 7:27 8.4(o): The required certifications are provided at the beginning of this application.
- NJAC 7:27 8.4(p): Appendix A of this application contains information Atlantic Shores wants the Department to take into consideration in making a decision on an application. Specifically, is contains requests that EPA consider, or reconsider, certain interpretations as part of the review of this OCS air permit application.

3.9 New Source Review

3.9.1 Compliance with Subchapter 18

This OCS Application documents compliance with the substantive NSR requirements from NJAC 7:27 Subchapter 18, as described below:

- NJAC 7:27 18.2: NSR applies because the Projects combined will have OCS-applicable potential emissions in the worst-case year of construction above 25 tons of NOx and 25 tons of VOC, and the COA is in nonattainment for ozone.
- NJAC 7:27 18.3(b)1.: Section 4 of this application documents that the OCS sources will meet LAER.
- NJAC 7:27 18.3(b)2.: Atlantic Shores does not own or operate any existing facilities in New Jersey, so there is no requirement for a certification that such facilities are operating in compliance with NJAC 7:27 and standards promulgated pursuant to the Clean Air Act.
- NJAC 7:27 18.3(c)1.: Atlantic Shores will secure emissions offsets as described in Section 3.9.2 below.
- NJAC 7:27 18.3(c)2.: The required analysis of alternative sites, sizes, and processes is described in Section 3.9.3 below.

3.9.2 Emission Offsets

O&M will require offsets per NJAC 7:27 Subchapter 18. Consistent with recent South Fork Wind and Vineyard Wind precedent, offsets are not required for project construction. See for example the July 11, 2022 Fact Sheet for Vineyard Wind, OCS-R1-03-M1. Also, per NJAC 7:27-18.3(h) offsets are not required for temporary emissions increases from construction.

Subchapter 18 regulates the generation and use of Certified Emission Reductions or CERs as offsets. In other jurisdictions, such transferrable offsets are often called Emission Reduction Credits or ERCs. Atlantic Shores will offset the Projects' potential NOx and VOC

emissions, plus an additional Minimum Offset Ratio. The Minimum Offset Ratio is 1.3 offsets for offsets that are obtained from within 100 miles, 2.6 if within 250 miles, and 5.2 if within 500 miles. If applying a lesser minimum offset ratio, an air quality simulation model can be used to demonstrate a net air quality benefit.

Based on the current estimate of O&M emissions, the total amount of NOx emissions to be offset is [397.8] tpy and the total amount of VOC emissions to be offset is [8.6] tpy. These would be divided between Project 1 and Project 2, with the division depending on the final resolution of the overlap area.

Consistent with NJAC 7:27-18.3(e), Atlantic Shores is providing the following emission offset demonstration as part of this application:

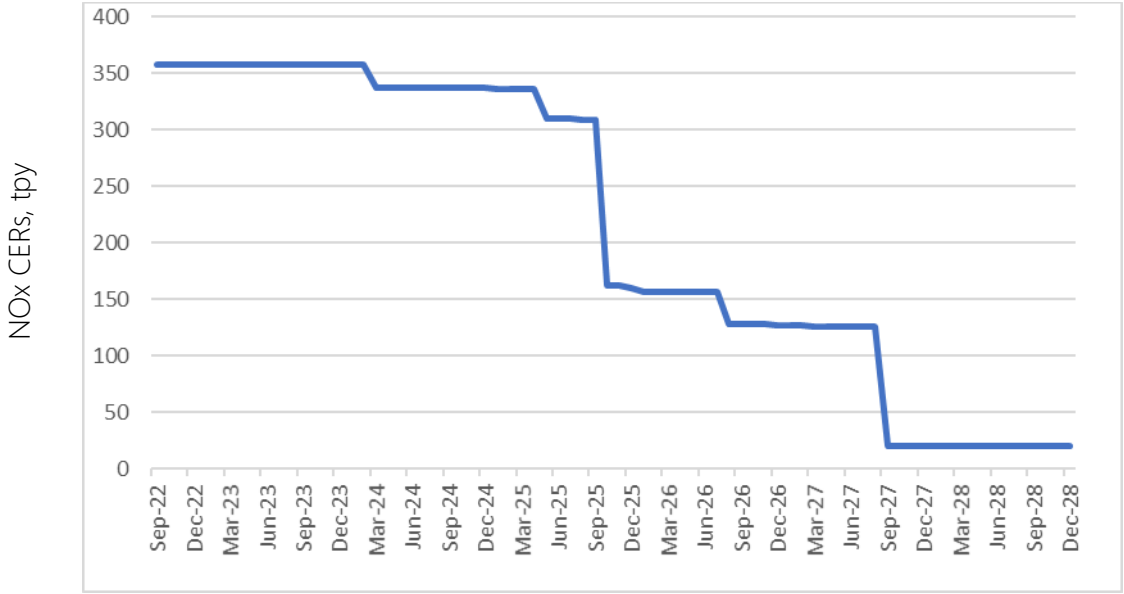
- The sources of the air contaminant emission reductions to be applied as emission offsets will be shutdowns of onshore emitting facilities that occur before the Projects commence commercial operation;
- Emission reductions will be effected through shutdown of emitting facilities;
- Atlantic Shores will make the permanent reduction of the emissions to be used as emission offsets Federally enforceable through the use of CERs or a similar banked reductions.
- Atlantic Shores will ensure that the permanent reduction of emissions shall be in effect on or before the initiation of operation of the newly constructed, reconstructed, or modified equipment or control apparatus by using CERs whose value after appropriate discounting meets or exceeds the required number of offsets applying the Minimum Offset Ratio.
- The offsets will comply with NJAC 7:27-18.5 by being banked in accordance with NJAC 7:27-18.8.

Atlantic Shores is not identifying a specific source of offsets with this initial OCS air permit application for two main reasons:

- The number and type of offsets needed is not certain. Per Appendix A, Atlantic Shores has requested several interpretations from EPA that would change the amount of offsets needed for the Projects. The technical review of this application may alter the number and type of offsets needed at the start of operation. The timing of the start of operation may change based on several factors.
- CERs and similar banked reductions available today would likely not satisfy the offset requirement at the start of construction. NJAC 7:27-18.3(f) states that the offsets must have occurred prior to initiation of operation. However CERs are discounted over time if regulations decrease an allowable emission limit (per NJAC 7:27-18.8(e)), for shutdown banked reductions are discounted 50 percent after five years and are no longer valid after ten years (per NJAC 7:27-18.8(f) and (g)). Per

Figure 3-1, the value of currently-banked shutdown NOx CERs statewide (per NJDEP's registry) drops significantly over time. By the planned operational dates of the Projects (2027 for Project 1 and 2028 for Project 2), the currently-available NOx shutdown CERs statewide would be insufficient for the Projects.

Figure 3-1 Value of currently banked NJ NOx shutdown CERs over time



Atlantic Shores expects additional CERs to be banked in the next few years, as existing emissions units retire. These new CERs would be more appropriate sources of offsets because they are less likely to be discounted before operation. Atlantic Shores also expects that during the technical review of this application there will be more clarity regarding the number of offsets needed, and the process to transfer credits and commit them for use as emissions sources[6].

3.9.3 Alternative sites, sizes, and processes

Per NJAC 7:27-18.3(c)2., this section provides an analysis of alternative sites within New Jersey, and of alternative sizes, production processes, including pollution prevention measures, and environmental control techniques, demonstrating that the benefits of the newly constructed, reconstructed, or modified equipment significantly outweigh the environmental and social costs imposed as a result of the location, construction, reconstruction or modification and operation of such equipment. Each portion of this analysis is taken in-turn.

[6] See https://www.state.nj.us/dep/aqpp/downloads/bec/FAQ.PDF, FAQ 14

- Alternative sites within New Jersey: The WTA is located within the New Jersey Wind Energy Area (NJWEA). The NJWEA was identified as suitable for offshore renewable energy development by the Bureau of Ocean Energy Management (BOEM) through a multi-year, public environmental review process. Through this review process, the NJWEA was sited to exclude areas of high value habitat and conflicting water and air space uses. Further information is available in Volume 1 Section 1.3.1 of the COP, and in information presented by NJDEP[7]. Other lease areas within the NJWEA are being developed by Atlantic Shores or other developers for offshore wind use.

The State of New Jersey recognized the value of offshore locations for energy production in issuance of the New Jersey Offshore Wind Economic Development Act (OWEDA). Atlantic Shores is developing the Projects in response to New Jersey offshore wind energy solicitations. Development onshore would not respond to these solicitations.

- Alternative sizes and production processes: Atlantic Shores has sited the Projects' facilities and developed the PDE to maximize renewable energy production, minimize environmental effects, minimize cost to ratepayers, and address stakeholder concerns. The PDE articulates the maximum design scenario for key project components, such as the type and number of WTGs, foundation types, OSS types, cable types, and installation techniques. The PDE provides Atlantic Shores with the necessary flexibility to respond to anticipated advancements in industry technologies and techniques, that even under a maximum scenario will not exceed an unreasonable level of environmental effects.
- Pollution prevention measures and environmental control techniques: As described below the Projects themselves are pollution control measures, because they will allow for the displacement of existing fossil fuel electric generation and its associated pollution. Per Section 4 of this OCS air permit application, air quality control measures for OCS sources meet applicable LAER, BACT, and SOTA requirements. Overall air quality control measures are described in Volume 2 Section 3.1 of the COP, and Volume 2 of the COP more broadly presents Potential Impacts and Proposed Environmental Protection Measures related to environmental setting, physical resources including air and water, biological resources, visual resources, cultural resources, socioeconomic resources, noise, and public health & safety.
- Demonstration that the benefits significantly outweigh the environmental and social costs: The Projects will result in a significant net decrease in harmful air pollutant emissions region-wide by displacing electricity from fossil fuel power plants.

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[7] https://www.nj.gov/dep/offshorewind/projects.html, accessed 8/27/2022

Available data on avoided emissions is summarized in Table 3-3, based on the Project 1 nameplate capacity of 1,510 MW with 50% capacity factor and 4% transmission losses displacing the latest-available output emission rate for the Reliability First Corporation (RFC) East subregion as published by the EPA (EPA 2020a).

TABLE 3-3 AVOIDED AIR EMISSIONS[1]

	NO_X, TONS/YEAR	$PM_{2.5}$, TONS/YEAR	SO_2, TONS/YEAR	CO_2E, TONS/YEAR
PROJECT 1	2,162	153	2,549	3,964,000
PROJECT 2[2]	1,374	97	1,621	2,520,000

[1]Based on the non-baseload output emission rate for NO_x, SO_2, and CO_2E; based on the total output emission rate for $PM_{2.5}$.[2] Based on a reasonable minimum Project 2 size of 960 MW.

The emissions savings shown in Table 3-3 provide only a partial description of the air quality-related benefits of the Projects, for the following reasons:

Traditional power plants do not include emissions associated with plant construction, fuel delivery, maintenance, worker commute, safety systems, vehicles, or machinery when reporting direct emissions.

- The Project will also avoid emissions of HAPs including mercury, acrolein, formaldehyde, and cadmium associated with fossil fuel generation.
- The emissions reductions will occur at fossil fuel power plants that tend to be near population centers, or upwind of population centers, including overburdened Environmental Justice communities. Project-related air emissions will predominately occur offshore away from population centers.

The Projects' avoided emissions will benefit human health and the environment over the entire operational life of the Projects.

3.10 Environmental Justice

3.10.1 New Jersey Environmental Justice Legislation

New Jersey has enacted Environmental Justice legislation (N.J.S.A. 13:1D-157, et seq.) protect overburdened communities which have been historically subject to a disproportionately high number of environmental and public health stressors. The law defines overburdened communities, and directs agencies to enact regulations focused on protecting those communities.

Implementing regulations are under development, including proposed new rules at NJAC 7:1C. NJDEP's Administrative Order No. 2021-25A extends public comment opportunities for certain permit issuances and renewals in mapped environmental justice communities. Because this OCS air permit application addresses activities in the WTA, and because the WTA is entirely offshore and so is not located in an overburdened community, this OCS air permit application is not subject to the legislation or the administrative order, and would not be subject to the implementing regulations. Onshore portions of the Projects do not require significant environmental permits, and would not trigger review under the legislation, the administrative order, or the proposed regulations.

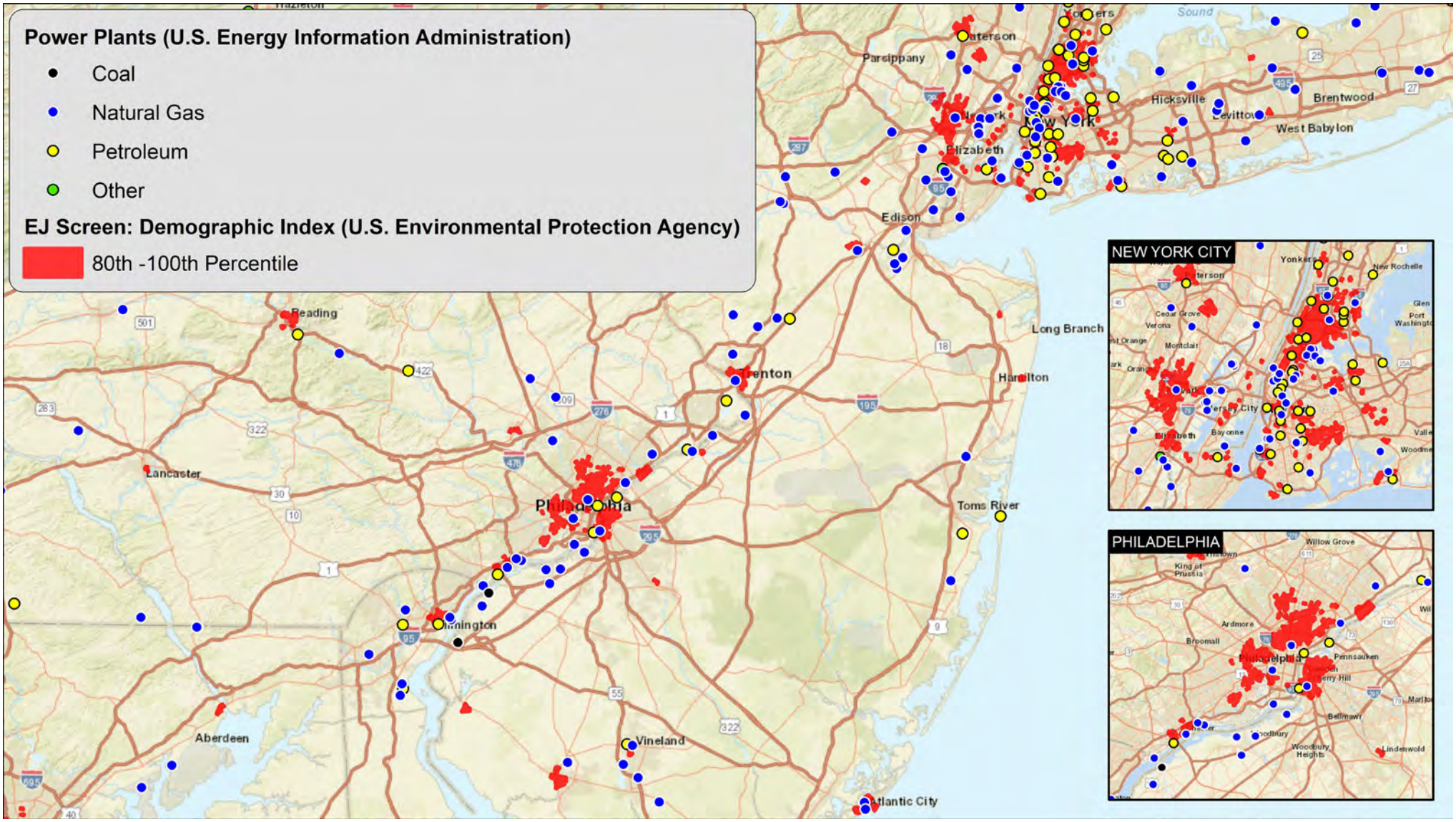
3.10.2 Federal Executive Order

Executive Order 12898 of February 11, 1994 titled "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" states: "*…each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations…*" The air emissions that are the subject of this OCS air permit application will not have effects on minority or low-income populations that are either disproportionally high or adverse. As shown in Section 5 of this application, peak air quality impacts from proposed operations are entirely over water, several miles from any minority or low-income populations. Section 5 also shows that the Project will not cause or significantly contribute to any exceedance of the NAAQS at any location. The NAAQS are standards set to protect human health from adverse effects from air emissions.

On the contrary, the effect of the Projects is likely to improve air quality in Environmental Justice communities. As shown in Table 3-3, the Projects will result in reduced air emissions region-wide by displacing electricity from existing fossil fuel power plants. Figure 3-2 shows the proximity of existing fossil fuel power plants to environmental justice populations in the region. It is reasonable to conclude that the Projects' effect of displacing electricity from existing fossil fuel power plants will serve to reduce the impact from those power plants on environmental justice communities.

3.10.3 Environmental Justice Outreach and Analysis

Atlantic Shores is addressing both enhanced outreach and enhanced analysis of impacts related to Environmental Justice communities through the BOEM-led NEPA process. Volume 1 Section 1.4.2 of the COP summarizes stakeholder outreach, including outreach to fishermen. Volume 2 Section 7.2 of the COP identifies Environmental Justice communities potentially affected by specific activities associated with the Projects, and reviews those potential impacts and proposed environmental protection measures.



ATLANTIC SHORES offshore wind

Figure 3-2

Proximity of Existing Fossil Fuel Power Plants to Environmental Justice Populations

4.0 Control Technology Review

As described in Section 3, elements of the Projects are subject to three requirements related to selection of emissions control technology. These are Best Achievable Control Technology (BACT), Lowest Achievable Emissions Rate (LAER), and State Of The Art (SOTA). This section describes each standard, reviews when the standard applies, and demonstrates how the Projects will satisfy the standard.

4.1 Regulatory Standards

BACT is defined (in part) as:

> *an emissions limitation … based on the maximum degree of reduction for each pollutant subject to regulation under [the Clean Air] Act which would be emitted from any proposed major stationary source or major modification which the Administrator, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems and techniques … for control of such pollutant. [40 C.F.R. § 52.21(b)(12)]*

LAER is defined as:

> *a limitation on the rate of emission from any source operation, equipment, or control apparatus which is consistent with the most stringent of the following: 1. The most stringent emission limitation which is contained in the SIP of any state for such class or category of source operation, equipment, or control apparatus, unless the owner or operator of the proposed new or altered equipment or control apparatus demonstrates to the satisfaction of the Department that such a limitation is not achievable by that equipment or control apparatus; 2. The most stringent emission limitation which is achieved in practice by such class or category of source operation, equipment, or control apparatus; or 3. The most stringent emission limitation established in any NSPS or NESHAP applicable to such class or category of equipment or control apparatus. [NJAC 7:27-18.1]*

Per NJDEP[8], The Air Pollution Control Act of New Jersey mandates that new or modified sources which emit air pollutants incorporate "advances in the art of air pollution control", commonly referred to as "State-of-the-Art" or "SOTA." Per NJAC 7:27-22.35, SOTA is equivalent to BACT or LAER for sources and pollutants subject to those standards.

[8] https://www.state.nj.us/dep/aqpp/sota.html, accessed 8/12

Otherwise, SOTA is addressed by "the use of up-to-date technology and methods, reflected in equipment, control apparatus, and procedures, that when applied to an emission source will reasonably minimize emissions of that contaminant" [NJAC 7:27-22.35(c)(5)].

4.2 Applicability to Projects Activities

4.2.1 Applicability Requirements

The control technology requirements BACT, LAER, and SOTA apply to activities associated with the Projects as follows:

- All three apply only to OCS sources. As described in Section 3, above, an OCS source includes any equipment, activity, or facility which emits or has the potential to emit any air pollutant, is regulated or authorized under the OCSLA (43 U.S.C. § 1331 et seq.) and is located on the OCS or in or on waters above the OCS, and includes vessels only when they are permanently or temporarily attached to the seabed and erected thereon and used for the purpose of exploring, developing or producing resources therefrom, within the meaning of section 4(a)(1) of OCSLA (43 U.S.C. §1331 et seq.); or physically attached to an OCS source, in which case only the stationary sources aspects of the vessels will be regulated.
- BACT applies only to air contaminants from OCS sources subject to PSD, as described in Section 3 above.
- LAER applies only to air contaminants from OCS sources subject to nonattainment NSR, as described in Section 3 above.

SOTA applies to air contaminants from OCS sources subject to PSD or nonattainment NSR, and also to any other air contaminant except carbon dioxide (CO2) with the potential to emit more than five tons per year.

- The Projects' OCS sources are subject to control technology reviews as follows:
- Diesel-fired engines[9] on domestic-flagged vessels meeting the definition of an OCS source;
- Diesel-fired engines on certain foreign-flagged vessels meeting the definition of an OCS source;
- Internal combustion engines on OCS sources; and

[9] Some vessels use oil-fired combustion turbines instead of engines; the applicable control technologies are similar.

- Electrical equipment on OCS sources[10].

Domestic and foreign-flagged vessels are addressed separately because different emission standards and requirements are feasible based on the regulations they are subject to.

4.2.2 Specific Equipment Subject to Control Technology Review

Consistent with prior OCS permitting precedent, jack-up vessels are OCS sources subject to control technology review requirements under certain conditions. As described by EPA in the Vineyard Wind Fact Sheet:

> *Since the jack-up vessel is a vessel, it must meet one of the two criteria for a vessel to be included as an OCS source and thus be considered part of the OCS source (i.e., the WDA [wind development area] facility). The EPA has determined that a jack-up vessel is included in the definition of an OCS source once three of the jack-up vessel's legs have attached to the seafloor, because the jack-up unit has become stationary and is no longer operating as a vessel or a barge. Once that occurs, the jack-up vessel is considered to be erected on the seabed since the vessel will not be using its engines to maneuver itself at that time. From that point forward (which, for brevity, we refer to as the unit's "attachment"), the jack-up vessel's activity and emissions equipment involve developing or producing resources from the seabed by erecting a WTG on the seabed that will convert wind energy into electricity or an ESP [electrical service platform] to convey this electricity to shore. The EPA expects that for the WDA facility, the first OCS source will be a jack-up vessel.*
>
> *Therefore, once a jack-up vessel (including the construction equipment on it) becomes part of the OCS source, all emission units on the jack-up vessel are subject to the applicable terms and conditions of the permit. At the conclusion of the jack-up vessel's construction activities at a given location in the WDA, the construction equipment ceases operating and the jack-up legs are raised from the seafloor. The jack-up vessel's stationary source activities thereon remain regulated as part of the OCS source, and subject to the term and conditions of the permit, until the point in time (which, for brevity, we refer to as the unit's "detachment") when fewer than three jack-up legs are attached to the seafloor. Once the jack-up vessel detachment occurs, it returns to its status as a vessel and is no longer subject to the stationary source requirements of part 55. The jack-up barge and its associated emission units are*

[10] As discussed in Section 4.6.3.4, the potential for fugitive emissions of SF6 from electrical equipment on WTGs does not cause the WTGs to meet the definition of OCS source. Such fugitive emissions are therefore not subject to control technology review requirements.

included in the potential emissions calculations for the WDA facility at all times when within 25 miles of the WDA facility and are subject to the permit's recordkeeping and NNSR offset requirements. However, the jack-up vessel is only subject to the specific emissions limits during the time it is attached to the seabed and regulated as a stationary source under part 55.

Atlantic Shores does not have any plan or expectation that other vessel engines will become OCS sources. Specifically:

- Except for the jack-up vessels described above, Atlantic Shores generally does not expect that any vessels will by themselves become OCS sources. There are no plans for any other vessels to temporarily or permanently attach to the seabed, and while attached to the seabed be used for the purpose of exploring, developing, or producing resources from the seabed. That is, Atlantic Shores does not plan for any air emissions from vessel engines that are attached to be related to be exploring, developing, or producing resources from the seabed by erecting a WTG or OSS on the seabed that will convert wind energy into electricity.
- Similarly, Atlantic Shores does not plan or expect that any vessel will become an OCS source by attaching to an OCS source. An important example is the use of an SOV or a CTV to deliver personnel or equipment to an OSS or a jack-up vessel. The SOV or CTV will in most or all circumstances will not attach to the OSS or jack-up vessel, and will instead use its own engines to push against the OSS or jack-up vessel during the transfer. Even if the vessel attaches to the OCS source, Atlantic Shores does not plan or expect that any air emissions from vessel engines that is attached to be related to be exploring, developing, or producing resources from the seabed by erecting or maintaining a WTG or OSS on the seabed that will convert wind energy into electricity. The vessel engines would not be used to perform work relating to the construction or maintenance of any WTG or OSS.

In the event that one or more vessels become OCS sources, they would be subject to the appropriate control technology review as described below.

Regarding diesel engines on OCS sources, the OSSs will have diesel-fired electric generators during the commissioning stage and some of the generators will remain on the OSSs during operation as a source of back-up power. These will be OCS sources subject to control technology review. Similarly, the WTGs may have diesel-fired generators during the commissioning stage. These will be OCS sources subject to control technology review.

Regarding electrical equipment, no emissions are expected during normal operations. Electrical equipment will contain some SF6, which is a GHG. Equipment containing SF6 will be present on the OSSs and the WTGs. The SF6 will be in hermetically sealed systems, and Atlantic Shores will not conduct any filling operations in the OCS. Fugitive emissions

of SF6 would be subject to control technology review if those emissions occur on an OCS source (the OSSs, which will have backup diesel generator air emission sources). The potential for fugitive SF6 emissions does not, by itself, cause the WTGs to become OCS sources.

4.3 Regarding Vessel Selection

4.3.1 Project Design Envelope

As described in Section 3.0 of the COP, Atlantic Shores is requesting review and authorization of the Projects using a PDE approach as outlined in BOEM's (2018) draft PDE guidance. The Projects' PDE includes a reasonable range of designs for proposed components (e.g., foundations, WTGs, export cables, onshore elements) and installation techniques (e.g., use of anchored, jack-up, or dynamic positioning [DP] vessels). Identifying a range of design parameters and installation methods allows BOEM to analyze the maximum impacts that could occur from the Projects while providing Atlantic Shores with the flexibility to optimize the Projects within the approved PDE during later stages of the development process. The PDE will enable Atlantic Shores to employ the best available technology, which often outpaces the permitting process, to maximize renewable energy production, minimize adverse environmental effects, address stakeholder concerns, and minimize cost to ratepayers.

As such, the specific WTG make and model has not been selected, and could be different for different portions of the Projects. The installation methods have not been finalized. The equipment descriptions and air emissions estimates provided in this OCS application represent the best information currently available to Atlantic Shores, and represent a conservative overall estimate of impacts, but do not represent a final design.

4.3.2 Contracting Process

For most or all construction and O&M contracts, the contracts will not be finalized until after the specific Project reaches financial close, which will not occur until after all permits, including the OCS air permit, are issued. To allow the Projects to maximize renewable energy production, minimize impacts, and minimize ratepayer costs, Atlantic Shores will carefully manage the rapidly-changing landscape of offshore construction and O&M equipment and personnel availability.

For many specialized operations, a very limited fleet of vessels currently exists worldwide. For example, as noted in the DOE *Offshore Wind Market Report: 2022 Edition*[11]:

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[11] https://www.energy.gov/sites/default/files/2022-08/offshore_wind_market_report_2022.pdf

> *As of 2022, no U.S.-flagged WTIVs [wind turbine installation vessels] exist that can lift the new 15-MW-class wind turbines. … Based on projected offshore wind energy deployment, the United States will require between four and seven WTIVs to meet the 30-GW-by-2030 deployment target. … To avoid supply chain bottlenecks stemming from a lack of WTIVs, developers must either commission the construction of new U.S.-flagged WTIVs or advance alternative Jones-Act compliant installation strategies that integrate foreign-flagged WTIVs and U.S.-flagged feeder vessels.*

Atlantic Shores has developed its COP and this OCS Air Permit Application based on the use of a foreign-flagged WTIV and U.S.-flagged feeder vessels. The exact specifics will depend on vessel and contractor availability, which will in-turn depend on final construction schedule of the Atlantic Shores Projects and other OSW projects. Those construction schedules cannot be established with any certainty until much later in the development process (i.e., after the OCS permit is issued).

Other vessel availability is also constrained. For example the DOE report states "In the short term, existing oil and gas platform service vessels may be adapted or repurposed as U.S.-flagged SOVs."

As such, Atlantic Shores is providing the following information regarding what vessels are available for use. A vessel is "available" if it is:

- capable of performing the work needed for the Project's specific activities in accordance with the Project's permits, environmental commitments, and other regulatory requirements (including the Jones Act);
- within the primary contractors and their subcontractors' fleet of vessels; and
- can be secured for the time period needed to maintain the Project's construction schedule.

Offshore wind projects are highly complex logistical projects that are sequenced carefully to avoid interruptions and to complete the full project on time, on budget, and without accidents. To secure the necessary experience to fabricate components, construct the Project, and begin delivering power on-schedule, the contractor will be responsible for securing the vessels necessary to support construction, as well as hiring multiple subcontractors for supporting activities such as scour protection installation, equipment transport, environmental monitoring, etc.

Selection of contractors is a complex and lengthy process addressing many issues. The selection of a primary contractor must account for: the technical feasibility of the contractor's methodology; the impact of the contractor's methodology on numerous resources; the proposed schedule; the experience of the contractor (including their safety record); the quality of the contractor's health; safety and environmental documentation; the contractor's ability to comply with permits/permit applications; ability to provide a

vessel spread that can perform the needed work and comply with the Jones Act; ability to accommodate changes to the design or schedule; the contractor's support for local businesses and labor; cost; and other factors. The primary contractors are limited to the fleet of vessels available to them or their subcontractors that are capable of performing the work needed to construct each Project.

4.4 Review of Control Technologies

4.4.1 Internal Combustion

Engine manufacturers incorporate pollution control measures into their designs. Techniques used by engine manufacturers include: ensuring complete combustion in the engines, by controlling of the combustion air, controlling fuel flow, ensuring complete mixing, and staging combustion; avoiding hot spots in the combustion process that can form NO_x, by staging combustion, injecting water, recirculating flue gas, and otherwise cooling the system; and using post-combustion controls to remove air pollutants after they have formed, by adding particulate filters, oxidation catalysts, and selective catalytic reduction systems. Options are available to retrofit older engines with some of these technologies; the specifics vary from engine to engine.

Control techniques can be categorized into three main groups which are changes in raw materials, process modifications, and add-on pollution controls. Changes in raw materials are discussed more in sections 4.5.1 and 4.5.2. This section will focus on the techniques and modifications used by manufacturers to control emissions from engines without changing the fuel used.

The first way that emissions are controlled from engines by the manufacturers is through the use of process modifications. Process modifications include engine optimizations, water injection, flue gas recirculation, reduced oil consumption, turbocharging and aftercooling, and general good combustion practices.

Engine optimizations can come in many forms including but not limited to the following:

- Fuel injection timing controls that delay the start of fuel injection to reduce the formation of NO_x. The delay in fuel injection results in the injection ending later in the combustion stroke when the cylinder volume is increasing, and heat is being removed from the gases through the expansion process. Injecting the fuel when the gases are cooling down reduces the temperature of the combustion process. NO_x formation during combustion is tied to temperature and increases exponentially with higher temperatures. Delaying the fuel injection reduces the combustion temperature and decreases NO_x emissions, however the trade off is that delayed fuel injection typically results in higher fuel consumption and products of incomplete combustion such as PM, CO, and VOC.

- High pressure injection which increases the injection pressure in order to create turbulent mixing. Turbulent mixing increases interactions between the soot particles and oxidants which can reduce the overall PM emissions. High pressure injection works by increasing the velocity of the fuel that is sprayed into the cylinder which results in increased motion of the air and fuel resulting in a more turbulent mixing process. This method is most effective at reducing PM in low load conditions and can also reduce the emissions of VOC and reduce fuel consumption. The tradeoff is a potential for slightly increased NO_x emissions at low loads and reduced efficacy of the method at higher loads which also have an increased risk of increased NO_x emissions due to the increased temperature from the turbulent mixing.
- Multiple fuel injection is another method that works similar to high pressure injection to increase turbulent mixing but works by having injection split into multiple different sprays to increase the turbulent motion inside the engine cylinder.

Water injection can come in the form of direct water injection (DWI), humidification of the intake air, and the generation of fuel-water emulsions. The general concept behind these three methods is to add water into the mix to absorb a portion of the heat of combustion thus lowering the resulting temperature which reduces NO_x emissions that are directly tied to combustion temperature. Decreasing the combustion temperature has the downside of increasing incomplete combustion that can result in other criteria pollutant generation such as CO and VOC. Each method accomplishes this temperature reduction differently. Fuel-water emulsions generate a mixture of fuel oil, water, and emulsifying agents that are injected into the system. Humidifying the intake air increases the water content of the intake air that is used for combustion rather than adding water to the fuel or directly injecting it into the process. The downside to intake air humidification is that more water is required compared to DWI and fuel-water emulsions to generate the same reduction in NO_x emissions. DWI systems inject water directly into the combustion chamber and allows for a more direct control over the water injection. The precise control is key to maximizing the NO_x reduction while minimizing the increase in products of incomplete combustion.

Flue gas recirculation (FGR) is a technique that takes a portion of the flue gas and returns it to the engine's cylinder. The flue gas has a reduced oxygen concentration compared to fresh air which reduces the amount of oxygen present for the reactions that form NO_x. The recycled gas also absorbs a portion of the combustion energy which reduces temperature and decreases NO_x formation. One potential complication with FGR systems is the presence of particulate matter in the flue gas which can cause deterioration and deposition of particulate within the engine components.

Another method for controlling emissions is the reduction of lubricating oil consumption which can help to reduce the emissions of particulate matter. The lubrication of the engine cylinders is a major contributor to particulate emissions from the engine. Oil consumption

can be reduced by improving ventilation systems, redesigning engine components, or valve stem seals. These changes reduce oil consumption by decreasing leaks of oil within the engine. There are also systems that can electronically control the system to inject a set volume of lubricating into the oil at certain intervals which maximizes the engine lubrication and minimizes waste of lubricating oil.

Turbochargers and aftercoolers are two pieces of equipment that can be incorporated into the engine design to minimize emissions. Turbochargers help maintain the airflow to the engine which helps reduce the emissions of particulate matter in the form of elemental carbon. Aftercoolers are heat exchangers that can be added to the engine to cool intake gases in order to reduce the combustion temperature which reduces the formation of NO_x. The general flow of the operation would be to have air flow through the turbocharger, then the aftercooler, then into the engine intake manifold. Many engines already incorporate these two technologies to manage the emissions of NO_x and particulate.

Engine operators can also influence the emissions by using good combustion practices when operating the engine. Good combustion practices can result in a general reduction of all pollutants. Generally accepted good combustion practices include performing regular maintenance, inspections, and evaluations of the engine, operating the engines according to manufacturer specifications, and maintaining a proper air to fuel ratio, residence time, and combustion temperature.

The second way that emissions from engines can be reduced is through the use of post combustion control devices. Common post combustion controls include selective catalytic reduction, selective non-catalytic reduction, particulate filters, oxidation catalysts, scrubbers, and carbon capture.

Selective Catalytic Reduction (SCR) systems are a common post combustion control technology that is used to reduce emissions of NO_x from combustion sources. SCR systems operate by reacting ammonia with the NO_x in the exhaust gas to form water and nitrogen gas via the following reaction:

$$4\ NO + 4\ NH_3 + O_2 \rightarrow 4\ N_2 + 6\ H_2O$$

The SCR system uses a catalyst to reduce the NO_x to nitrogen at a relatively low temperature. The ammonia is supplied through the injection of either aqueous ammonia, anhydrous ammonia, or a urea-water mix upstream of the reactor. The reactor typically consists of a honeycomb ceramic or metal panel substrate lined with a thin coating of catalyst. The reaction occurs in a relatively low temperature range. If the temperature is too low, the reaction occurs slowly, and the control efficiency is reduced. If the temperature goes too high, the catalyst will be rapidly destroyed. Sulfur compounds can foul and reduce the effectiveness of the catalyst, so low sulfur fuels like ultra-low sulfur diesel (ULSD) or natural gas should be used with an SCR system.

Selective non-catalytic reduction (SNCR) is a technology that works similarly to an SCR but without the use of a catalyst. Since there is no catalyst, a higher temperature (1,600 – 2,000 °F) is required for the reaction to occur. If the temperature is too low, some of the ammonia reagent can pass throw the system unreacted in the form of ammonia slip. If the temperature is too high, additional NO_x can form from the oxidation of the reagent.

Another add-on control technology is a diesel oxidation catalyst (DOC). DOC systems are devices that the exhaust gas flows through that contains a coating of catalyst to oxidize CO and organic compounds. As a result, CO, VOC, and the organic component of PM are reduced by DOC systems. DOC systems have the potential to oxidize sulfur into sulfate compounds which can lower the effectiveness of the control technology for the PM.

Particulate matter emissions can be controlled through the use of diesel particulate filters (DPF). DPF systems consist of wall-flow filters that physically capture the fine particulate matter by passing the exhaust through a porous media with very small openings. The small openings increase back pressure, requiring additional force to push the exhaust through the filter which can result in additional fuel consumption. DPF systems can oxidize the captured particulate matter by using the high temperature of the exhaust gas or through external electric or fuel heating. There are also Catalytic DPF units which can operate at lower temperatures due to the use of a catalyst to help oxidize the PM however at higher temperatures the catalyst can result in oxidation of SO_2 into sulfates which can reduce the control effectiveness. A side benefit of catalytic DPF units is that they have the potential to oxidize products of incomplete combustion (CO and VOC) if the exhaust temperature is high enough. Other particulate filter options such as fabric filters and flow through filters can be used as well.

Scrubbers can be used to control emissions of nitrogen oxides or sulfur oxides. Scrubbers work by passing water and the exhaust gas by each other in order to transfer the NO_x or SO_2 into the water. In NO_x scrubbers, the end result would be water with a high nitrogen concentration which can cause issues if discharged to open water from the vessel. In SO_2 scrubbers, the SO_2 would convert into sulfuric acid in the water which can then be reacted with a base such as caustic or carbonate in order to neutralize the acid. The solids are captured and collected for onshore disposal while all or a portion of the treated water can be discharged into the ocean.

There are technologies to control carbon dioxide emissions such as carbon capture and sequestration which captures the carbon dioxide, compresses it, transports it, and then sequesters it. This technology requires large amounts of space and a way to pipe the CO_2 to a storage location and is not common as the technology is not very efficient, has large costs, and requires a lot of space which makes it unlikely to be feasible for use in most applications.

4.4.2 Electrical Switchgear

Sulfur hexafluoride (SF6) will be used to insulate electrical equipment. SF6 is commonly used in the power industry, and SF6 allows for protection from short circuits and arcs, using equipment that takes a small amount of space. SF6 is very chemically stable, and is used in sealed systems. Some leaks are possible as fugitive emissions from those sealed systems. Available technologies are alternatives that do not use SF6, and leak minimization. Alternatives that do not use SF6 include air-insulated equipment, which takes up more space, and certain alternative fluorinated chemicals (fluoronitriles) which are in development and early implementation.

4.5 LAER

Following the definition of LAER in NJAC 7:17-18.1, this section documents that each emission source and pollutant subject to LAER meets: the most stringent (applicable, achievable) emission limitation in any SIP; the most stringent emission limitation achieved in practice; and the most stringent emission limitation established in any applicable NSPS or NESHAP.

Per EPA guidance (1990), LAER is expressed as an emission rate and may be achieved from one or a combination of: (1) a change in the raw material processed (i.e., a change in fuel type); (2) a process modification; and (3) add-on pollution controls.

Emissions subject to LAER include:

- NOx and VOC emissions from vessels that become OCS sources (foreign and domestic-flagged jack-up vessels); and
- NOx and VOC emissions from stationary engines on OCS sources.

4.5.1 Foreign & Domestic Jack-up Vessels

4.5.1.1 SIP

Atlantic Shores reviewed SIPs for coastal states[12] to identify regulations potentially-applicable to marine engines. The following regulations were identified:

- California Code of Regulation (CCR) Title 13 Chapter 2299.3 and Title 17 Chapter 93118.3 "Airborne Toxic Control Measure for Auxiliary Diesel Engines Operated on Ocean-Going Vessels At-Berth in a California Port." This regulation does not apply to OCS sources because vessels will not be OCS sources while at berth.

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[12] https://www.epa.gov/air-quality-implementation-plans/approved-air-quality-implementation-plans, accessed 8/22/2022

- CCR Title 17 Chapter 93118.5 (excluding (e)(1)) "Airborne Toxic Control Measure for Commercial Harbor Craft."

The requirements at 17 CCR 93118.5 would not apply to jack-up vessels for the Projects because:

1. Any jack-up feeder would not be subject to the SIP-approved version of the regulations. The approved version of the regulations is dated November 19, 2008, and the subsequent amendments to the regulation (that address crew and supply vessels) are not incorporated into the California SIP. The SIP-approved regulations only apply to multipurpose harbor craft, which would not include the jack-up feeders[13].
2. Any WTG installation vessel would also not be subject to the SIP-approved version of the regulations as described above. Further, any WTG installation vessel would meet the definition of "Ocean-going Vessel" (17 CCR 98118.5(d)(52)) and would be exempt from the regulation (17 CCR 98118.5(c)(6)).

4.5.1.2 Achieved-in-Practice

The following sources were used to evaluate the most stringent NOx and VOC emissions limitations that have been achieved in practice:

- EPA's RACT/BACT/LAER Clearinghouse
- Other BACT databases and guidelines (California Air Resources Board (CARB), Texas Commission on Environmental Quality, South Coast Air Quality Management District)
- NJDEP SOTA Manuals
- EPA and CARB Verified Technologies Lists
- EPA's Air Permit Policy & Guidance Databases
- Recent OCS Air Permit/PSD permits issued by the EPA and their associated Statement of Basis

While not yet "achieved in practice," the OCS air permits issued for Vineyard Wind 1 (OCS-R1-03-M1) and South Fork Wind (OCS-R1-04) represent the most relevant LAER determinations for the Projects. For Vineyard Wind, EPA stated:

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[13] Because crew and supply vessels are not subject to the version of CCR § 93118.5(e)(6) that is incorporated into the California SIP, Atlantic Shores believes that these vessel categories should not have been specifically defined in the Vineyard Wind 1 and South Fork Wind permits to ensure the emission limits in the permit are at least as stringent as the California SIP.

All technologies or work practices, except for use of the highest tiered engine at the "time of deployment," are technologically infeasible for vessels meeting the definition of an OCS source. Based on this determination, the EPA finds that emission limits that could be achieved by technologies other than use of the highest tiered engine at the "time of deployment" to be unachievable. Thus, LAER is determined to be the use of the highest tier internal combustion engine at the time of deployment.

The South Fork Wind LAER determination uses similar language.

4.5.1.3 Emission-Limiting Techniques

LAER is an emission rate which "may result from a combination of emissions-limiting measures such as (1) a change in the raw material processed, (2) a process modification, and (3) add-on controls" (EPA, 1990). In determining LAER, the reviewing agency may consider technology transfer; that is, air pollution control techniques that could be applied from similar categories of applications. As such, the emission-limiting techniques reviewed for the jack-up vessels include techniques applied to marine engines and internal combustion engines more broadly, as well as other methods of power delivery.

Changes in Raw Materials

Changes in raw materials could encompass alternative power methods and sources, or the use of lower-emitting fuels in marine diesel engines. Neither is feasible for the proposed Projects for the following reasons:

- Onboard renewable energy sources (e.g., wind, solar) would not have the energy density needed to perform the necessary tasks.
- Batteries would not provide the needed energy for the duration of the project, and the use of battery-powered electric motors is not feasible as a replacement for internal combustion engines. Technologies that are existing and in advanced development are insufficient to reliably provide the needed energy in the quantities and durations needed to safely perform the vessels' duties. Available hybrid electric propulsion systems must be recharged using the internal combustion engines, with little or no ability to recharge using onshore power. As such, hybrid engines can offer a modest efficiency improvement by allowing the engines to operate more at their optimal load, but cannot eliminate the use of fuel combustion.
- The use of Liquefied Petroleum Gas (LPG) on vessels has been limited to very recent (2020 and later) conversions of LPG tankers, where there is an available supply of fuel. The conversion of offshore construction vessels to LPG use would require reliable access to LPG supply, and substantial replacement of vessel power plants.

While one potential source of LPG has been identified (at Marcus Hook, Pennsylvania), the overall supply of LPG is not broad enough or reliable enough to permit the conversion of large offshore construction vessels.

- Compressed Natural Gas (CNG) does not have the energy density needed to supply offshore marine construction vessels; there would not be space to store enough CNG for the vessel to serve its function.
- A limited number of Liquefied Natural Gas (LNG) capable vessels are in use or in-production, and some existing diesel engines can be converted to fire a blend of natural gas (from LNG) and diesel fuel. However, the infrastructure to refuel offshore construction vessels on the eastern U.S. seaboard is insufficient to provide a reliable source of fuel.
- Other alternative fuels (such as biodiesel, methanol, and hydrogen fuel blends) have significant safety, reliability, and availability issues in the marine environment, and in any event are unlikely to offer any real reduction in NOx and VOC emissions.
- For all fuel changes, the change would require a retrofit or replacement of not only the primary engines and drive system for the vessel but also likely the fuel storage configuration and location. These changes could easily alter a vessel's stability because of changes in weight distribution.
- For all fuel changes, large construction vessels do (and must) work globally in order to justify their high cost to construct & operate and the very specific niche they are designed for. As such, any fuel source must be accessible globally (not just in the U.S. or one region of the U.S.).

Process Modifications

As described in Section 4.4.1, above, options are available to engine manufacturers to limit NOx emissions by avoiding hot spots in the combustion process that can form NOx. This can be accomplished by staging combustion, injecting water, recirculating flue gas, and otherwise cooling the system. Options are available to engine manufacturers to limit VOC emissions by ensuring complete combustion. This can be accomplished by controlling of the combustion air, controlling fuel flow, ensuring complete mixing, and staging combustion. Depending on the vessel and the engine, some of these emissions limiting techniques can be applied to existing equipment through retrofits. Techniques available for onshore engines are generally transferrable to marine engines, with limitations on feasibility based on the conditions in the marine environment.

Add-on Controls

As described in Section 4.4.1, above, NOx can be removed from the engine exhaust using selective catalytic reduction, and VOC can be removed from the exhaust using an oxidation catalyst. Both techniques are available for new vessel engines and for vessel retrofits, subject to the technical challenges of operation in the marine environment and the specifics of the application.

4.5.1.4 LAER Determination

Therefore, use of a marine diesel engine that has been optimized to minimize NOx and VOC emissions via process modifications requires the Project to:

1. use a vessel with engines that already incorporate these process modifications to meet EPA or MARPOL Annex VI emission standards;
2. require contractors to replace old engines with newer engines that use these technologies; or
3. require contractors to retrofit a vessel's engine to have lower NOx and VOC emissions via process modifications.

It is not technically feasible for Atlantic Shores to meet LAER by replacing or retrofitting specific marine engines. Key reasons are detailed below:

- Atlantic Shores will not know which vessels and engines will be used until much closer to the start of construction and operation, and therefore cannot determine whether the vessels could accommodate the modifications. Space constraints, engineering issues, and health & safety factors could all render engine modifications impossible.
- The contracting process for offshore installation activities, including WTG installation, is not complete. At this early stage, the primary contractors would not know which vessels within their fleet may be available on the Project's schedule.
- Vessels including WTG installation vessels will need to meet Project-specific criteria regarding size, power, lifting capacity, sea state working limits, and other factors. Many of these specifications will depend on the WTG model has been selected and the foundations have been designed. This process may not be completed until after the federal permitting process is complete, and Atlantic Shores will need to have the flexibility to select appropriate vessels at that time.
- Even after contractor selection, the specific vessels used could change on short notice due to because of schedules (Atlantic Shores' and other projects'), weather, and needed equipment maintenance or repairs. That uncertainty is compounded by limitations on construction configuration options associated with the Jones Act.

- All vessels that are OCS sources will be third-party vessels; these vessels are not controlled by Atlantic Shores and will only be available to the Projects for a limited period of time. The vessels are very likely to be scheduled for other OSW-related work immediately before and after they are used for the proposed Projects. Taking such vessels out of service for upgrades or retrofits would be a months-long process, and Atlantic Shores will have no ability to require such upgrades or retrofits.
- Limitations on Atlantic Shores' ability to mandate controls for vessels that become OCS sources will exist for the construction period, and also for any major repairs that require the use of vessels that become OCS sources. During O&M, jack-up vessels are typically used infrequently for larger maintenance or repair activities and will be contracted for short periods. They may also be contracted quickly to address unplanned O&M activities, including O&M activities needed to address safety issues.

Per EPA's NSR Workshop Manual (1990), ""A LAER is not considered achievable if the cost of control is so great that a major new source could not be built or operated. This applies generically, i.e., if no new plants could be built in that industry if emission limits were based on a particular control technology." A requirement to vessel engines meeting specific limits (beyond using the best engines that are available at the time of deployment) would impose costs that could render the entire OSW industry non-viable for two reasons:

1. <u>To have economically viable projects, the industry needs competition among available equipment suppliers.</u> Project developers cannot select a contractor solely based on vessel air emissions. Requiring developers to select the contractor with the lowest-emitting vessel(s) would eliminate competition during the contract selection/negotiation process, which could drive up costs to the point where the projects would not be built.

2. <u>Project schedule delays can have follow-on effects severe enough to render an entire project non-viable.</u> Offshore wind construction projects are very complex, and are sequenced carefully to avoid interrupting each other and to complete the full project on time, on budget, and safely. Vessel sequencing and scheduling must address the order of installation, time of year (TOY) restrictions imposed by regulatory agencies, and weather constraints. If a particular installation window is missed, it could be months or years before the appropriate vessels are available again. The financial model for a successful project is equally complex, considering power deliver contracts, tax credits, and financing. The financial viability of any OSW project is extremely dependent on that project's ability to deliver power on-time. Constraints that mandate the construction or major retrofit of vessels, or that limit the vessels that can be used, can add enough schedule risk that OSW projects could not be financed or built.

The ability of Atlantic Shores to apply a specific LAER emission limitation to an unknown set of vessels that are temporarily supplied by third-party vendors is very limited. Delaying activities while waiting for a vessel with cleaner engines would likely serve to increase overall actual emissions, as vessels will be forced to idle, maneuver, and take additional trips to port. Following the Vineyard Wind and South Fork precedents, Atlantic Shores proposes to meet LAER by using vessels with the highest-tiered engines that are available at the time of deployment.

- For US-flagged vessels, the Project will ensure that all engines meet the highest applicable EPA Tier emission standards at 40 CFR Part 1042 (i.e., Tier 4 or Tier 3, depending on engine size), unless such a vessel is unavailable at the time of deployment, in which case the Project will use a vessel with engines meeting the emission limits for the next lower Tier. In no event, will the engines emit more than the Tier 1 emission limits at 40 CFR Part 1042 – Appendix I.
- For foreign-flagged vessels, the Project will ensure that all engines (except those ≤130 kW or emergency engines)[14] meet the MARPOL Annex VI Tier III NOx emission limits, unless such a vessel is unavailable at the time of deployment, in which case the Project will use a vessel with engines meeting the emission limits for the next lower Tier. In no event, will the engines emit more than the MARPOL Annex VI Tier I NOx emission limits.

Atlantic Shores does not expect any OCS sources of the vessel categories subject to the requirements at 17 CCR 98118.5. If a vessel subject to one of the categories described in 17 CCR 98118.5 becomes an OCS source, as part of LAER that vessel would need to meet the applicable requirements in 17 CCR 98118.5.

4.5.2 Engines on OCS Sources

This section presents the NOx and VOC LAER analysis for non-emergency[15] compression-ignition internal combustion (i.e., diesel) engines on the WTGs and OSSs.

[14] MARPOL Annex VI NOx emission limits do not apply to engines with a power output of 130 kW or less or emergency diesel engines.

[15] The engines on the OSSs will predominately be used for emergencies, but during commissioning and other planned activities they could have non-emergency use.

4.5.2.1 SIP

With respect to NOx and VOC emission limits for stationary compression-ignition internal combustion engines, most SIPs have adopted the NSPS at 40 CFR Part 60, Subpart IIII. Also, most SIPs have adopted the NESHAPs at 40 CFR 63, Subpart ZZZZ. This rule does not limit VOC directly but limits organic HAPs, which are VOCs. Atlantic Shores is not aware of any other rules or limits in SIPs that are more stringent than the applicable NSPS.

4.5.2.2 Achieved-in-Practice

This section reviews NOx and VOC emission limits for diesel engines that have been achieved in practice as well as relevant LAER determinations.

The same resources as described in Section 4.5.1 were used to evaluate the most stringent NOx and VOC emissions limitations that have been achieved in practice. The EPA's RACT-BACT-LAER Clearinghouse (RBLC) was searched for sources similar to the proposed source. The LAER analysis reviewed engines that fall into the two categories listed: engines rated below and above 500 HP. As a second step, the general RBLC search function was used to review other determinations from across the country for similar units. The determinations summarize the source (engine type, size, fuel, and use), the emission limit, and the type of emission limit (PSD-BACT, LAER, Case by Case, etc.).

4.5.2.3 Emission-Limiting Techniques

Emission-limiting techniques can include changes in the raw materials, process modifications, and add-on controls, and can apply techniques from similar categories of sources. LAER can therefore include other techniques to deliver electric power in the absence of power from the electric grid.

Changes in Raw Materials

Changes in raw materials could encompass alternative power methods and sources, or the use of lower-emitting fuels in marine diesel engines. Neither is feasible for the proposed Projects for the following reasons:

- Onboard renewable energy sources (e.g., wind, solar) would not have the energy density needed to perform the necessary tasks.
- Batteries are feasible for some offshore power needs, and will indeed be used for backup power supply on WTGs. The specific commissioning and OSS engines cannot be replaced by batteries because the weight and size of the batteries would exceed the constraints of the offshore installation, and energy could be needed for periods that would exceed the charge of a battery.

- The engines will be used to provide power during emergencies, and will be available for use in planned (non-emergency) situations when the use of electric grid power is not practical. To allow the engine to function in emergencies, the fuel used by the engine must be readily available, able to be stored locally, and fired without the need for external energy input as the engines will be situated offshore away from any pipeline fuel supplies. This requirement eliminates the feasibility of using natural gas.
- There may be unresolvable safety issues regarding bulk LPG handling while commissioning an ESP over water. Handling a fuel that generates flammable and explosive vapors while high-voltage equipment is being tested has inherent fire safety risks that could be impossible to mitigate.
- The fuel used by these engines would need to be supplied through bulk transfer (bunkering) or by using portable tanks. Bulk transfer of LPG would be unique for the small quantities needed for standby engines, and would carry significant fire safety risks (especially when performed in close quarters with electrical equipment). The use of portable LPG tanks would require lifting heavy tanks of hazardous materials, with safety risks associated with making and breaking piping connections to replace the portable tanks. These combined factors render the use of LPG infeasible.
- As a result, ULSD is the only remaining fuel that is feasible for use for stationary engines on OCS sources.

Process Modifications and Add-on Controls

Process modifications for internal combustion engines are generally as-described for vessel engines are discussed in detail in Section 4.4. Most process modifications are intrinsic to the design of the engine, and many add-on controls are similarly custom-designed for the engine. As such, process modifications are addressed by acquiring engines that meet the applicable engine certification standards. Depending on the certified engine, add-on controls such as catalysts are part of the application package.

For the diesel generators that will be OCS sources, the most stringent EPA Tier standards for engines firing ULSD are specified at 40 CFR Part 60, Subpart IIII, which in-turn references Tier 4 emission standards at 40 CFR Part 1039 for some types of engines. However, in recognizing the special challenges of reliable engine operation in a marine environment, EPA has issued separate marine diesel standards at 40 CFR Part 1042, and the standards for non-emergency stationary engines listed at 40 CFR § 60.4201 allow the substitution of the equivalent marine diesel standards in 40 CFR Part 1042 for engines used solely in marine offshore installations.

4.5.2.4 LAER Determination

Therefore, use of a marine diesel engine that meets the highest-tier applicable nonroad or marine diesel EPA standard satisfies LAER. This is consistent with other recent OCS air permit approvals, notably Vineyard Wind.

4.6 BACT

EPA policy and precedent establishes a five step "top-down" methodology as for identifying BACT, as follows:

1. The first step in the BACT process requires the identification of all available control options including air pollution control technologies or techniques with the practical potential for application to the emissions units for the pollutant in question. These technologies and techniques include the available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of the pollutant and includes technologies that are employed outside the United States. This process includes considering inherently lower-polluting process that are available as control alternatives and technologies that are existing and applied to similar source categories through technology transfer and innovative control technologies.

2. The second step of the BACT process looks at the technical feasibility of all the control technologies identified in the first step. These technologies are evaluated with respect to source specific factors. Any claim of technical infeasibility is to be clearly documented and based on "physical, chemical, and engineering principles, that technical difficulties would preclude the successful use of the control option on the emissions unit under review." Any technologies that are deemed technically infeasible are eliminated from consideration in the next steps of the BACT process.
3. The third step of the BACT process is to rank the technically feasible control technologies that remain after the second step. These are ranked based on efficacy with the most effective control alternative at the top of the list. This ranking list should include an analysis of control efficiency, expected emission rate and reduction, economic impacts, environmental impacts, and energy impacts.
4. The fourth step of the BACT process is to evaluate the controls cost effectiveness based on economic, environmental, and energy impacts. If a control technology is found to be inappropriate based on economic, environmental, or energy impacts basis, the next most stringent alternative becomes the new top control to be evaluated.
5. The fifth and final step of the BACT process is to select BACT based on the four prior steps with the top ranked control technology that was not eliminated based on economic, environmental, and energy impacts in step 4 being chosen as the proposed BACT for the pollutant under consideration.

BACT is often determined separately for each subject pollutant. For internal combustion, a combined analysis is preferable because changes in engine design & operation affect multiple pollutants. For example, reducing peak combustion temperature can reduce emissions of NOx but increase products of incomplete combustion.

In general, Atlantic Shores is unaware of control technologies used for internal combustion engines used for the Projects that are not in use in the United States. In all cases, Atlantic Shores has made a good faith effort to compile the appropriate information from available sources for the purposes of this BACT analysis. Atlantic Shores also considered the LAER and BACT determinations contained in the Vineyard Wind 1 and South Fork Wind OCS Air Permits, even though the limits have not yet been achieved in practice, since those permits contain the most recent and most relevant LAER and BACT determinations for the Atlantic Shores Projects.

4.6.1 Foreign & Domestic Jack-up Vessels

The foreign and domestic jack-up vessels that are used for the project are considered OCS sources, and as such have to comply with the requirements of LAER as described above for both NO_x and VOC emissions. As such, a separate BACT analysis is not performed for NO_x and VOC emissions from these vessels as BACT and LAER function similarly, except that LAER is more stringent in that it does not allow for the elimination of a technology from consideration based on energy, environmental, or economic impacts. Since LAER is always more stringent than BACT, the BACT for NO_x and VOC emissions is to comply with the LAER determination provided in Section 4.5. For the rest of the pollutants, a top-down BACT analysis is required using the five step methodology outlined in Section 4.6 above.

Per step 1 of the BACT process, the following paragraphs identify and list the control technologies for each pollutant that are available for internal combustion engines.

Carbon monoxide is a product of incomplete combustion similar to VOC and as such is typically controlled through the use of similar technologies as outlined in Sections 4.4 and 4.5. CO can be controlled by the use of control technologies that include:

1. Diesel oxidation catalyst
2. Catalytic particulate filter
3. 4-way catalytic converter
4. Good combustion practices.

Particulate matter, which is typically regulated as PM_{10} and $PM_{2.5}$, can be controlled through the use of engine modifications and control technologies that include:

1. Oil consumption reduction
2. Turbochargers

3. Induced turbulent mixing
4. Diesel particulate filter (or catalytic diesel particulate filter)
5. Fabric filter (baghouse)
6. Flow through filter
7. 4-way catalytic converter
8. Use of clean fuels
9. Good combustion practices

Greenhouse gases (GHG) from engines include carbon dioxide, methane, and nitrous oxide. The nitrous oxide component of the greenhouse gas emissions is controlled as NO_x as described in the NO_x LAER analysis in Section 4.5. Carbon dioxide makes up the bulk of GHG emissions and is the primary pollutant of concern when controlling GHG emissions from combustion. The control technologies available for GHG emissions are:

1. Carbon capture and sequestration (CCS)
2. Use of clean fuels
3. Good combustion practices

Per step 2 of the BACT process, each of these controls was evaluated on a technical feasibility basis as outlined in the following paragraphs.

Diesel oxidation catalyst can be used to control products of incomplete combustion such as CO and VOC. Based on precedent from EPA Region 4 in 2014, diesel oxidation catalysts were deemed technically infeasible for third-party engines and large internal combustion engines. The catalyst systems can cause increased back pressure on engines which is a safety risk and the engine lube oils can contain chemicals that can damage the oxidation catalyst reducing its efficacy. With few examples of diesel oxidation catalyst on marine engines and precedent stating that it is technically infeasible, the use of diesel oxidation catalyst was eliminated as BACT based on technical infeasibility.

Catalytic diesel particulate filters can control particulate as well as products of incomplete combustion. Marine engines operating at variable loads would not maintain a sustained exhaust temperature that is high enough for the catalyst to function properly. Additionally, at lower temperatures, it is possible for the filters to become plugged which results in pollutants not oxidizing correctly and a potential increase in back pressure due to filter plugging which is a safety concern. As such, the use of catalytic diesel particulate filter was eliminated as BACT based on technical infeasibility.

The use of 4-way catalytic converters is still in the development stages for marine applications. Similar to diesel oxidation catalysts, it is possible that certain elements found in the engine lube oils used would not be combusted and can damage the catalyst over time. As such, the use of 4-way catalytic converters was eliminated as BACT based on technical infeasibility.

Fabric filters, such as baghouses, can be used to control particulate matter emissions from engines. These systems are typically designed for land based sources and can require a large amount of space to control particulate matter. The large footprint of this technology can be an issue with space constraints on vessels and as such, the use of fabric filters was eliminated as BACT based on technical infeasibility.

Flow through filters are another filter type that can be used to control particulate emissions from engines. There are no flow through filters that have been designed for or tested on a commercially available scale for marine engines. As such, the use of flow through filters was eliminated as BACT based on technical infeasibility.

Carbon capture sequestration consists of four steps, each of which must be technically feasible for the system to be technically feasible as a whole. The four steps are carbon capture, compression, transport, and sequestration. All four of these steps were determined to be technically infeasible for application to vessel marine engines for the Atlantic Shores projects. Carbon capture requires the use of an organic solvent to capture the CO_2 in the exhaust gas and then use heat to evaporate the solvent leave a separate concentrated CO_2 stream. The necessary absorption units require a large volume of space which is problematic with the constrained space available on a vessel. Additionally, the capture technology works best on steady state units which would be problematic given the variable loads the marine engines will operate at. The compression step requires a large space for the equipment to compress the CO_2 which is problematic given the constrained space on a vessel. Transporting the stored CO_2 back to land would require both large volumes of storage space and additional trips to port to offload the CO_2. The extra space is not available given the space constraints of a vessel and the additional trips would result in an increase of all other criteria pollutants during the additional transits to and from port. The sequestration step requires injection and long-term storage in geologic formations. The CO_2 would need to be transported from the vessel to port and from port to a storage location which would likely be many miles away. Given all of these technical challenges and the lack of precedent for the application of carbon capture sequestration on marine applications or even larger land-based applications, carbon capture sequestration was eliminated as BACT based on technical infeasibility.

The remaining technologies are oil consumption reduction, turbocharger use and improvement, induced turbulent mixing, non-catalytic diesel particulate filters, the use of clean fuels, and good combustion practices. While the use of oil consumption reduction, turbocharger use and improvement, induced turbulent mixing, and non-catalytic diesel particulate filters are technically feasible, it is not technically feasible for Atlantic Shores to

require contractors to replace older engines or retrofit existing engines to include these technologies. Rather, these technologies should be used by engine manufacturers to ensure the compliance of the vessel engines with applicable emissions standards based on marine engine and nonroad engine tiers. As such, Atlantic Shores has found these technologies to be technically infeasible. It is feasible to group these technologies together into the use of the highest tiered engines available as these technologies can be used by manufacturers to comply with the higher engine tiers. As such, it is technically feasible for the projects to be required to use vessels with the highest tiered engines available at the time of deployment as defined in past precedent for both the Vineyard Wind I and South Fork Wind projects. While it is technically feasible to require the use of a vessel with the highest tiered engines available at the time of deployment, it is not feasible to slow down, delay, or extend the Project's construction schedule to enable use of a vessel with a higher tiered engine.

Step 3 of the BACT process requires the ranking of the remaining control technologies for each pollutant. The remaining technologies across all pollutants are the use of the highest tiered engines available at the time of deployment, good combustion practices and the use of clean fuels. All of these technologies are technically feasible and can be used in conjunction with each other. As such, no comparative ranking is required as all three technologies can be incorporated.

Step 4 of the BACT process requires the comparison of technologies based on economic, environmental, and energy impacts. All of the remaining technologies can be used together and are not infeasible on an economic, environmental, or energy basis, and as such are all feasible as BACT.

Step 5 of the BACT process is the selection of BACT. Atlantic Shores proposes the following as BACT for internal combustion engines on vessels that are OCS sources (foreign and domestic jack-up vessels).

1. Atlantic Shores will use vessels with the highest tiered engines that are available at the time of deployment as described in the LAER analysis in Section 4.5 and as described in the precedent in the Vineyard Wind I and South Fork Wind projects.
2. Atlantic Shores will use clean fuels for the vessels. The use of clean fuels refers to the use of ULSD, marine distillate fuel oil, and marine residual fuel oil. The cleanest fuel oil possible will be used where feasible. Vessels that are not able to use fuel oil that meets the ULSD standard of 15 ppm of sulfur will use fuel oil with a sulfur content less than 1,000 ppm in accordance with the MARPOL Annex VI requirements for Emission Control Areas.
3. Atlantic Shores will operate all engines efficiently and with good combustion practices based on the most recent manufacturer's specifications issued for the engines at the time they are operating. Efficient operation includes complying with the energy efficiency measures outlined in the IMO MARPOL Annex VI that went

into effect in 2013. These include a requirement for existing ships to have an energy management plan that addresses things such as "improved voyage planning, cleaning the underwater parts of the ship and the propeller more often, introducing technical measures such as waste heat recovery systems, or even fitting a new propeller." All ships are also required to have a Ship Energy Efficiency Management Plan (SEEMP). Additionally, new ships are required to comply with minimum energy efficiency level per capacity mile based on their type and size. These requirements are intended to ensure that all engines are operated efficiently and that GHG emissions are minimized from vessels associated with the projects.

4.6.2 Engines on OCS Sources

Similar to the engines on foreign and domestic jack-up vessels discussed in Section 4.6.1, the non-emergency compression-ignition internal combustion engines for the WTGs and OSSs are on OCS sources and as such have to comply with the requirements of LAER as described in Section 4.5 above for NO_x and VOC emissions. As such, a separate BACT analysis is not performed for NO_x and VOC emissions from the engines on OCS sources as LAER is more stringent than BACT due to not allowing for the elimination of a technology from consideration based on energy, environmental, or economic impacts. Since LAER is always more stringent than BACT, the BACT for NO_x and VOC emissions is to comply with the LAER determination provided in Section 4.5. For the rest of the pollutants, a top-down BACT analysis is required using the five step methodology outlined in Section 4.6 above.

Per step 1 of the BACT process, the following paragraphs identify and list the control technologies for each pollutant that are available for internal combustion engines found on OCS sources.

Carbon monoxide emissions can be controlled as discussed in Sections 4.4, 4.5 and 4.6.1 above. The CO control technologies that are available for internal combustion engines on OCS sources are:

1. Diesel oxidation catalyst
2. Catalytic particulate filter
3. 4-way catalytic converter
4. Good combustion practices.

Particulate matter emissions can be controlled as discussed in Sections 4.4, 4.5 and 4.6.1 above. The PM control technologies that are available for internal combustion engines on OCS sources are:

1. Oil consumption reduction
2. Turbochargers
3. Induced turbulent mixing

4. Diesel particulate filter (or catalytic diesel particulate filter)
5. 4-way catalytic converter
6. Use of clean fuels
7. Good combustion practices

GHG emissions can be controlled as discussed in Sections 4.4, 4.5 and 4.6.1 above. As mentioned in Section 4.6.1, the nitrous oxide component of the greenhouse gas emissions is controlled as NOx as described in the NOx LAER analysis in Section 4.5. The GHG control technologies that are available for internal combustion engines on OCS sources are:

1. Carbon capture and sequestration (CCS)
2. Use of clean fuels
3. Good combustion practices

Per step 2 of the BACT process, each of these controls was evaluated on a technical feasibility basis. Carbon capture and sequestration is technically infeasible due to size and practicality constraints as discussed in detail in Section 4.6.1 above. The rest of the post combustion control technologies and engine optimizations listed above have the potential to be feasible for stationary internal combustion engines that are likely to operate at high load percentages when operated. Whether the technology is feasible depends on the specific engine design. The process modifications and post combustion control devices can be integrated by engine manufacturers into the engine design in order to comply with EPA emission limits. Precedent from the South Fork Wind Fact Sheet states that:

> *"A manufacturer of a Tier 3 or Tier 4 engine will incorporate technically feasible emission reduction technology into the engine's design. For example, a Tier 4 engine typically has an SCR system to reduce NOx emissions and a diesel particulate filter in combination with a diesel oxidation catalyst to reduce fine particulates. In other words, the pollution control equipment becomes an integral part of the overall engine, and accordingly, any additional pollution control equipment is considered infeasible."*

As such, the use of post combustion controls for these engines are not evaluated individually but rather as the use of the highest available tier engine (either marine engine tier or nonroad engine tier depending on the specific use case and requirements of the individual engine). In the South Fork Wind Fact Sheet, EPA recognizes that diesel engines beyond the highest tiered certification for the specific engine application will not be available for use. As such, it is only feasible for Atlantic Shores to use engines that inherently incorporate the necessary control technologies to comply with the EPA tier limits and it is not feasible to require the addition of any extra air pollution control equipment beyond the necessary integral controls required to meet the tier limits. There

are two standards that the engines can certify compliance with. The first is the nonroad standards at 40 CFR 1039 that are typically used for onshore activities. The New Source Performance Standards for engines recognizes that an engine located in a marine environment can instead be certified in compliance with the marine engine standards at 40 CFR Part 1042. Whether the engines on OCS sources will be certified with the nonroad standards at 40 CFR Part 1039 or the marine standards at 40 CFR Part 1042 will depend on the specific engines that will be installed and the installation methods and use case proposed by the installation contractors. This will also be impacted by engine availability at the time of the Projects' need for the engines.

Per Step 3 of the BACT process, the remaining technologies are ranked based on control effectiveness. The three remaining technologies are the use of clean fuels, the use of good combustion practices, and the use of engines meeting the highest EPA tier standards for either marine or nonroad engines. Since the remaining technologies are not mutually exclusive, Atlantic Shores is proposing the use of all three remaining technologies. Since all three remaining technologies can and will be used together it is not necessary to rank the technologies in order of control effectiveness.

Step 4 of the BACT process requires considering the energy, environmental, and economic impacts of each control technology. Since all three remaining can and will be used together it is not necessary to analyze the energy, environmental, and economic impacts of each technology as none will be eliminated based on infeasibility in these categories.

Step 5 of the BACT process is the selection of BACT. Atlantic Shores proposes the following as BACT for internal combustion engines on OCS sources.

1. Atlantic Shores will use engines that meet the highest tier standards for either marine or nonroad engine requirements set forth in 40 CFR Part 1042 and 40 CFR Part 1039 respectively. The highest tier marine engines would meet Tier 3 or Tier 4 marine standards depending on engine size. The highest tier nonroad engines would meet Tier 4 nonroad standards. The exact emissions limits for each pollutant would vary based on engine size, displacement, and/or power density, as well as which tier standard (marine or nonroad) compliance is certified to.
2. Atlantic shores will use engines that combust clean fuels through the use of ULSD with a maximum sulfur content of 15 ppm.
3. Atlantic Shores will operate all engines using good combustion practices based on the most recent manufacturer's specifications issued for the engines at the time they are operating.

4.6.3 Electrical Switchgear

4.6.3.1 Electrical switchgear

Sulfur hexafluoride (SF6) will be used to insulate electrical equipment. SF6 is commonly used in the power industry, and SF6 allows for protection from short circuits and arcs, using equipment that takes a small amount of space. SF6 is very chemically stable and is used in sealed systems. Some leaks are possible as fugitive emissions from those sealed systems. Available technologies are alternatives that do not use SF6, and leak minimization. Alternatives that do not use SF6 include air-insulated equipment, which takes up more space, combinations of vacuum switching and air insulation, and certain alternative fluorinated chemicals (fluoronitriles) which are in development and early implementation.

4.6.3.2 Air-insulated equipment

For onshore applications, air-insulated switchgear (AIS) and gas-insulated switchgear (GIS) are commonly used in utility, industrial, and commercial electrical service equipment applications. AIS uses air as the main insulating medium, but that air is either open to the atmosphere in the case of open elevated bus structures or encapsulated in metal containers ("metal clad"). For the same service, AIS is larger, heavier, and uses more total parts than GIS. AIS requires more frequent maintenance, and performance and integrity of AIS is negatively affected by environmental contaminants and humidity. GIS is inherently arc resistant compared to air, because of its high dielectric strength and no open exposed contacts, and has better heat dissipation properties. GIS is more commonly used in high voltage applications.

4.6.3.3 Alternatives to SF6 in GIS

Atlantic Shores is aware of some suppliers marketing blends of fluoronitrile gas for some electrical equipment. These could be available for medium-voltage GIS, including the interarray cable equipment on the WTGs and OSSs, but are not available for high-voltage GIS, including the export cable equipment on the OSSs.

Even with the medium voltage GIS, there are limitations on where alternatives exist based on needed equipment ratings. Most equipment manufacturers offer alternatives for lower ampacities (~3000A), but the Atlantic Shores switchgear arrangement will require some 4000A rated GIS where no alternatives exist.

The replacement gases have lower global warming potential than SF6, because the fluoronitrile gases themselves have lower global warming potential and because the fluoronitrile gases are mixed with distillates of air (e.g., carbon dioxide and oxygen). GE and Hitachi both market equipment using Novec™ Insulating Gases supplied by 3M. These products have been used in demonstration projects and limited commercial applications.

Additional maintenance may be required, effectiveness may be reduced at lower temperatures, and there is currently less infrastructure to reuse or dispose of the SF6 replacement gases.

4.6.3.4 Applicability of Control Technology Review requirements

SF6 as a chemical is not subject to LAER rules, and potential emissions are well below New Jersey State Of The Art (SOTA) applicability thresholds. SF6 is subject to BACT requirements as a GHG, based on the potential for fugitive emissions from OSSs. As discussed in the regulatory applicability section, the WTGs themselves are not OCS sources during operation, and therefore any potential SF6 fugitive emissions from equipment leaks on WTGs are not subject to BACT.

The potential for fugitive leaks from sealed systems containing SF6 does not by itself cause an operation to be an OCS source. As evidence:

- The preamble for publication of 40 CFR Part 55, states that EPA "interpreted its regulatory authority under section 328 to be restricted to federal and state criteria pollutants, and pollutants regulated pursuant to PSD, and has limited its rule to these pollutants" [see 57 FR 40804 (September 4, 1992)];
- The PSD regulations at 40 CFR § 52.21(b)(1)(iii) specifically exclude fugitive emissions when determining whether a source is a major stationary source for PSD applicability;
- EPA's authority to regulate GHG emissions in the absence of criteria pollutant emissions has been limited in *Utility Air Regulatory Group v EPA*, 573 US 302 (2014) and elsewhere; and
- The OCS air regulations at 40 CFR § 55.13 exclude review of certain air related regulations that are not "rationally related" to achieving NAAQS compliance. While the reference is specific to 40 CFR Part 61 and related NESHAP requirements, it provides further evidence that the intent of the regulation is to address criteria pollutants only.

The WTGs do not have criteria pollutant emissions during operation[16], but the OSSs will have diesel generators with criteria pollutant emissions. The OSSs are therefore OCS emissions sources, and the potential SF6 emissions from leaks of sealed equipment on the OSSs are subject to BACT as GHG emissions.

[16] Portable generators may be utilized to provide power for commissioning or for storm protection in the event of a longer-term grid outage; these are not planned operations.

4.6.3.5 Top-down BACT analysis

The following analysis follows EPA guidance and precedent to document BACT for SF6 emissions from electrical equipment on OCS sources.

Step 1: Identify All Control Technologies:

Available control technologies to reduce GHG emissions from electrical switchgear are:

- Use of Air Insulated Switchgear
- Use of fluoronitrile gas blends to replace SF6
- Use of sealed SF6 systems and leak detection techniques

Step 2: Eliminate Technically Infeasible Options

The following options are technically infeasible:

- Use of Air Insulated Switchgear. Available air-insulated electrical equipment would be much too large for use offshore. Air insulated equipment would also be heavier, require more maintenance, and be significantly more at-risk of failure due to corrosion in the marine environment. This is true for traditional air-insulated switchgear and for combinations of vacuum switching and air insulation.
- Use of fluoronitrile gas blends to replace SF6. SF6 replacement gases are in the early stages of adoption for onshore and offshore applications. The use of SF6 alternatives will not be feasible for some switchgear and may not be feasible for any switchgear. For the use of SF6 alternatives, the equipment manufacturers would need to use GIS with higher ratings (e.g., up to 170 kV-class equipment instead of 66 kV equipment). These would have larger footprints and would be heavier, so may be infeasible based on space or weight constraints. In the event that equipment using SF6 alternatives requires additional maintenance, the GHG emissions from those additional trips could offset any potential GHG savings from the reduced potential for SF6 leaks.

Atlantic Shores will request suppliers for option pricing to allow the use of SF6 alternatives where such equipment would meet the safety and performance requirements of the supplied equipment. At the time of this OCS Air permit application, it appears unlikely that the use of SF6 alternatives would be technically and economically feasible for any supplied equipment.

Step 3: Rank Remaining Control Technologies by Control Effectiveness

The remaining control technology is the use of sealed SF6 systems and leak detection techniques.

Step 4: Evaluate most effective controls and document results.

Atlantic Shores conducted a search of permits through the EPA's RACT/BACT/LAER Clearinghouse. That review identified 22 facilities with entries for SF6 emissions from switchgear. The most stringent emission rate identified is the use of equipment in manufacturer-sealed systems, certified by the manufacturer to meet a leak rate of no more than 0.5% per calendar year, equipped with leak detection systems and alarms.

Step 5: Document BACT

Atlantic Shores will limit its use of SF6 on OCS sources to hermetically sealed-pressure switchgear, certified by the manufacturer to meet a leak rate of no more than 0.5% per calendar year, equipped with leak detection systems and alarms.

4.7 SOTA

As described in Section 4.1 above, compliance with LAER or BACT constitutes compliance with SOTA. There is only 1 air pollutant, SO_2,that is subject to SOTA that is not also subject to BACT (or LAER and BACT). Therefore, compliance with LAER and BACT as described above constitutes compliance with SOTA for all other pollutants.

For SO_2, Atlantic Shores must document compliance with NJ SOTA requirements. For pollutants subject to BACT, LAER, MACT, or NSPS, compliance with the applicable rule constitutes compliance with SOTA per Section 1.4 of the General SOTA Manual. Since SO_2 is not subject to Federal BACT, LAER, MACT, and there are no SO_2 limitations in the applicable NSPS, SO_2 emissions are only subject to NJ SOTA requirements. Per Section 1.4(e) of the NJ SOTA Manual, for any air contaminant that does not have a BACT, LAER, MACT, or NSPS requirement to comply with, documentation of compliance with SOTA can be accomplished through compliance with an applicable SOTA Manual, case-by-case determination, or compliance with a general permit issued under NJAC 7:27-8.8 that is applicable to the source.

The NJ SOTA Manual for Reciprocating Internal Combustion Engines published by NJDEP with an effective date of 2003, has requirements for sulfur dioxide in Table 1. Table 1 of this manual states that the SOTA Emission Performance Level for Stationary Reciprocating Internal Combustion Engines for sulfur dioxide is 30 ppm sulfur in fuel or less for liquid fuel (No. 2, diesel, or kerosene). The only control technologies that are considered generally applied to meet SOTA performance levels for sulfur dioxide in Table 2 of this manual, is the use of low sulfur fuel.

Atlantic Shores is proposing the use of low sulfur fuel per the determination in the BACT analysis found in Section 4.6 above. For engines on the OCS sources, the fuel used will be ULSD which has a sulfur content of 15 ppm. As such, the engines on OCS sources will comply with the NJ SOTA standard without the need for a case-by-case determination. For

vessel engines, the fuel proposed in the BACT analysis is ULSD, marine distillate fuel oil, and marine residual fuel oil. The cleanest fuel oil possible will be used where feasible. Vessels that are not able to use fuel oil that meets the ULSD standard of 15 ppm of sulfur will use fuel oil with a sulfur content less than 1,000 ppm in accordance with the MARPOL Annex VI requirements for Emission Control Areas. Since some of these engines have the potential to use fuels with a fuel sulfur content that exceeds 30 ppm, a case-by-case SOTA determination is required.

Case-by-case SOTA determinations follow a similar top-down process to BACT. For sulfur dioxide, the only control technologies are low sulfur fuels and scrubbers. Scrubbers are technically feasible but not widely used for larger marine engines. However, as described in the LAER and BACT sections above, it is not feasible for Atlantic Shores to require contractors to retrofit vessel engines with SO_2 scrubbers. Additionally, vessels that already include scrubbers typically use the scrubbers as an alternative to complying with the fuel sulfur content limits in MARPOL Annex VI. SO_2 scrubbers are intended to be an alternative to operating on low sulfur marine distillate or ULSD and not intended to be used in conjunction with these low sulfur fuels. Atlantic Shores proposes that the use of the fuel with the lowest possible sulfur content in compliance with MARPOL Annex VI requirements for Emission Control Areas as described in the BACT and LAER analyses above be determined as the case-by-case SOTA for the marine engines on the foreign and domestic jack-up vessels. The lowest possible sulfur content fuel is defined as ULSD meeting the 15 ppm sulfur content limit where possible, and fuel with a sulfur content less than 1,000 ppm where the use of ULSD is not possible.

5.0 Air Quality Impact Assessment

This OCS air permit application uses air quality dispersion modeling to document compliance with certain requirements to protect ambient air quality. This Section describes the regulatory requirements that are satisfied using air quality dispersion modeling, the modeling techniques being used, and the results. The modeling analyses documents compliance with all relevant regulatory standards, and demonstrates that the Projects will not cause or contribute to any condition of unhealthy air.

As described in Section 3, 40 CFR Part 55 regulates air emissions associated with OCS sources, defined in part as equipment that can emit air pollutants on structures and vessels "permanently or temporarily attached to the seabed and erected thereon and used for the purpose of exploring, developing or producing resources therefrom" (40 CFR §55.2). Unlike onshore sources, when comparing project potential emissions to regulatory thresholds, the emissions from vessels servicing an OCS source are included when at the OCS source or en route to or from the OCS source within 25 nautical miles (nm) of the OCS source. Because of this difference between onshore and offshore requirements, PSD review under 40 CFR § 52.21 is triggered. The specific analyses required are dependent on the interpretation of the regulatory requirements; the regulations at 40 CFR Part 55 and its underlying statute pre-date the viability of utility-scale offshore wind projects and were not written with offshore wind in mind.

As described elsewhere in this application, vessel and equipment specifications will change during development and construction of the Projects. Vessel availability at the time of construction or O&M cannot be foreseen with any certainty, given the rapidly changing nature of the offshore wind industry and limitations on vessel use associated with the Jones Act. Vessel data will remain highly speculative throughout the permitting of the Projects. Vessel selection will not be refined until much closer to the start of construction, and vessels may be changed out even after construction begins. Therefore, modeling uses currently best-available information on representative vessel types, with typical or fleet-average emission rates. The number, type, size, and emission rates of vessels could be higher or lower than modeled for any individual activity. Overall, the use of the maximum design scenario associated with the Projects' PDE serves to ensure a reasonably conservative estimate of emission rates and impacts from the Projects. Only sources subject to PSD review are included in the modeling.

For portions of the Projects subject to PSD review, air quality dispersion modeling is needed to assess impacts to AQRV, including visibility, per 40 CFR § 52.21(p). A separate modeling analysis has been prepared relating to AQRV, for review in conjunction with the appropriate Federal Land Managers (FLMs), included as Appendix C.

Atlantic Shores uses the Coupled Ocean-Atmosphere Response Experiment (COARE) bulk flux algorithm, as implemented within the AERCOARE program for use in the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). The AERCOARE-AERMOD modeling system is an alternative for assessing compliance with air quality standards when emission sources and dispersion occur over water. Prognostic data from the Weather Research and Forecast (WRF) Model is used to derive the hourly surface data and upper air data (i.e., humidity, temperature, and water surface temperature) that is used for meteorological observations.

When modeling impacts of nitrogen dioxide (NO_2), Atlantic Shores accounts for the fact that not all Project nitrogen oxide (NOx) emissions will form NO_2 using the Ambient Ratio Method (ARM2) screening technique.

The AECOARE-AERMOD modeling system does not address secondary pollutant formation. Because the Projects will be subject to NNSR for ozone, ozone modeling is not required. For secondary formation of particulate matter smaller than 2.5 microns ($PM_{2.5}$), Atlantic Shores uses the View QLIK Modeled Emission Rate Precursor (MERP) methodology stack modeling results to derive a project-specific MERP in accordance with current EPA guidance.

Nearly all construction and O&M activities will take place for only a few hours or days at any one WTG or OSS position, and most emissions sources will be in-motion. Techniques to address this variability depend on the applicable standard, pollutant, and averaging time.

When documenting compliance with NAAQS or New Jersey Ambient Air Quality Standards (NJAAQS), modeled concentrations are added to the appropriate measured background concentration for comparison to the standard.

Atlantic Shores notes that the peak impacts will be entirely over water miles from shore, where there cannot possibly be any residences, and where the public is extremely unlikely to remain for any extended period. When modeling over-water impacts, Atlantic Shores places modeling receptors outside of any safety exclusion zone.

As of the date of this modeling analysis, there are no existing sources of air emissions near enough to the Projects to cause a concentration gradient at over-water receptors. Therefore, no cumulative modeling is performed.

Per the PSD modeling requirements at 40 CFR § 52.21(o), the analysis of impacts to visibility are incorporated into the analysis of AQRV in Appendix C. Impacts to soils and vegetation is reviewed using a screening procedure, and the general commercial, residential, industrial, and other growth associated with the Projects is reviewed using a qualitative analysis.

5.1 Source Parameters

Emissions are predominantly from internal combustion engines, as described in detail in Section 2. Construction activities are based on the strategies developed within the PDE established for the Projects. As such, plans reflect different construction methodology alternatives. Operation & Maintenance (O&M) activities are based on the logistical concept developed by Atlantic Shores, and includes all vessels, generators, and equipment that are expected to be used during the Project's operation. Operations estimates include routine and planned non-routine operations.

For all calculations, Atlantic Shores and its consultants worked to develop consistent calculations for vessel sizes, vessel engine sizes and types, days and hours/day of activity, and number of transits to appropriate ports. Engines powering equipment were calculated similarly. Engines do not operate at full power all the time, but instead vary their power output to provide the mechanical energy needed to perform the engine's task. The amount of energy used by each engine while doing work, expressed as a fraction of the engine's maximum capacity, is the engine's load factor. Emission factors are based on the content of the fuel, regulatory limits (which depend on engine size, age, and operation) and published BOEM and EPA factors.

The above calculations will serve to provide estimates of emission rates that are generally conservative and consistent with the PDE but cannot be considered not-to-exceed limits as each individual emission rate could be higher or lower than calculated.

Information is not broadly available to estimate the stack parameters to be used for the various construction vessel types. Atlantic Shores has prepared a best-efforts basis set of exhaust parameters based on the following sources:

- a review of available specification sheets for identified representative vessels, supported and checked with an evaluation of available vessel imagery;
- stack parameters provided in the Source Guide attachment that accompanied the Vineyard Wind, LLC OCS Air Permit application (EPA OCS-R1-03);
- stack parameters provided in the South Fork Wind, LLC OCS air permit application (EPA OCS-R1-04); and
- California EPA Air Resources Board's (2005) Appendix G: Draft Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach.

For angled stacks on stationary sources, the stacks are modeled as vertical stacks, with the exhaust velocity calculated based on the vertical component of the angled exhaust. For example, a stack with a 45-degree angle has a vertical component of the cosine of

45 degrees (0.707). This reasonably represents the vertical momentum flux. The buoyant flux is somewhat under-estimated due to the lower modeled flow rate; this under-estimate is conservative.

The range of stack parameters serve to estimate the different sizes of vessels and engines that will be used in the Projects, and different heights from which engine emissions will be emitted. Actual stack parameters will not be known until vessels are retained for the Project (and vessels may be changed mid-project to meet changing needs).

Vessels will be in motion while operating, so emissions from vessels will not come from a fixed point in space. When using the AERCOARE-AERMOD modeling system, emissions from moving vessels are typically represented as volume sources, where the volume represents a conservatively small estimate of the locations over which the vessel would move during the course of an hour. Emissions during transits (moving at-speed from one location to another) are included as line volume sources. Downwash is only addressed for stationary structures (such as jack-up vessels and platforms). This analysis does not address the effect of waves on stack heights and angles (which would generally serve to increase dispersion).

5.2 Emissions Subject to Modeling

As described in Section 3, PSD regulations apply to each criteria pollutant that is emitted in excess of a defined Significant Emission Rate. During construction, the SER will be exceeded for nitrogen oxides (NOx), volatile organic compounds (VOC, as an ozone precursor), carbon monoxide (CO), particulate matter smaller than 10 microns (PM_{10}), and particulate matter smaller than 2.5 microns ($PM_{2.5}$). GHG emissions are also included as a PSD pollutant because potential emissions expressed as carbon dioxide equivalent (CO_2e) are greater than 75,000 tpy, but because GHGs are of global, not local, concern, there are no ambient air quality standards for GHGs and no modeling is required for GHGs. Specific emission rates from the Projects subject to PSD permitting will depend on interpretations of regulatory applicability, as discussed in Section 3.

As described in Section 3, air emissions that occur before any OCS source is established are not subject to PSD review, and onshore emissions are not vessel emissions and are not subject to PSD review. Only sources subject to PSD review are included in the modeling. Much like any other unregulated onshore and offshore construction activities, such emissions are appropriately addressed by including measured background concentrations in the NAAQS model results. As described in page 3-10 and 3-11 of the protocol, Atlantic Shores does not intend to include other increment consuming or expanding sources in its analysis of PSD increment.

The Projects will be subject NNSR under NJAC Chapter 27 Subchapter 18 for NO_X and VOC as ozone precursors. Per NJAC 7:27-18.4, and air quality impact analysis is required for NO_2, but not VOC or ozone. The requirements to conduct modeling for NO_2 overlap with

the PSD review requirements, and the same modeling analysis is used to address both regulations. Other New Jersey air regulations incorporated at Appendix A to 40 CFR Part 55 do not include requirements for air quality dispersion modeling, beyond the PSD review requirements.

5.3 Ambient Air Quality Standards

The nation's first Federal efforts at controlling air pollution began in 1963 with passage of the CAA. Four amendments followed in 1967, 1970, 1977, and 1990. The CAA was enacted by Congress to protect the health and welfare of the public from the adverse effects of air pollution. As required by the CAA, EPA promulgated NAAQS for six criteria pollutants: nitrogen dioxide (NO2), sulfur dioxide (SO2), particulate matter (characterized as having an aerodynamic diameter of 10 micrometers or less [PM10] or as having an aerodynamic diameter of 2.5 micrometers or less [PM2.5]), carbon monoxide (CO), ozone (O3), and lead (Pb).

The NAAQS includes both "primary" and "secondary" standards. The primary standards are intended to protect human health; whereas, the secondary standards are intended to protect public welfare from any known or anticipated adverse effects associated with the presence of air pollutants, such as damage to vegetation. The state of New Jersey has established NJAAQS, which generally follow the NAAQS with some exceptions.

The NAAQS presented in Table 5-1 specify concentration levels for various averaging times, subject to modeling for the Projects. PSD review is not triggered for SO_2 or lead, ozone is not modeled directly because it is regulated under NNSR, and per New Jersey Department of Environmental Protection (NJDEP) guidance if the NAAQS for PM_{10} and $PM_{2.5}$ are met, then NJDEP assumes the total suspended particulate NJAAQS will also be met (NJDEP 2021).

TABLE 5-1 NATIONAL AND NEW JERSEY AMBIENT AIR QUALITY STANDARDS

POLLUTANT	AVERAGING PERIOD	NAAQS (µG/M³)		NJAAQS (µG/M³)	
		PRIMARY	SECONDARY	PRIMARY	SECONDARY
CO	8-Hr (1)	10,000	Same	10,000	Same
	1-Hr (1)	40,000	Same	40,000	Same
NO_2	Annual (2)	100	Same	100	100
	1-Hr (3)	188	None	None	None
$PM_{2.5}$	Annual (4)	12	15	None	None
	24-Hr (5)	35	Same	None	None

TABLE 5-1 NATIONAL AND NEW JERSEY AMBIENT AIR QUALITY STANDARDS (CONTINUED)

POLLUTANT	AVERAGING PERIOD	NAAQS (μG/M³)		NJAAQS (μG/M³)	
		PRIMARY	SECONDARY	PRIMARY	SECONDARY
PM_{10}	24-Hr [6]	150	Same	None	None
Suspended Particulate Matter [7]	24-Hour [1]	None	None	260	150
	Annual [3]	None	None	75	60

[1] Not to be exceeded, more than once per year.
[2] 98th percentile of one-hour daily maximum concentrations, averaged over three years.
[3] annual mean
[4] annual mean, averaged over three years.
[5] 98th percentile, averaged over three years.
[6] Not to be exceeded more than once per year on average over 3 years
[7] NJDEP modeling guidance (2021) states that the Department assumes that if the NAAQS for PM10 and PM2.5 are met, then the TSP NJAAQS will also be met.

The NAAQS also reflect various durations of exposure. The short-term periods (24 hours or less) refer to exposure levels not to be exceeded more than once a year. Long-term periods refer to limits that cannot be exceeded for exposure averaged over three months or longer.

PSD increments are the maximum allowable increase in concentration that is acceptable to occur above a baseline concentration for a pollutant, for projects subject to PSD review. Class I increments are intended to be protective of Class I areas. Class I areas are geographic areas recognized by the EPA as being of the highest environmental quality and requiring maximum protection; these areas have special national or regional scenic, recreational, or historic value. The nearest Class I area to the WTA is the Brigantine Wilderness area. Class II areas comprise most of the US and there are currently no Class III areas.

Table 5-2 presents the PSD increments subject to modeling for the Projects. PSD review is not triggered for SO_2.

TABLE 5-2 PSD INCREMENTS

POLLUTANT	AVERAGING PERIOD	PSD INCREMENTS ($\mu G/M^3$)	
		CLASS I	CLASS II
NO_2	Annual arithmetic mean	2.5[1]	25[1]
$PM_{2.5}$	24-Hour maximum	2[2]	9[2]
	Annual arithmetic mean	1[1]	4[1]
PM_{10}	24-Hour maximum	8[2]	30[2]
	Annual arithmetic mean	4[1]	17[1]

(1) Not to be exceeded, more than once per year.
(2) Not to be exceeded.

EPA has relied on the use of Significant Impact Levels (SILs) to represent thresholds of insignificant (i.e., de minimis) modeled source impacts. The SILs are intended to be small fractions of the NAAQS and PSD increment. Separate SILs are established for comparison to the NAAQS and to the PSD increment.

NO_2 and PM_{10} Class I PSD increment SILs are described in detail in the July 23, 1996 Proposed Rulemaking (61 Federal Register [FR] 38249). The $PM_{2.5}$ Class I PSD increment SILs are described in the April 17, 2018 *Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program*. There are no Class I PSD increment SILs for CO, GHGs, or 1-hour NO_2.

The applicable SILs are summarized in Table 5-3, for pollutants subject to modeling for the Projects.

TABLE 5-3 SIGNIFICANT IMPACT LEVELS

POLLUTANT	AVERAGING PERIOD	RECOMMENDED SIGNIFICANT IMPACT LEVELS FOR NAAQS ANALYSES (µG/M³)	PSD SIL INCREMENTS (µG/M³)	
			CLASS I	CLASS II
CO	1-Hour	2,000[1]	None	2,000[1]
	8-Hour	500[1]	None	500[1]
NO_2	1-Hour	7.5[2]	None	None
	Annual	1	0.1[1]	1[1]
$PM_{2.5}$	24-Hour	1.2[3]	0.27[3]	1.2[3]
	Annual	0.2[4]	0.05[4]	0.2[4]
PM_{10}	24-Hour	5[1]	0.3[1]	5[1]
	Annual	1[1]	0.2[1]	1[1]

[1] Concentration not to be exceeded
[2] Highest 1-hour Modeled concentration averaged over 5 years
[3] Highest 24-hour modeled concentration averaged over 5 years
[4] Highest annual modeled concentration averaged over 5 years.

5.4 Modeling Intermittent & Transient Sources

5.4.1 Addressing Operations Separately

There is a temporally and spatially varying aspect to be considered. Construction and O&M operations are dynamic, with activities occurring in one area of the WTA on one day and in a different location the next day. Generally, groups of vessels will work together to perform discrete activities such as WTG installation, scour protection, etc.

Atlantic Shores uses the following approach for modeling short-term standards:

- Model each operation separately (i.e., including all the vessels and engines that would be in a single area at the same time), at the single location with the highest potential for impacts (e.g., for Class I PSD increments, at the closest location to the Brigantine Wildlife Refuge);
- Model as if the operation takes place at that single location for the entire modeling period (three years of meteorological data); and
- Do not model other operations going on simultaneously. The conservatism associated with the single operation occurring year-round at one spot renders that unnecessary, as discussed further below.

The source operation resulting in the highest total impact at any receptor represents the worst-case impact.

Each operation includes all the vessels and engines that would be in a single area at the same time. Operations are described in Section 2 of this application. Appendix D provides information regarding the emission points and exhaust parameters for each operation.

Emissions during O&M will be much lower than during construction. The air modeling methodology focuses on routine O&M activities and major repairs that are reasonably foreseeable; major unforeseen repairs are not covered in the O&M modeling. Section 2 of this application describes the typical O&M activities that are anticipated to occur on an annual basis.

As a conservative approach for modeling against annual standards, vessel transits will be included in the analysis to compare to the annual NAAQS and PSD increments. Transit emissions are included when comparing to long-term standards only, because impacts at any one location will last for a few seconds and will not impact short-term concentrations. Vessels in motion are addressed in two categories. Transiting vessels individual vessels traveling at (relatively) high speed in a straight line over a long distance from one location to another. Maneuvering vessels are moving at relatively low speed in one general area. Because transit emissions will only occur at any one location for a few seconds, those emissions cannot contribute to 1-hour, 3-hour, 8-hour, or 24-hour average ambient concentrations in any meaningful way at any one location.

Long-term impacts are modeled by modeling each source operation (including transit emissions) at each location where it could occur. Conservative simplifying assumptions are applied to allow for manageable processing of the modeling.

The engines located on each of the OSSs will be exercised for testing on a routine basis. Modeling for this effort will account for this testing and assume that the engines operate intermittently and no more than 500 hours in a year during O&M.

During the technical review of this application, Atlantic Shores will work with EPA to analyze the likelihood that any two operations could overlap in space and time in a manner that would require additional analysis. The chances of overlapping impacts is small, and combined with the additional levels of conservatism described above represent a possibility that is exceedingly small. Enforcing compliance with NAAQS and PSD increments based on an extremely unlikely confluence of events imparts a level of conservatism beyond what was envisioned with the establishment of the relevant standards. To support the statement that overlapping impacts are unlikely, Atlantic Shores offers the following:

- The concentration gradient associated with individual operations is limited and localized. The modeling results in Section 5.13 provide details in the form of the significant impact area (SIA) for each operation.
- The entire construction operation covers over 200 positions, and will take more than a year to complete. The operations with substantial emissions each take 40 hours or less to complete. Unless specifically scheduled to occur near each other, the chances of operations with substantial emissions occurring in nearby positions is very low.
- Atlantic Shores has no intention of scheduling major construction operations near each other. For safety and logistics reasons, Atlantic Shores will avoid having large groups of vessels operating near one another.
- Similarly, during O&M the chances that routine maintenance will be happening near a significant repair, when spread across over 200 positions and when each activity takes only a few hours, is very low.
- The chance of an O&M activity having overlapping impacts with a construction activity is even less likely. Such occurrences by definition would be one-time occurrences, and substantial construction will be complete for each Project before operations begin. While there is some small possibility that final construction commissioning activities at one position when O&M activities are occurring at a nearby activity, as described in Section 5.13 the commissioning activities do not create a significant concentration gradient.

5.4.2 Using EPA Guidance for 1-hour NO_2

When assessing impacts against the 1-hour NO_2 standard, Atlantic Shores may model emissions as occurring at different locations over the course of the construction year, consistent with the EPA 2011 guidance document *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO2 National Ambient Air Quality Standard* (the "Memorandum"), which states "assuming continuous operations for intermittent emissions would effectively impose an additional level of stringency beyond that intended by the level of the standard itself." Following this guidance allows a basis for accounting for spatial and temporal variability when modeling.

There is direct, relevant precedent for the application of the guidance for intermittent source operation on offshore wind OCS air permit modeling. See Section 4.8.3 of the Vineyard Wind Air Quality Modeling Report: Operation & Maintenance Emissions, October 2018. See also EPA's Fact Sheet and Statement of Basis for Vineyard Wind LLC on page 46:

> *Vineyard Wind justified treatment of certain emissions as intermittent with regard to the 1-hour NO2 NAAQS as addressed in the EPA's March 1, 2011 memorandum, "Additional Clarification Regarding Application of Appendix W Modeling Guidance*

for the 1-hour NO2 National Ambient Air Quality Standard" (EPA's March 1, 2011 Guidance). As such, Vineyard Wind applied a ratio of the number of operating hours per year by 8,760 hours to the 1-hour NO2 emissions because anticipated emissions. The EPA agrees that Vineyard Wind has appropriately represented the intermittent sources and accounted for their expected operation with respect to the 1-hour NO2 standard.

Consistent with EPA guidance and established precedent for intermittent sources, Atlantic Shores construction and O&M operations that occur for significantly less than the full year and do not operate on a predictable schedule are modeled using their operating hours divided by 8,760 when addressing 1-hour NO2 impacts. These include construction activities that only occur once at any location, O&M activities (such as scour protection repairs) that only occur once or twice a year, and intermittent sources such as the emergency and standby generators.

The operation of the vessels performing construction and operation and maintenance (O&M) activities are most appropriately modeled as intermittent sources when documenting compliance with probabilistic standards. The construction and O&M activities will not occur on a set schedule. Weather conditions will dictate the particulars of construction, routine inspection, and maintenance activities. The vessels will visit each of the positions (WTGs and OSSs), but the timing and order of those visits is not expected to be in a pre-predictable pattern.

Construction activities will happen only once per location. For O&M, the vessel's position will not be the same visit to visit. Some inspections will not involve disembarking at the WTG or OSS; the vessel will instead slowly circumnavigate the WTG or OSS while crew visually inspect for damage or wear. When crew are disembarking from SOVs the vessel will approach from different directions depending on the wind and waves. The SOV will typically use a gangway for transfer of crew. After transfer of crew, the vessel will then back away from the WTG or OSS and station nearby while the crew is working. Again, the vessel will station itself at a different location each time depending on the wind and waves.

This section quotes relevant selections from the Memorandum, and describes how they apply to the operation of the vessels performing regular (O&M) activities. Text from the Memorandum is quoted below, followed by a discussion of relevance.

Modeling of intermittent emission units… has proven to be one of the main challenges for permit applicants undertaking a demonstration of compliance with the 1- hour NO2 NAAQS. …

The O&M vessels are emitting at any one location only intermittently. For example, the SOV will be at any particular WTG or OSS location for less than 40 hours each year. While at the location the SOV will typically only approach the WTG or OSS to transfer personnel and materials, and will then move some distance away (to a general area that will vary depending on weather) or transit to the next location. Typical visits to a position will last between one half-hour and 10 hours, depending on the activity. Construction vessels will visit each position only once, and the more intensive operations will occur for 40 hours or less at each position.

> *…by assuming continuous operation of intermittent emissions the modeled design value for the 1-hour NO2 NAAQS effectively assumes that the intermittent emission scenario occurs on the specific hours of the specific days for each of the specific years of meteorological data included in the analysis which factor into the multiyear average of the 98th-percentile of the annual distribution of daily maximum 1-hour values. The probability of the controlling emission episode occurring on this particular temporal schedule to determine the design value under the probabilistic standard is significantly smaller than the probability of occurrence under the deterministic standard; thereby increasing the likelihood that impact estimates based on assuming continuous emissions would significantly overestimate actual impacts for these sources.*

The chances that an O&M vessel would be operating at a specific location for each of the hours needed to have the same modeled impact as a continuous emissions source is vanishingly small. For the probabilistic one-hour standard, the chance that an O&M vessel would be operating at specific location for each of the specific hours needed to have the same modeled impact as a continuous source is less than a quadrillion to one.

Construction impacts have zero chance of having the same modeled impact as a continuous source. The 1-hour NO2 standard is 100 ppb based on the 3-year average of 98th percentile of the yearly distribution of 1-hour daily maximum concentrations. Construction impacts will take place once only, and will not occur consecutively over three years.

> *We will consider it acceptable to limit the emission scenarios included in the modeling compliance demonstration for the 1-hour NO2 NAAQS to those emissions that are continuous enough or frequent enough to contribute significantly to the annual distribution of daily maximum 1-hour concentration*

At any one location, the O&M vessel emissions are not continuous enough or frequent enough to contribute significantly to an annual distribution of daily maximum 1-hour concentrations. Construction vessel emissions cannot contribute the same impact as a continuous source to an annual distribution of daily maximum 1-hour concentrations

because construction emissions only occur once, and will not occur it the subsequent years. By the reasoning in the Memorandum, excluding the vessel emissions from the 1-hour NO2 modeling would be acceptable.

> *Additional discretion may need to be exercised in such cases to ensure that public health is protected. For example, an intermittent source that is permitted to operate up to 500 hours per year, but typically operates much less than 500 hours per year and on a random schedule that cannot be controlled would be appropriate to consider under this guidance. On the other hand, an "intermittent" source that is permitted to operate only 365 hours per year, but is operated as part of a process that typically occurs every day, would be less suitable for application of this guidance since the single hour of emissions from each day could contribute significantly to the modeled design value based on the annual distribution of daily maximum 1-hour concentrations.*

Extra efforts to protect public health are not warranted in this case. There are no members of the public residing nine to twenty miles out at sea.

While some of the inspection and maintenance activities are "routine", the timing and order of the visits will not be in a set pattern, and the schedule will change regularly based on weather conditions. Each construction activity will happen for a single stretch of time, which for intense activities such as foundation installation is a few days or less. Construction activities at any one position will be scheduled based on the weather and based on shifting logistics for the entire construction effort. Construction activities therefore cannot contribute significantly to the annual distribution of daily maximum 1-hour concentrations.

> *Another aspect of intermittent emissions worth noting is the distinction between intermittent emissions that can be scheduled with some degree of flexibility vs. intermittent emissions that cannot be scheduled.*

Again, the timing of the visits will be scheduled around weather events. For construction, scheduling will also be adjusted in real-time to address other elements of the complicated overall effort, and will need to address time-of-year restrictions.

> *Another approach that may be considered in cases where there is more uncertainty regarding the applicability of this guidance would be to model impacts from intermittent emissions based on an average hourly rate, rather than the maximum hourly emission. For example, if a proposed permit includes a limit of 500 hours/year or less for an emergency generator, a modeling analysis could be based on assuming continuous operation at the average hourly rate, i.e., the maximum hourly rate times 500/8760. This approach would account for potential worst-case meteorological conditions associated with emergency generator emissions by assuming continuous*

operation, while use of the average hourly emission represents a simple approach to account for the probability of the emergency generator actually operating for a given hour

Atlantic Shores modeled vessels at a representative position based on the number of hours per year they would be emitting at that location, divided by 8,760. Per the above, this is a more conservative approach than excluding the vessels from modeling against the 1-hour NO2 standard.

5.5 Comparison to Standards

5.5.1 Significant Impact Levels

This Section evaluates the impacts against SILs in order to determine if there could be a "significant impact" on air pollutant concentrations and establish whether a NAAQS or PSD increment modeling analysis is necessary. The SIA is determined for each pollutant above the PSD increment SIL.

Direct emissions are modeled for comparison to the SILs for NOx, CO, and PM_{10}. For $PM_{2.5}$, the impacts of both direct $PM_{2.5}$ emissions and $PM_{2.5}$ precursor emissions will be addressed. The direct and secondary impacts is added together to compare to the SIL; for impacts are greater than the SIL, a NAAQS and/or PSD increment analysis will be completed for $PM_{2.5.}$

5.5.2 NAAQS Analysis

For pollutants and averaging times with modeled impacts above the SILs for the NAAQS, a comparison is made to the NAAQS. Background concentrations from a representative monitoring site are added to the modeling results to compare against the NAAQS. The background data used for this analysis are described in Section 5.7. For activities with $PM_{2.5}$ impacts greater than the SIL, the Project's direct $PM_{2.5}$ emissions are modeled using the AERCOARE-AERMOD system and secondary impacts will be accounted for using the MERP approach. The $PM_{2.5}$ direct and secondary impacts are combined with background concentrations for comparison to the $PM_{2.5}$ NAAQS.

Cumulative sources are not modeled. Per 40 CFR Part 51, Appendix W Section 8.3.3, explicit modeling should be performed for sources in the vicinity of the proposed modification for emissions limits that are not adequately represented by ambient monitoring data. There are no sources in the vicinity of the WTA, and the background data is taken from areas that adequately represent ambient conditions.

Ocean Wind, LLC's Ocean Wind 1 is a project proposed in an adjacent federal lease area. At the time of this submission, Atlantic Shores does not have access to Ocean Wind 1's OCS Air Permit application and does not know if EPA has determined that application to be administratively complete. During the technical review of this (Atlantic Shores) OCS Air

permit application, Atlantic Shores will consult with the reviewing agency regarding the necessity of explicitly including proposed emissions from the Ocean Wind 1 project. The evaluation will concentrate on two questions:

- Whether Ocean Wind 1's proposed emissions could create a concentration gradient in the vicinity of the proposed modification. Per the Appendix W guidance, the magnitude of a concentration gradient will be greatest in the proximity of the source and will generally not be significant at distances greater than 10 times the height of the stack(s) at that source. This distance is smaller for longer averaging periods. As stated in the March 1, 2011 memorandum *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard* "even accounting for some terrain influences on the location and gradients of maximum 1-hour concentrations… the emphasis on determining which nearby sources to include in the modeling analysis should focus on the area within about 10 kilometers of the project location in most cases…"
- Whether impacts could reasonably occur at the same place and the same time. Both Atlantic Shores and Ocean Wind 1 are attempting to take modeling guidance and methods designed for continuous, stationary sources and apply them to intermittent, mobile sources spread out over very large areas. Depending in part on project schedules, the chances that the sources modeled by Ocean Wind 1 would have impacts co-located with Atlantic Shores impacts may be very small, and the conservatism associated with modeling the combined impacts may be beyond that envisioned with the establishment of the relevant standard.

5.5.3 PSD Increment Analysis

For pollutants and averaging times with modeled impacts above the PSD increment SILs, the PSD increment is modeled. The amount of PSD increment available for a new project depends on whether the minor source baseline has been triggered. Once the minor source baseline is triggered, increment consumption must be evaluated for changes that occur at sources after that date.

Based on a review of the NJDEP Technical Manual 1002 (NJDEP 2021), and confirmed via consultation with NJDEP August 17, 2021, the PSD minor source trigger date for PM_{10} is November 17, 1988. The PSD minor source trigger date for $PM_{2.5}$ is April 16, 2014. Therefore, this Section presents the results of modeling each of the Projects' operational scenarios against the PSD increment for any pollutants and averaging times that are greater than the SIL.

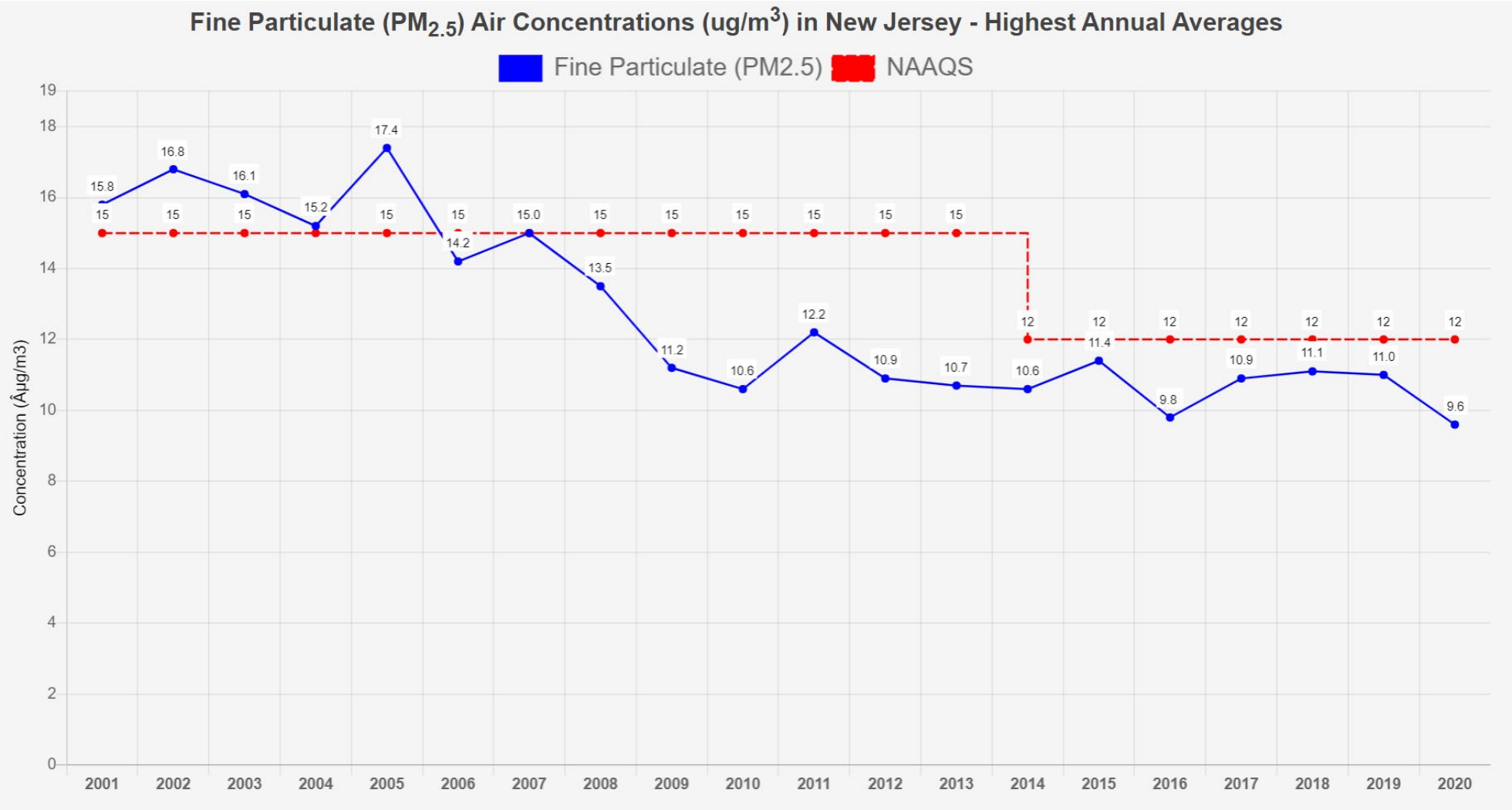
Atlantic Shores does not include other increment consuming or expanding sources in its analysis of PSD increment. This Section includes following documentation:

- A review of major source operating permits for facilities near the Brigantine Wildlife Refuge, based on NJDEP records posted online[17]. No nearby major sources have had emissions increases since the appropriate baseline date that are significant enough to consume either Class I or Class II increment in the vicinity of the Projects.
- A review of potential increment-expanding sources. The shutdown of the BL England coal-fired power plant serves to expand both Class I and Class II increments in the vicinity of the Projects. Atlantic Shores does not take credit for this expansion. This is because of anticipated difficulties in documenting the actual emissions reductions and stack parameters at the shuttered facility, and the difficulties in incorporating onshore and offshore emissions sources in the same modeling analysis.
- Documentation of no $PM_{2.5}$ secondary increment consumption. Atlantic Shores notes a decrease in measured ambient concentration trends in the vicinity (see Figure 5-1), and that a general downward trend that increment expansion, not consumption, has occurred. At this time, Atlantic Shores does not take credit for $PM_{2.5}$ secondary emission increment expansion.

As discussed above, Atlantic Shores does not have access to Ocean Wind 1's OCS Air Permit application. During the technical review of this (Atlantic Shores) OCS air permit application, in consultation with the reviewing agency Atlantic Shores will analyze whether the SIAs of the projects could reasonably overlap, and whether the intermittency of the emissions at each of the projects means that modeling the combined impacts could impart a level of conservatism associated with modeling the combined impacts may be beyond that envisioned with the establishment of the relevant standard.

Analysis of impacts to Class I area PSD increments focuses on the Brigantine Wildlife Refuge, as other Class I areas are much further and will be impacted much less.

[17] https://njdep.maps.arcgis.com/apps/webappviewer/index.html?id=76194937cbbe46b1ab9a9ec37c7d709b



Source: https://www.nj.gov/dep/airmon/criteria-pollutants.html

ATLANTIC SHORES offshore wind

Figure 5-1
Decreasing PM2.5 Concentration Trend

5.5.4 Soils, Vegetation, and Growth

PSD regulations require analysis of air quality impacts on sensitive vegetation types with significant commercial or recreational value or sensitive types of soil. Evaluation of impacts on sensitive vegetation is performed by comparing predicted impacts with screening levels presented in *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils and Animals* (EPA 1980). Most of the designated vegetation screening levels are equivalent to or exceed NAAQS and/or PSD increments, so satisfaction of NAAQS and PSD increments assures compliance with sensitive vegetation screening levels. Most of the designated vegetation screening levels are equivalent to or exceed NAAQS and/or PSD increments. The vegetative screening thresholds are reported in Table 5-4 along with the relevant NAAQS for comparison purposes.

TABLE 5-4 VEGETATIVE SCREENING THRESHOLDS

POLLUTANT	AVERAGING PERIOD	SECONDARY NAAQS (µG/M^3)	VEGETATIVE SCREENING THRESHOLD (µG/M^3)	FORM OF MODELED COMPARISON
NO_2	4-hour	N/A	3760	Maximum 1-hour
	1-Month	N/A	564	Maximum 1-hour
	Annual	100	94	Annual
CO	Week	N/A	1,800,000	Maximum 1-hour
PM_{10}	24-hour	150	N/A	24-hour
$PM_{2.5}$	24-hour	35	N/A	24-hour
	Annual	0.49	N/A	Annual

This Section assesses the impact of emissions from secondary growth. This is a qualitative analysis that will describe the Projects' direct and induced job creation, and its impact on secondary growth. This assessment concludes that no new significant emissions from secondary growth during either construction or operations are anticipated.

5.6 Air Quality Impact Analysis Approach

The modeling approach follows the guidance in the EPA's Guideline on Air Quality Models (EPA 2017) supplemented with NJDEP's Technical Manual 1002 (NJDEP 2021) to ensure that the ambient concentrations are protective of all applicable air quality standards.

The draft EPA New Source Review (NSR) Workshop Manual (EPA 1990) states that the air dispersion modeling analysis is separated into two distinct phases: 1) the preliminary analysis, and 2) a full impact analysis. In the preliminary analysis, only the significant increase in potential emissions of a pollutant from a proposed new source or the significant net emissions increase of a pollutant from a proposed modification are

modeled. The results of this analysis are used to determine the worst-case stack parameters, which criteria pollutants require a full impact analysis, and the receptor locations to be used in the cumulative source modeling analysis (if necessary).

The EPA does not require a full impact analysis for a pollutant if the results of the preliminary analysis indicate that the emissions from the proposed source or modification will not increase ambient concentrations by more than pollutant-specific SILs.

5.7 Background Air Quality Data

For pollutants and averaging times with modeled impacts above the NAAQS SIL, modeled concentrations due to emissions from Projects are added to ambient background concentrations to obtain total concentrations. These total concentrations are compared to the relevant NAAQS.

Consistent with the May 2022 air modeling protocol, Atlantic Shores requests the use of existing conservatively representative monitoring data are available for the Project. Therefore, instead of conducting pre-construction monitoring data for background ambient air concentrations, the observed concentration data from local and regional ambient air quality monitors described below are proposed.

This section addresses the preconstruction monitoring requirements per 40 CFR 52.21(m)(1) by providing an analysis of ambient air quality in the area that the major stationary source would affect for each pollutant that it would have the potential to emit in a significant amount (pollutants not explicitly modeled are addressed above). To estimate background pollutant concentrations, data are taken from EPA's website: https://www.epa.gov/outdoor-air-quality-data. Background concentrations are determined from the closest and most representative monitoring stations to the WTA, and to the Brigantine Wildlife refuge. Preference is given to monitoring stations that represent coastal conditions. Given the over-water environment of the WTA, utilization of these predominantly urban monitoring locations for the background concentrations is conservative in nature. A summary of the background air quality concentrations is presented in Table 5-5. For the short-term averaging periods and for annual average $PM_{2.5}$, the form of the standard value is used; the highest monitored value is used for annual averages.

TABLE 5-5 OBSERVED AMBIENT AIR QUALITY CONCENTRATIONS AND SELECTED BACKGROUND LEVELS

POLLUTANT	AVERAGING PERIOD	FORM	POLLUTANT CONCENTRATION			UNITS	2019-2021 BACKGROUND LEVEL (µG/M3)	NAAQS (µG/M3)	LOCATION
			2019	2020	2021				
CO (1)	1-Hour(4)	H2H(5)	2.2	2.3	2.5	ppm	2865	40000	7 Broad St, Elizabeth, NJ
	8-Hour(4)	H2H	1.90	2	2.3	ppm	2635.8	10000	
NO_2 (7)	1-Hour	98th %	34.8	32.4	34	ppb	63.4	188	Millville, NJ
NO_2 (2)	Annual(3)	H(6)	6.31	6.33	6.30	ppb	11.87	100	Millville, NJ
PM_{10}	24-Hour	H2H	34	30	38	µg/m^3	38	150	Jersey City Firehouse, NJ
$PM_{2.5}$	24-Hour(3)	98th %	14.2	11.2	16.6	µg/m^3	14.0	35	Brigantine, NJ
	Annual(3)	H	6.03	4.65	6.30	µg/m^3	5.66	12	

Notes:
From 2019-2020 EPA's AirData Website and NJ DEP Airmon Website (https://www.nj.gov/dep/airmon/, http://www.epa.gov/airquality/airdata)
1 CO reported in ppm. Converted to µg/m3 using factor of 1 ppm = 1146 µg/m3.
2 NO2 reported in ppb. Converted to µg/m3 using factor of 1 ppb = 1.88 µg/m3.
3 Background level is the average concentration of the three years.
4 Background level is the maximum concentration of the three years.
5 Background level is based on the highest-second-high value (H2H).
6 Background level is based on the highest value (H).
7 Background level is based on the 98th percentile (98th).

5.8 Alternative Model Approval

The air quality model used for analysis of over-water impacts is the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) Modeling System with meteorological data prepared using the AERCOARE meteorological data preprocessor program. AERCOARE is used to implement the Coupled Ocean-Atmosphere Response Experiment (COARE) bulk flux algorithm. EPA issued an alternative model approval and concurrence for Atlantic Shores' proposed use of AERMOD/AERCOARE on July 28, 2022.

In coordination with EPA, Atlantic Shores will further support the use of AERMOD/AERCOARE by providing a demonstration of the range of distance in which shoreline fumigation would be of concern.

5.9 Air Quality Model Options

The COARE bulk flux algorithm is a series of equations which use the air-sea temperature difference, overwater humidity, and wind speed measurements to estimate the sensible heat, latent heat, and momentum fluxes. Version 3 of the COARE algorithm has been implemented within the meteorological data processor program, AERCOARE, to prepare meteorological data for use in AERMOD. AERCOARE, in conjunction with AERMOD, is an alternative model for assessing compliance with air quality standards when emission sources and dispersion occur over water.

AERCOARE-AERMOD offers the following technical advantages, options, and features available in the model:

- The Plume Rise Model Enhancements (PRIME) downwash algorithm can be used to assess impacts in the cavity and wake regions of structures.
- The Plume Volume Molar Ratio Method (PVMRM) and Ozone Limiting Method (OLM) may be used to estimate the conversion of oxides of nitrogen (NOx) to NO_2. While this analysis uses the ARM2 screening technique, if needed during technical review of the application PVMRM or OLM may be used as part of revisions.[18]
- Output can be generated in the statistical form that is needed to assess compliance with the newer statistically based NAAQS, such as 1-hour NO_2, and $PM_{2.5}$.
- The AERMOD-AERCOARE model can model multiple line sources and multiple area sources within the same model run and does not limit the number of sources that can be modeled simultaneously.
- The AERMOD-AERCOARE model can model volume sources.
- Calm wind conditions can be processed by the AERMOD-AERCOARE model.
- The dispersion algorithms used in the AERMOD portion of AERCOARE-AERMOD are considered state-of-art by EPA.
- AERCOARE-AERMOD does not artificially limit the number of receptors that can be considered in an analysis.
- AERCOARE will directly accept WRF data model predicted hourly meteorological output from the Mesoscale Model Interface (MMIF) program.

The modeling analysis uses the most recent version of AERMOD (v22112).

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[18] EPA approval is required prior to using PVMRM or OLM for a regulatory modeling application. The Proponent would supplement its modeling protocol with the appropriate details concerning this Tier 3 modeling approach for EPA's consideration.

5.10 Meteorological Data for Modeling

The modeling analysis uses prognostic meteorological data. This is appropriate because there is no representative National Weather Service (NWS) station and given the offshore nature of the Projects it is infeasible to collect adequately representative site-specific data. Atlantic Shores has requested and received prognostic (i.e., WRF data) data from EPA. EPA processed the WRF data using the MMIF to convert the prognostic meteorological data into a format suitable for dispersion modeling applications. Use of prognostic meteorological data requires concurrence from the appropriate reviewing authority and collaborating agencies that the data are of acceptable quality and representative of the modeling application. Appendix E to this application provides an analysis following the procedures in the EPA's Evaluation of Prognostic Meteorological Data in AERMOD Applications Guidance Document, to document that the prognostic meteorological data is acceptable for use in this modeling application.

5.10.1 AERCOARE Meteorological Data Preparation

EPA provided the MMIF processed WRF data for 2018-2020. This data was processed by AERCOARE in order to generate the surface and profile meteorological data for AERMOD. The following parameters were selected in processing the meteorological data for the Project:

The data extraction point for the prognostic dataset was: 74.126° W, 39.248° N

MMIF was run using the following settings:

- Use of WRF output settings for mixing height ("AER_MIXHT = WRF", as opposed to a MMIF-diagnosis of mixing height).
- Use of surface characteristics provided by WRF (as opposed to use of AERSURFACE).
- Use of a minimum mixing height of 25 meters.
- Use of a minimum absolute value of Monin-Obukhov Length of 5 meters.

AERCOARE was executed using the following settings:

- Default settings recommended in EPA's AERCOARE User's Manual,[19] except as specified below:
- Minimum wind speed used by AERMOD is 0.5 m/s. Wind speeds below this value were considered calms; WSCALM = 0.5 m/s.

[19] User's Manual AERCOARE Version 1.0, EPA-910-R-008. 2012.

Mixing heights provided by WRF-MMIF were used, instead of calculated by AERCOARE. The minimum mixing height of 25 m, assigned under the MMIF processing step, was maintained.

Warm layer and cool-skin effects were not considered.

Friction velocity was determined from wind speed only; wave-height was not considered.

The data provided by EPA were missing the final six hours in 2020; these hours were left blank. The dataset received by EPA meets the minimum completeness criteria for air dispersion modeling. Figure 5-2 is the wind rose for the 2018-2020 prognostic meteorological data.

5.11 Receptors

When assessing compliance with NAAQS and Class II PSD increments, the receptors are entirely over water. There cannot possibly be any residences, and the public is extremely unlikely to remain for any extended period in any of the locations being modeled. The standards were established to be protective of public health based on repeated or prolonged exposure, and the possibility of repeated or prolonged exposure does not exist miles from shore.

Regarding the placement of over-water receptors, the analysis uses a polar nested receptor grid centered on the stacks from the largest vessel in the source operating group. Construction activities and some O&M activities will have safety exclusion zones, where access to the public will be limited. Receptors will be removed inside of locations which are subject to such safety exclusion zones. Based on the results of the modeling, the receptor field is refined to ensure that the maximum impacts from the different activities are being captured and to determine the extent of the significant impact area.

For modeling impacts against Class I PSD increments, receptors are used following National Park Service (NPS) guidance[20]. Specifically, NPS Air Resources Division (ARD) has developed a database of modeling receptors for all of the Class I areas in the United States; Atlantic Shores uses the modeling receptors developed by NPS ARD for the Brigantine Wildlife Refuge.

[20] https://irma.nps.gov/DataStore/Reference/Profile/2249830

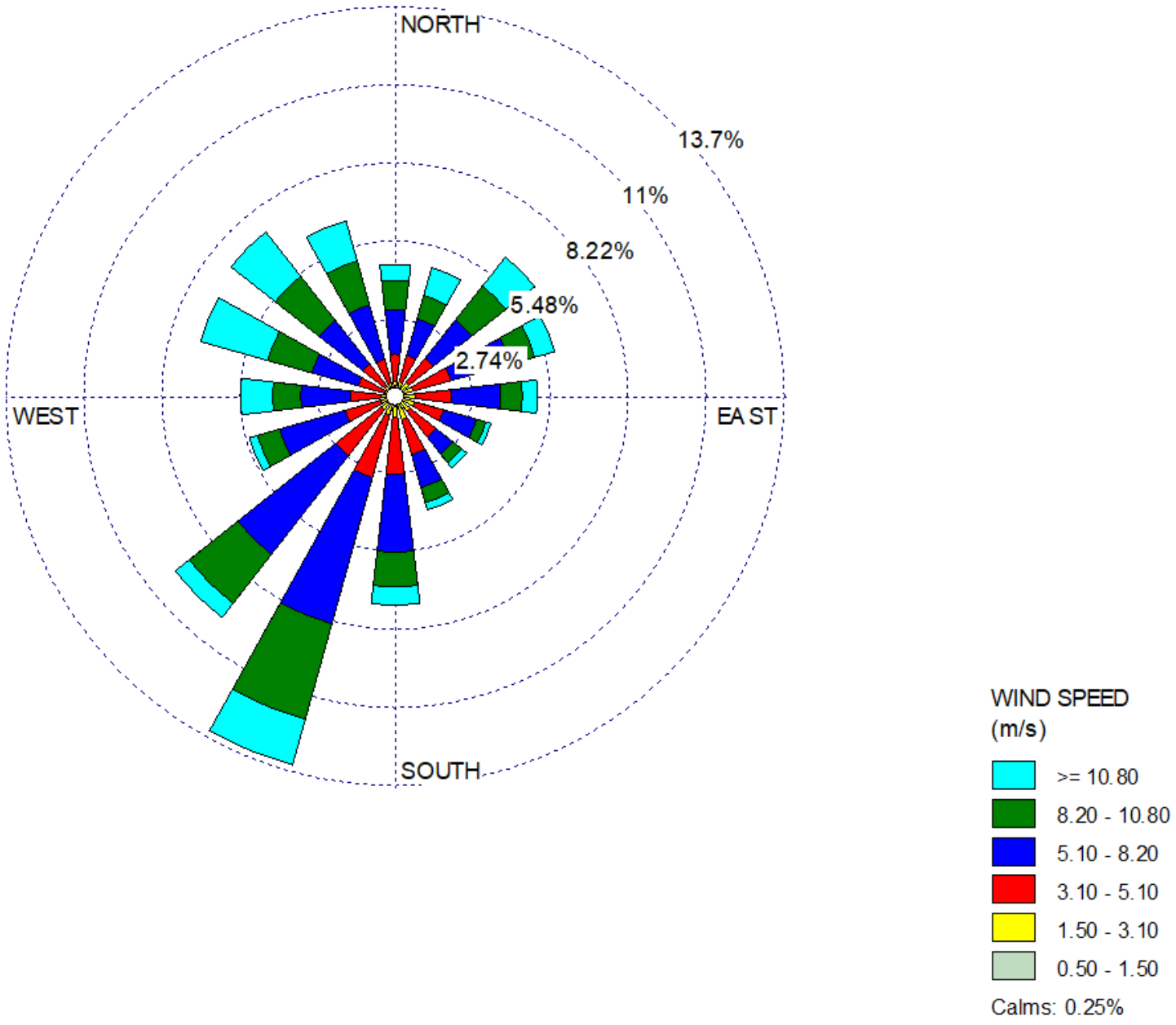

Figure 5-2

Wind Rose for 2018-2020 Prognostic Meteorological Data

5.12 Secondary Pollutant Formation

For NOx, CO, and PM_{10}, only the Project's direct emissions will be modeled. For $PM_{2.5}$, emissions include primary emissions (which are emitted directly from a source) and secondary emissions (which form when precursor emissions such as SO_2 and NOx undergo a chemical transformation in the atmosphere). Following EPA established guidance for sources with potential emissions greater than or equal to 10 tons per year of direct $PM_{2.5}$ and 40 tons per year of NOx, this modeling analysis addresses the impacts of both primary and secondary $PM_{2.5}$ emissions. This analysis includes the use of an Appendix W preferred model for assessing the primary impacts coupled with one of three secondary impact approaches described by EPA. Atlantic Shores uses the Tier 1 approach using the *Guidance on the Development of Modeled Emission Rates for Precursors* (MERPs) (EPA, 2019). Following Table V-2 in that guidance, Atlantic Shores addresses secondary formation of $PM_{2.5}$ from NOx and SO_2 emissions using the MERP approach. Because the Projects are subject to NNSR for ozone, ozone modeling is not required.

EPA's (2018) Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program established recommended SIL values for $PM_{2.5}$ NAAQS. On April 30, 2019 EPA finalized guidance centered on using the MERP approach as a Tier 1 screening approach (EPA 2019). EPA has posted tools online to provide access to EPA's hypothetical single source modeled impacts of $PM_{2.5}$ to support appropriate PSD applications[21].

As a first-tier approach, Atlantic Shores uses the illustrative hypothetical single source modeled impacts for annual and daily maximum average PM2.5 by Precursor presented in for Kent County, Delaware, which is the closest and most representative location.

Following the MERP Guidance (Eq. 2), secondary impact on daily and annual $PM_{2.5}$ is calculated according to the following equation:

Project Impact = Project emission rate * Modeled air quality impact from hypothetical source/ Modeled emission rate from hypothetical source

These calculated secondary impacts are added to primary impacts when evaluating the total predicted concentrations of PM2.5 and comparing against relevant standards.

When assessing Class I impacts, the short-term analysis uses the distance from the closest emission points and the long-term analysis uses the distance to the centroid. Atlantic Shores applies the project-specific MERP for each source group, addressing operations separately as described in Section 5.4.1 and conservatively assuming emissions out a single

[21] https://www.epa.gov/scram/merps-view-qlik

stack. As discussed in Section 5.4.1, during the technical review of this application, Atlantic Shores will work with EPA to analyze the likelihood that any two operations could overlap in space and time in a manner that would require additional analysis.

5.13 Additional Impact Analyses

40 CFR 52.21 (o)(1) states "the owner or operator shall provide an analysis of the impairment to visibility, soils and vegetation that would occur as a result of the source or modification and general commercial, residential, industrial and other growth associated with the source or modification. The owner or operator need not provide an analysis of the impact on vegetation having no significant commercial or recreational value." 40 CFR 52.21 (o) (2) states "The owner or operator shall provide an analysis of the air quality impact projected for the area as a result of general commercial, residential, industrial and other growth associated with the source or modification." Each requirement is addressed below.

5.13.1 Visibility

Appendix C contains the initial Class I Air Quality Related Values Modeling Report, satisfying the visibility analysis requirements of 40 CFR 52.21(p)(3). The Brigantine Wildlife Refuge Class I area is sufficiently representative of nearby onshore areas that the analysis specific to that Class I area serves to also address the broader visibility analysis per 40 CFR 52.21 (o)(1).

5.13.2 Soils and Vegetation

The Project is located on open water, miles from the nearest land (and therefore the nearest vegetation). Therefore, the nearest vegetation with any commercial or recreational value is miles away, and there is no reasonable opportunity for emissions from the Projects to have any impact on soils or vegetation. Further, the over-water modeling results show that vegetative screening thresholds shown in Table 5-4 could not be exceeded, even over water. Therefore, air emissions from the Projects will not negatively impact soils or vegetation.

5.13.3 Growth

As described in Volume 1 Section 2.0 of the COP, The Projects will be meaningful contributors to the region's economy by creating thousands of well-paid jobs in the burgeoning renewable energy sector.

The importance of the renewable energy sector in revitalizing the U.S.' economy is exemplified in Presidential Executive Order 14008 (Tackling the Climate Crisis at Home and Abroad), which describes clean energy jobs as a central pillar of the President's Build Back Better and economic recovery plan and directs the Secretary of the Interior to review siting and permitting processes to identify steps to double offshore wind energy production by 2030 (see Section 207; White House 2021). As described in the Executive Order, the

construction, manufacturing, engineering, and skilled-trades jobs needed to build a clean energy economy will bring opportunity to communities "that have suffered as a result of economic shifts and places that have suffered the most from persistent pollution, including low-income rural and urban communities, communities of color, and Native communities."

A significant portion of the Projects' economic and community benefits will be realized in New Jersey. As identified in the New Jersey Offshore Wind Strategic Plan, the development of offshore wind energy, such as the Atlantic Shores' Projects, is critical to addressing climate change and to building the State's clean energy economy (Ramboll 2020). As described by New Jersey Governor Phil Murphy, "Developing New Jersey's offshore wind industry will bring thousands of good-paying jobs and millions of dollars in economic development to our state to aid our economic recovery from COVID-19" (NJBPU 2020).

As described in the COP (Volume 1 Section 2.1), the Projects are expected to directly create more than 33,285 full time equivalent (FTE) jobs throughout their lifecycle. During the development and construction period, direct jobs will primarily be in construction, manufacturing, professional services (e.g., engineering and general management), transport, and warehousing. During operations and maintenance (O&M) and decommissioning, direct jobs will include jobs in operations and maintenance (e.g., wind turbine generator [WTG] technicians) as well as professional services.

Atlantic Shores has prioritized using local suppliers for a significant amount of development activities, including for survey activities, technical analysis, environmental and economic analysis, and legal services. Atlantic Shores has signed a first-of-its kind memorandum of understanding (MOU) with six local unions (UBCJA [Carpenters, Divers, Dock builders and Piledrivers], LIUNA [Laborers], IBEW [Electricians], IUOE [Operating Engineers], Ironworkers, and Union Millwrights) to help train and employ a productive, safe, skilled, local workforce.

As described in Volume 1 Section 5.5 of the COP, Atlantic Shores is proposing to establish a new O&M facility in Atlantic City to host its O&M personnel, dock vessels, and store equipment, tools, spare parts, and consumables. The O&M facility will host long-term jobs in technical services, project planning, data analysis, WTG preventative maintenance and repair, cable and foundation monitoring, and substation maintenance. The O&M facility will also create economic activity for a wide range of subcontractors including shipyards, spare part producers, and vessel and harbor services.

The Projects are designed to support existing infrastructure in the Region. If any new personnel move to the area to support the Projects, a significant housing market is already established and available. Therefore, no significant new housing is expected. Further, due to the significant level of existing commercial activity in the area, beyond the O&M facility described above and evaluated through by BOEM through the NEPA process, significant new commercial construction is not foreseen to be necessary to support the Projects' work force.

Thus, no new significant emissions from secondary growth during either construction or operations are anticipated.

5.14 Modeling Results

The modeling results in Appendix D document that the most substantial operations will not cause or significantly contribute to any exceedance of any relevant air quality standard. This initial application addresses the source groups, pollutants & averaging times, and emission rates with the highest chance of elevated impacts. Other operations will have lower impacts, and the analyses and results presented here document that lesser-emitting operations will similarly not cause or significantly contribute to any exceedance of any relevant air quality standard. During the technical review of this application, Atlantic Shores will consult with the reviewing agency regarding the need for additional analysis to document impacts from specific, lower-emitting operations.

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Appendix A

Regulatory Interpretation Requests

Appendix A: Regulatory Interpretation Requests

Relevant law and regulations pre-date the development of commercially viable utility-scale offshore wind projects. Which air quality regulatory programs apply to the Projects will depend on the definition of OCS source, and on related regulatory interpretations. Atlantic Shores has prepared and submitted this OCS air permit application based on a best-efforts understanding of current agency regulatory interpretations, policy, and precedent. However, Atlantic Shores believes there are alternative interpretations that EPA could take that would significantly simplify the review process for the Projects and other OSW projects. These alternative interpretations would still comply with all applicable laws and regulations, continue to meet the intent of those laws and regulations, and continue to protect public health and the environment. Atlantic Shores requests that EPA consider, or reconsider, the following interpretations as part of the review of this OCS air permit application.

1. Atlantic Shores requests that EPA determine that PSD and NSR requirements do not apply to vessels not servicing an OCS Source. Per 40 CFR § 55.2, "emissions from vessels servicing or associated with an OCS source shall be considered direct emissions from such a source while at the source, and while enroute to or from the source when within 25 miles of the source." Expected OCS sources during construction and O&M will include jack-up vessels, and foundations that have air emissions sources (such as generators) installed on them. Activities such as cable laying, transporting new GBS foundations to the WTA, foundation installation, operation of monitoring vessels, and fuel bunkering operations will not occur at any OCS source, and will not occur enroute to any OCS source. Atlantic Shores therefore proposes exclusion of such operations when determining applicability of PSD and NSR requirements, and exclusion of such operations from the requirements of the PSD (40 CFR § 52.21) and nonattainment NSR (NJAC 7:27-18) programs.

2. Atlantic Shores requests that EPA consider regulatory applicability separately for the construction and operation phases of the Projects. In support of this approach:

    a. The phases would be considered separately under federal operating permit regulations. The major source definition at 40 CFR 71.2 says "*a stationary source or group of stationary sources shall be considered part of a single industrial grouping if all of the pollutant emitting activities at such source or group of sources on contiguous or adjacent properties belong to the same Major Group (i.e., all have the same two-digit code) as described in the Standard Industrial Classification Manual, 1987.*" Construction would fall under SIC Code 1639[1] [Heavy Construction, includes the following examples: Dredging—general contractors; Marine construction—general contractors; Pile driving—contractors; Power plant construction—general contractors]. Operation would fall under SIC Code 4911[2] [Industry: 4911—Electric Services, Establishments engaged in the generation, transmission, and/or distribution of electric energy for sale.]

b. Per 40 CFR § 52.21(b)(5)-(6), "Stationary source means any building, structure, facility, or installation which emits or may emit a regulated NSR pollutant" and "Building, structure, facility, or installation means all of the pollutant-emitting activities which belong to the same industrial grouping . . . Pollutant-emitting activities shall be considered as part of the same industrial grouping if they belong to the same "Major Group" (i.e., which have the same first two digit code) as described in the Standard Industrial Classification Manual . . . ." As noted above, Construction would fall under SIC Code 1639[1] [Heavy Construction, includes the following examples: Dredging—general contractors; Marine construction—general contractors; Pile driving—contractors; Power plant construction—general contractors]. Operation would fall under SIC Code 4911[2] [Industry: 4911—Electric Services, Establishments engaged in the generation, transmission, and/or distribution of electric energy for sale.]

c. The Cape Wind Fact Sheet [EPA OCS R1-01, 2010] separates construction and operational phases, and reviews air permit regulatory applicability separately for each phase.

d. More recent precedent also shows that a facility can stop being an OCS source when OCS activities cease. Per EPA's letter to Chevron April 20, 2021, "*EPA maintains its view that CAA permitting requirements for OCS sources cease to apply once the relevant "equipment, activity, or facility" no longer satisfies the criteria in the definition of "OCS source" in section 328 of the CAA and EPA's implementing regulations at 40 C.F.R. part 55. In addition, the Agency maintains the position that associated vessel emissions alone are not sufficient to satisfy the potential to emit criteria necessary to establish an OCS source and that the Platforms would no longer qualify as OCS sources after all existing emissions-generating equipment is removed from the Platforms.*"[22]

3. Atlantic Shores requests that EPA determine the WTGs are not OCS sources. Consistent with EPA's letter to Chevron April 20, 2021, after commissioning the WTGs will have all emissions-generating equipment removed. The WTGs may have electrical gear containing sulfur hexafluoride (SF6), but SF6 is not a regulated air pollutant in this context, and the SF6 would be used in sealed systems with no vents or similar exits to atmosphere.

4. Atlantic Shores requests that EPA determine that PSD review and NSR review are not triggered for the O&M phase of the Projects. Following the reasoning in the points above, the O&M phase can be considered separately from construction, only vessels at or enroute to an OCS source should be included in the Projects' potential to emit when comparing against regulatory thresholds, and the WTGs will not be OCS sources. Remaining OCS sources during

[22] https://www.epa.gov/sites/default/files/2021-04/documents/chevron_combined_042021.pdf

O&M will include the OSSs and any jack-up vessels used for repairs. Evaluating the O&M phase of the Projects separately from the construction phase, and including only vessels located at or enroute to OCS sources, emissions during O&M would be below PSD and NSR review thresholds.

5. Atlantic Shores requests that EPA reconsider its interpretation of 40 CFR § 52.21(i)(3)(i), and specifically the criteria to determine that a source "*would impact no Class I area*". Since that regulation continues "*… and no area where an applicable increment is known to be violated*" it is reasonable to interpret "*impact*" to mean exceed the Class I increment. This application documents that construction emissions from the Projects will not exceed the Class I increment. Given the reinterpretation requested here, the fact that the Projects' construction will be temporary consistent with recent EPA interpretations, and the documentation provided by Atlantic Shores that no applicable increment is known to be violated, per 40 CFR § 52.21(i)(3) the modeling requirements in 40 CFR § 52.21(k), (m), and (o) would not apply to the construction phase of the Projects.

6. Atlantic Shores requests that EPA require analysis of NAAQS and PSD increment compliance only at onshore locations.

    a. When assessing compliance with NAAQS and Class II PSD increments, the peak impacts are entirely over water miles from shore. There cannot possibly be any residences, and the public is extremely unlikely to remain for any extended period in any of the locations being modeled. Given that the standards were established to be protective of public health based on repeated or prolonged exposure, and that possibility of repeated or prolonged exposure does not exist miles from shore, Atlantic Shores requests that EPA limit placement of modeling receptors to locations where the public could have repeated or prolonged exposure to ambient air. Specifically, Atlantic Shores requests that receptors should be placed at the shoreline, and at onshore publicly-accessible locations. This is consistent with BOEM's approach for offshore areas where BOEM is the regulatory agency.
    b. Atlantic Shores notes in particular that there is no requirement, and no value, to enforcing PSD increment consumption limits at locations that are miles offshore. PSD applies to areas that have been designated as attainment or unclassifiable with the NAAQS, but EPA makes no such designation for offshore areas.
    c. As a secondary alternative, EPA could allow placement of receptors outside of the Atlantic Shores lease area. The lease allows certain property controls over the lease area, which would serve to prevent any member of the public from "residing" within the lease area.

7. Atlantic Shores requests that EPA allow further consideration of the transient nature of emissions when modeling impacts. Modeling moving, intermittent emissions sources as if they were fixed, continuous sources effectively imposes an additional level of stringency beyond that intended by the level of the standard itself. This is especially true for probabilistic

standards (and this application applies guidance from EPA's March 1, 2011 memo regarding the 1-hour NO2 NAAQS), but the concept extends to all NAAQS. For example, the PM2.5 24-hour PSD increment is "not to be exceeded more than once per year." An operation that only occurs for about 40 hours at any one location could not possibly have the same impact as a continuous source, because the O&M operation will not be emitting for any two days for 24 hours/day.

8. Atlantic Shores requests that EPA limit its interpretation of what air emissions need to be offset in the NSR program.

    a. It is established precedent that the NSR requirement to meet LAER applies only to OCS sources themselves, not to vessels at or enroute to OCS sources. EPA can and should apply this same reasoning to the NSR requirement to obtain emissions offsets.

    b. If vessel emissions must be offset, Atlantic Shores requests (consistent with the points above) that EPA limit the requirement to vessels at or enroute to OCS sources. Vessels not traveling to OCS sources (such as OSSs with generators or jack-up vessels) would not need to have their emissions offset.

9. Atlantic Shores requests that EPA allow a mechanism to document that OSW projects generate their own emissions offsets. Atlantic Shores documents in this OCS application that the Projects will reduce emissions by displacing fossil fuel fired electricity generation. While those emissions reductions will not occur at facilities owned by Atlantic Shores, EPA could still approve the reductions as a pollution prevention measure per NJAC 7:27-18.5(b)7.

Appendix B

Emissions Calculation Tables

Total Emissions

Activity Group	Fuel Consumption (gal)	Emissions (tons)														
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	4,992,914.2	705.9	23.6	227.6	24.3	23.7	1.5	0.00	1.6	0.07	57,435.1	1.0	2.0	25.0	599.0	58,059.2
Offshore Substation Installation (OSS)	654,566.3	103.8	2.5	28.8	3.4	3.3	0.2	0.00	0.2	0.01	7,528.9	0.1	0.3	2.4	90.6	7,621.9
Scour Protection	1,028,760.7	171.5	3.9	40.7	6.0	5.8	1.1	0.00	0.4	0.05	11,403.5	0.1	0.6	1.8	165.0	11,570.3
Inter Array Cable Installation	1,193,952.0	198.3	4.6	46.8	7.0	6.7	1.4	0.00	0.5	0.06	13,226.2	0.1	0.6	2.1	191.4	13,419.7
WTG Installation	7,528,737.1	1,429.7	20.1	323.8	43.4	42.1	2.0	0.01	2.5	0.09	89,494.5	0.6	4.3	13.8	1,278.2	90,786.5
Export Cable Installation	4,717,787.2	792.0	16.2	190.6	27.1	26.3	3.9	0.00	1.9	0.18	52,512.6	0.3	2.5	8.2	756.5	53,277.2
Fuel Bunkering	554,115.0	77.3	2.4	24.2	2.8	2.7	0.2	0.00	0.2	0.01	6,228.1	0.1	0.2	2.4	69.7	6,300.2
Commissioning Generators	149,185.7	13.0	1.6	11.5	0.2	0.2	0.0	0.00	0.0	0.00	1,702.8	0.1	0.0	1.7	4.1	1,708.6
Miscellaneous	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.00	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	20,820,018.2	3,491.5	75.8	894.0	114.2	110.8	10.3	0.01	7.3	0.47	239,531.7	2.3	10.6	57.4	3,154.6	242,743.6

Vessel Emissions

Activity Group	Fuel Consumption (gal)	Emissions (tons)														
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	3,351,386.2	593.4	9.5	138.9	19.2	18.6	1.3	0.00	1.2	0.06	38,699.2	0.2	1.9	6.0	553.7	39,259.0
Offshore Substation Installation (OSS)	528,939.2	95.2	1.5	22.0	3.0	2.9	0.2	0.00	0.2	0.01	6,095.1	0.0	0.3	0.9	87.1	6,183.2
Scour Protection	1,028,760.7	171.5	3.9	40.7	6.0	5.8	1.1	0.00	0.4	0.05	11,403.5	0.1	0.6	1.8	165.0	11,570.3
Inter Array Cable Installation	1,193,952.0	198.3	4.6	46.8	7.0	6.7	1.4	0.00	0.5	0.06	13,226.2	0.1	0.6	2.1	191.4	13,419.7
WTG Installation	7,528,737.1	1,429.7	20.1	323.8	43.4	42.1	2.0	0.01	2.5	0.09	89,494.5	0.6	4.3	13.8	1,278.2	90,786.5
Export Cable Installation	4,717,787.2	792.0	16.2	190.6	27.1	26.3	3.9	0.00	1.9	0.18	52,512.6	0.3	2.5	8.2	756.5	53,277.2
Fuel Bunkering	410,115.0	68.4	1.3	16.4	2.3	2.3	0.2	0.00	0.1	0.01	4,584.5	0.0	0.2	0.7	65.8	4,651.0
Commissioning Generators	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	18,759,677.3	3,348.5	57.1	779.2	108.1	104.7	10.1	0.01	6.8	0.46	216,015.6	1.3	10.4	33.5	3,097.7	219,146.8

Non-Vessel Emissions

Activity Group	Fuel Consumption (gal)	Emissions (tons)														
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	1,641,528.0	112.5	14.0	88.7	5.1	5.1	0.2	0.00	0.4	0.01	18,735.9	0.8	0.2	19.0	45.3	18,800.2
Offshore Substation Installation (OSS)	125,627.1	8.6	1.1	6.8	0.4	0.4	0.0	0.00	0.0	0.00	1,433.9	0.1	0.0	1.5	3.5	1,438.8
Scour Protection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0
Inter Array Cable Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0
WTG Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0
Export Cable Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0
Fuel Bunkering	144,000.0	8.9	1.1	7.8	0.4	0.4	0.0	0.00	0.0	0.00	1,643.6	0.1	0.0	1.7	4.0	1,649.2
Commissioning Generators	149,185.7	13.0	1.6	11.5	0.2	0.2	0.0	0.00	0.0	0.00	1,702.8	0.1	0.0	1.7	4.1	1,708.6
Miscellaneous	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.00	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	2,060,340.9	143.0	18.7	114.7	6.1	6.1	0.2	0.00	0.5	0.01	23,516.1	1.0	0.2	23.8	56.9	23,596.8
Engines Only B02	2,060,340.9	143.0	17.8	114.7	6.1	6.1	0.2	0.00	0.5	0.01	23,516.1	1.0	0.2	23.8	56.9	23,596.8

OCS Emissions

Activity Group	Fuel Consumption (gal)	Emissions (tons)														
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	4,348,006.0	596.0	21.6	201.4	20.6	20.1	1.1	0.002	1.3	0.1	50,097.9	1.0	1.7	23.9	493.9	50,615.6
Offshore Substation Installation (OSS)	488,050.1	74.6	2.0	21.9	2.4	2.4	0.1	0.000	0.2	0.0	5,599.4	0.1	0.2	2.1	63.0	5,664.5
Scour Protection	488,050.1	152.7	3.4	36.3	5.3	5.1	1.0	0.001	0.4	0.0	10,148.6	0.1	0.5	1.6	146.7	10,296.9
Inter Array Cable Installation	1,007,319.2	167.5	3.9	39.6	5.9	5.7	1.1	0.001	0.4	0.1	11,162.4	0.1	0.5	1.7	161.5	11,325.7
WTG Installation	6,684,714.4	1,265.8	17.9	286.8	38.5	37.3	1.8	0.006	2.2	0.1	79,231.0	0.5	3.8	12.3	1,131.7	80,375.0
Export Cable Installation	2,341,195.9	393.2	8.0	94.7	13.4	13.0	1.9	0.002	0.9	0.1	26,064.6	0.2	1.3	4.1	375.4	26,444.1
Fuel Bunkering	466,992.7	62.8	2.1	20.7	2.3	2.2	0.2	0.000	0.1	0.0	5,254.6	0.1	0.2	2.2	55.8	5,312.6
Commissioning Generators	149,185.7	13.0	1.6	11.5	0.2	0.2	0.0	0.000	0.0	0.0	1,702.8	0.1	0.0	1.7	4.1	1,708.6
Miscellaneous	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	15,973,514.1	2,725.6	61.5	712.9	88.7	86.1	7.3	0.01	5.6	0.3	189,261.3	2.0	8.2	49.6	2,432.1	191,742.9

OCS Vessel Emissions

Activity Group	Fuel Consumption (gal)	Emissions (tons)														
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	2,706,478.0	483.6	7.6	112.7	15.5	15.0	0.97	0.0	0.9	0.0	31,362.0	0.2	1.5	4.9	448.6	31,815.4
Offshore Substation Installation (OSS)	362,423.0	66.0	1.0	15.1	2.0	2.0	0.10	0.0	0.1	0.0	4,165.5	0.0	0.2	0.6	59.5	4,225.7
Scour Protection	488,050.1	152.7	3.4	36.3	5.3	5.1	0.98	0.0	0.4	0.0	10,148.6	0.1	0.5	1.6	146.7	10,296.9
Inter Array Cable Installation	1,007,319.2	167.5	3.9	39.6	5.9	5.7	1.13	0.0	0.4	0.1	11,162.4	0.1	0.5	1.7	161.5	11,325.7
WTG Installation	6,684,714.4	1,265.8	17.9	286.8	38.5	37.3	1.82	0.0	2.2	0.1	79,231.0	0.5	3.8	12.3	1,131.7	80,375.0
Export Cable Installation	2,341,195.9	393.2	8.0	94.7	13.4	13.0	1.90	0.0	0.9	0.1	26,064.6	0.2	1.3	4.1	375.4	26,444.1
Fuel Bunkering	322,992.7	53.9	1.0	12.9	1.8	1.8	0.17	0.0	0.1	0.0	3,611.0	0.0	0.2	0.6	51.8	3,663.4
Commissioning Generators	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	13,913,173.3	2,582.6	42.8	598.2	82.5	79.9	7.1	0.01	5.1	0.3	165,745.1	1.0	8.0	25.7	2,375.2	168,146.1

OCS Non-Vessel Emissions

Activity Group	Fuel Consumption (gal)	Emissions (tons)														
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	1,641,528.0	112.5	14.0	88.7	5.1	5.1	0.17	0.00	0.40	0.01	18,735.9	0.76	0.15	19.0	45.3	18,800.2
Offshore Substation Installation (OSS)	125,627.1	8.6	1.1	6.8	0.4	0.4	0.01	0.00	0.03	0.00	1,433.9	0.06	0.01	1.5	3.5	1,438.8
Scour Protection	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
Inter Array Cable Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
WTG Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
Export Cable Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
Fuel Bunkering	144,000.0	8.9	1.1	7.8	0.4	0.4	0.02	0.00	0.02	0.00	1,643.6	0.07	0.01	1.7	4.0	1,649.2
Commissioning Generators	149,185.7	13.0	1.6	11.5	0.2	0.2	0.02	0.00	0.04	0.00	1,702.8	0.07	0.01	1.7	4.1	1,708.6
Miscellaneous	0.0	0.0	0.9	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
Total B02	2,060,340.9	143.0	18.7	114.7	6.1	6.1	0.22	0.00	0.48	0.01	23,516.1	0.95	0.19	23.8	56.9	23,596.8
Engines Only B02	2,060,340.9	143.0	17.8	114.7	6.1	6.1	0.22	0.00	0.5	0.01	23,516.1	0.95	0.19	23.8	56.9	23,596.8

Peak Year OCS Emissions																
Activity Group	Fuel Consumption (gal)	Emissions (tons)														
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	3,043,604.2	417.2	15.1	141.0	14.4	14.1	0.8	0.002	0.9	0.0	35,068.5	0.7	1.2	16.7	345.7	35,430.9
Offshore Substation Installation (OSS)	488,050.1	74.6	2.0	21.9	2.4	2.4	0.1	0.000	0.2	0.0	5,599.4	0.1	0.2	2.1	63.0	5,664.5
Scour Protection	341,635.1	106.9	2.4	25.4	3.7	3.6	0.7	0.000	0.3	0.0	7,104.0	0.0	0.3	1.1	102.7	7,207.8
Inter Array Cable Installation	1,007,319.2	167.5	3.9	39.6	5.9	5.7	1.1	0.001	0.4	0.1	11,162.4	0.1	0.5	1.7	161.5	11,325.7
WTG Installation	4,718,622.0	893.5	12.6	202.5	27.2	26.3	1.3	0.004	1.6	0.1	55,927.8	0.3	2.7	8.6	798.9	56,735.3
Export Cable Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fuel Bunkering	233,496.3	31.4	1.0	10.4	1.1	1.1	0.1	0.000	0.1	0.0	2,627.3	0.0	0.1	1.1	27.9	2,656.3
Commissioning Generators	149,185.7	13.0	1.6	11.5	0.2	0.2	0.0	0.000	0.0	0.0	1,702.8	0.1	0.0	1.7	4.1	1,708.6
Miscellaneous	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	9,981,912.6	1,704.1	39.2	452.2	55.0	53.4	4.1	0.007	3.5	0.2	119,192.1	1.3	5.0	33.1	1,503.8	120,729.1

Peak Year OCS Vessel Emissions																
Activity Group	Fuel Consumption (gal)	Emissions (tons)														
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	1,894,534.6	338.5	5.3	78.9	10.9	10.5	0.7	0.002	0.7	0.0	21,953.4	0.1	1.1	3.4	314.0	22,270.8
Offshore Substation Installation (OSS)	362,423.0	66.0	1.0	15.1	2.0	2.0	0.1	0.000	0.1	0.0	4,165.5	0.0	0.2	0.6	59.5	4,225.7
Scour Protection	341,635.1	106.9	2.4	25.4	3.7	3.6	0.7	0.000	0.3	0.0	7,104.0	0.0	0.3	1.1	102.7	7,207.8
Inter Array Cable Installation	1,007,319.2	167.5	3.9	39.6	5.9	5.7	1.1	0.001	0.4	0.1	11,162.4	0.1	0.5	1.7	161.5	11,325.7
WTG Installation	4,718,622.0	893.5	12.6	202.5	27.2	26.3	1.3	0.004	1.6	0.1	55,927.8	0.3	2.7	8.6	798.9	56,735.3
Export Cable Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fuel Bunkering	161,496.3	27.0	0.5	6.5	0.9	0.9	0.1	0.000	0.1	0.0	1,805.5	0.0	0.1	0.3	25.9	1,831.7
Commissioning Generators	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	8,486,030.2	1,599.3	25.7	367.9	50.6	49.0	4.0	0.007	3.1	0.2	102,118.6	0.6	4.9	15.8	1,462.5	103,596.9

Peak Year OCS Non-Vessel Emissions																
Activity Group	Fuel Consumption (gal)	Emissions (tons)														
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	1,149,069.6	78.7	9.8	62.1	3.5	3.5	0.12	0.00	0.28	0.01	13,115.2	0.53	0.11	13.3	31.7	13,160.2
Offshore Substation Installation (OSS)	125,627.1	8.6	1.1	6.8	0.4	0.4	0.01	0.00	0.03	0.00	1,433.9	0.06	0.01	1.5	3.5	1,438.8
Scour Protection	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
Inter Array Cable Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
WTG Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
Export Cable Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
Fuel Bunkering	72,000.0	4.4	0.6	3.9	0.2	0.2	0.01	0.00	0.01	0.00	821.8	0.03	0.01	0.8	2.0	824.6
Commissioning Generators	149,185.7	13.0	1.6	11.5	0.2	0.2	0.02	0.00	0.04	0.00	1,702.8	0.07	0.01	1.7	4.1	1,708.6
Miscellaneous	0.0	0.0	0.5	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.0	0.0
Total B02	1,495,882.5	104.8	13.5	84.3	4.4	4.4	0.16	0.00	0.36	0.01	17,073.6	0.69	0.14	17.3	41.3	17,132.2
Engines Only B02	1,495,882.5	104.8	13.0	84.3	4.4	4.4	0.16	0.00	0.36	0.01	17,073.6	0.69	0.14	17.3	41.3	17,132.2

Year 1 OCS Emissions																
Activity Group	Fuel Consumption (gal)	Emissions (tons)														
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	1,304,401.8	178.8	6.5	60.4	6.2	6.0	0.3	0.001	0.4	0.0	15,029.4	0.3	0.5	7.2	148.2	15,184.7
Offshore Substation Installation (OSS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scour Protection	146,415.0	45.8	1.0	10.9	1.6	1.5	0.3	0.000	0.1	0.0	3,044.6	0.0	0.1	0.5	44.0	3,089.1
Inter Array Cable Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WTG Installation	1,966,092.5	372.3	5.3	84.4	11.3	11.0	0.5	0.002	0.7	0.0	23,303.2	0.1	1.1	3.6	332.9	23,639.7
Export Cable Installation	2,341,195.9	393.2	8.0	94.7	13.4	13.0	1.9	0.002	0.9	0.1	26,064.6	0.2	1.3	4.1	375.4	26,444.1
Fuel Bunkering	233,496.3	31.4	1.0	10.4	1.1	1.1	0.1	0.000	0.1	0.0	2,627.3	0.0	0.1	1.1	27.9	2,656.3
Commissioning Generators	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	5,991,601.5	1,021.5	22.3	260.7	33.7	32.7	3.2	0.004	2.2	0.1	70,069.1	0.7	3.1	16.4	928.3	71,013.8

Year 2 OCS Emissions																
Activity Group	Fuel Consumption (gal)	Emissions (tons)														
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	3,043,604.2	417.2	15.1	141.0	14.4	14.1	0.8	0.002	0.9	0.0	35,068.5	0.7	1.2	16.7	345.7	35,430.9
Offshore Substation Installation (OSS)	488,050.1	74.6	2.0	21.9	2.4	2.4	0.1	0.000	0.2	0.0	5,599.4	0.1	0.2	2.1	63.0	5,664.5
Scour Protection	341,635.1	106.9	2.4	25.4	3.7	3.6	0.7	0.000	0.3	0.0	7,104.0	0.0	0.3	1.1	102.7	7,207.8
Inter Array Cable Installation	1,007,319.2	167.5	3.9	39.6	5.9	5.7	1.1	0.001	0.4	0.1	11,162.4	0.1	0.5	1.7	161.5	11,325.7
WTG Installation	4,718,622.0	893.5	12.6	202.5	27.2	26.3	1.3	0.004	1.6	0.1	55,927.8	0.3	2.7	8.6	798.9	56,735.3
Export Cable Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fuel Bunkering	233,496.3	31.4	1.0	10.4	1.1	1.1	0.1	0.000	0.1	0.0	2,627.3	0.0	0.1	1.1	27.9	2,656.3
Commissioning Generators	149,185.7	13.0	1.6	11.5	0.2	0.2	0.0	0.000	0.0	0.0	1,702.8	0.1	0.0	1.7	4.1	1,708.6
Miscellaneous	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	9,981,912.6	1,704.1	39.2	452.2	55.0	53.4	4.1	0.007	3.5	0.2	119,192.1	1.3	5.0	33.1	1,503.8	120,729.1

Total Emissions

Activity Group	Fuel Consumption (gal)	Emissions (tons)													
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	3,370,306.2	475.2	16.0	153.7	16.4	16.0	1.0	0.002	1.1	38,752.2	0.7	1.4	17.0	402.9	39,172.1
Offshore Substation Installation (OSS)	327,283.2	51.9	1.3	14.4	1.7	1.7	0.1	0.000	0.1	3,764.5	0.0	0.2	1.2	45.3	3,811.0
Scour Protection	681,350.4	113.6	2.6	27.0	4.0	3.8	0.7	0.000	0.3	7,553.6	0.0	0.4	1.2	109.2	7,664.0
Inter Array Cable Installation	786,571.5	130.7	3.0	30.9	4.6	4.4	0.9	0.001	0.3	8,715.5	0.1	0.4	1.4	126.1	8,843.0
WTG Installation	5,083,172.5	972.4	13.7	220.3	29.5	28.6	1.4	0.004	1.7	60,864.6	0.4	2.9	9.4	869.3	61,743.3
Export Cable Installation	2,361,137.0	396.4	8.1	95.4	13.6	13.1	1.9	0.002	0.9	26,281.4	0.2	1.3	4.1	378.6	26,664.0
Fuel Bunkering	379,578.1	53.0	1.6	16.6	1.9	1.9	0.2	0.000	0.1	4,266.1	0.1	0.2	1.6	47.9	4,315.6
Commissioning Generators	60,205.7	5.2	0.6	4.6	0.1	0.1	0.0	0.000	0.0	687.2	0.0	0.0	0.7	1.7	689.5
Miscellaneous	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	13,049,604.5	2,198.4	47.7	562.7	71.8	69.6	6.2	0.009	4.6	150,885.0	1.5	6.6	36.5	1,981.1	152,902.6

Vessel Emissions

Activity Group	Fuel Consumption (gal)	Emissions (tons)													
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	2,253,620.5	398.7	6.4	93.4	12.9	12.5	0.9	0.002	0.8	26,006.6	0.2	1.2	4.0	372.1	26,382.8
Offshore Substation Installation (OSS)	264,469.6	47.6	0.7	11.0	1.5	1.5	0.1	0.000	0.1	3,047.5	0.0	0.1	0.5	43.6	3,091.6
Scour Protection	681,350.4	113.6	2.6	27.0	4.0	3.8	0.7	0.000	0.3	7,553.6	0.0	0.4	1.2	109.2	7,664.0
Inter Array Cable Installation	786,571.5	130.7	3.0	30.9	4.6	4.4	0.9	0.001	0.3	8,715.5	0.1	0.4	1.4	126.1	8,843.0
WTG Installation	5,083,172.5	972.4	13.7	220.3	29.5	28.6	1.4	0.004	1.7	60,864.6	0.4	2.9	9.4	869.3	61,743.3
Export Cable Installation	2,361,137.0	396.4	8.1	95.4	13.6	13.1	1.9	0.002	0.9	26,281.4	0.2	1.3	4.1	378.6	26,664.0
Fuel Bunkering	281,863.8	47.0	0.9	11.3	1.6	1.6	0.2	0.000	0.1	3,150.8	0.0	0.2	0.5	45.2	3,196.5
Commissioning Generators	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	11,712,185.2	2,106.4	35.4	489.1	67.7	65.6	6.0	0.009	4.3	135,620.1	0.8	6.5	21.0	1,944.2	137,585.3

Non-Vessel Emissions

Activity Group	Fuel Consumption (gal)	Emissions (tons)													
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	1,116,685.7	76.5	9.5	60.3	3.4	3.4	0.1	0.00	0.3	12,745.5	0.5	0.1	12.9	30.8	12,789.3
Offshore Substation Installation (OSS)	62,813.6	4.3	0.5	3.4	0.2	0.2	0.0	0.00	0.0	716.9	0.0	0.0	0.7	1.7	719.4
Scour Protection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inter Array Cable Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WTG Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Export Cable Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fuel Bunkering	97,714.3	6.0	0.7	5.3	0.3	0.3	0.0	0.00	0.0	1,115.3	0.0	0.0	1.1	2.7	1,119.1
Commissioning Generators	60,205.7	5.2	0.6	4.6	0.1	0.1	0.0	0.00	0.0	687.2	0.0	0.0	0.7	1.7	689.5
Miscellaneous	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	1,337,419.3	92.0	12.3	73.6	4.0	4.0	0.1	0.00	0.3	15,264.9	0.6	0.1	15.5	36.9	15,317.3
Engines Only B02		92.0	11.4	73.6	4.0	4.0	0.1	0.00	0.3	15,264.9	0.6	0.1	15.5	36.9	15,317.3

OCS Emissions															
Activity Group	Fuel Consumption (gal)	Emissions (tons)													
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	2,954,506.7	404.9	14.7	136.9	14.0	13.7	0.8	0.001	0.9	34,040.5	0.6	1.1	16.2	335.4	34,392.1
Offshore Substation Installation (OSS)	244,025.1	37.3	1.0	11.0	1.2	1.2	0.1	0.000	0.1	2,799.7	0.0	0.1	1.0	31.5	2,832.2
Scour Protection	244,025.1	104.2	2.4	24.8	3.6	3.5	0.7	0.000	0.3	6,926.1	0.0	0.3	1.1	100.1	7,027.4
Inter Array Cable Installation	693,173.4	115.3	2.7	27.2	4.0	3.9	0.8	0.000	0.3	7,682.7	0.0	0.4	1.2	111.1	7,795.1
WTG Installation	4,514,956.4	862.0	12.2	195.3	26.2	25.4	1.2	0.004	1.5	53,954.7	0.3	2.6	8.3	770.7	54,733.7
Export Cable Installation	1,171,744.1	196.8	4.0	47.4	6.7	6.5	0.9	0.001	0.5	13,045.1	0.1	0.6	2.0	187.9	13,235.0
Fuel Bunkering	317,866.4	42.8	1.4	14.1	1.6	1.5	0.1	0.000	0.1	3,576.5	0.1	0.1	1.5	38.0	3,616.0
Commissioning Generators	60,205.7	5.2	0.6	4.6	0.1	0.1	0.0	0.000	0.0	687.2	0.0	0.0	0.7	1.7	689.5
Miscellaneous	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	10,200,503.0	1,768.4	39.8	461.3	57.5	55.8	4.6	0.007	3.6	122,712.6	1.3	5.3	32.1	1,576.4	124,321.1

Total Emissions															
Activity Group	Fuel Consumption (gal)	Emissions (tons)													
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	2,383,810.4	337.2	11.2	108.6	11.6	11.3	0.7	0.001	0.7	27,423.2	0.5	1.0	11.9	286.3	27,721.4
Offshore Substation Installation (OSS)	327,283.2	51.9	1.3	14.4	1.7	1.7	0.1	0.000	0.1	3,764.5	0.0	0.2	1.2	45.3	3,811.0
Scour Protection	495,091.4	82.5	1.9	19.6	2.9	2.8	0.5	0.000	0.2	5,487.9	0.0	0.3	0.9	79.4	5,568.1
Inter Array Cable Installation	592,150.5	98.4	2.3	23.2	3.5	3.3	0.7	0.000	0.3	6,561.1	0.0	0.3	1.0	94.9	6,657.1
WTG Installation	3,564,771.6	681.9	9.6	154.5	20.7	20.1	1.0	0.003	1.2	42,686.5	0.3	2.0	6.6	609.7	43,302.8
Export Cable Installation	2,361,137.0	396.4	8.1	95.4	13.6	13.1	1.9	0.002	0.9	26,281.4	0.2	1.3	4.1	378.6	26,664.0
Fuel Bunkering	266,721.5	37.3	1.1	11.6	1.3	1.3	0.1	0.000	0.1	2,997.7	0.0	0.1	1.1	33.7	3,032.5
Commissioning Generators	49,302.9	4.3	0.5	3.8	0.1	0.1	0.0	0.000	0.0	562.7	0.0	0.0	0.6	1.4	564.7
Miscellaneous	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	10,040,268.4	1,689.9	36.9	431.1	55.4	53.7	5.0	0.007	3.5	115,764.9	1.1	5.1	27.4	1,529.2	117,321.5

Vessel Emissions															
Activity Group	Fuel Consumption (gal)	Emissions (tons)													
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	1,602,130.4	283.7	4.6	66.4	9.2	8.9	0.6	0.001	0.6	18,501.3	0.1	0.9	2.9	264.7	18,768.9
Offshore Substation Installation (OSS)	264,469.6	47.6	0.7	11.0	1.5	1.5	0.1	0.000	0.1	3,047.5	0.0	0.1	0.5	43.6	3,091.6
Scour Protection	495,091.4	82.5	1.9	19.6	2.9	2.8	0.5	0.000	0.2	5,487.9	0.0	0.3	0.9	79.4	5,568.1
Inter Array Cable Installation	592,150.5	98.4	2.3	23.2	3.5	3.3	0.7	0.000	0.3	6,561.1	0.0	0.3	1.0	94.9	6,657.1
WTG Installation	3,564,771.6	681.9	9.6	154.5	20.7	20.1	1.0	0.003	1.2	42,686.5	0.3	2.0	6.6	609.7	43,302.8
Export Cable Installation	2,361,137.0	396.4	8.1	95.4	13.6	13.1	1.9	0.002	0.9	26,281.4	0.2	1.3	4.1	378.6	26,664.0
Fuel Bunkering	198,150.0	33.0	0.6	7.9	1.1	1.1	0.1	0.000	0.1	2,215.0	0.0	0.1	0.3	31.8	2,247.1
Commissioning Generators	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	9,077,900.5	1,623.5	27.8	378.0	52.5	50.8	4.9	0.007	3.3	104,780.7	0.7	5.0	16.3	1,502.7	106,299.6

Non-Vessel Emissions															
Activity Group	Fuel Consumption (gal)	Emissions (tons)													
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	781,680.0	53.6	6.7	42.2	2.4	2.4	0.1	0.00	0.2	8,921.9	0.4	0.1	9.0	21.6	8,952.5
Offshore Substation Installation (OSS)	62,813.6	4.3	0.5	3.4	0.2	0.2	0.0	0.00	0.0	716.9	0.0	0.0	0.7	1.7	719.4
Scour Protection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inter Array Cable Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WTG Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Export Cable Installation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fuel Bunkering	68,571.4	4.2	0.5	3.7	0.2	0.2	0.0	0.00	0.0	782.7	0.0	0.0	0.8	1.9	785.3
Commissioning Generators	49,302.9	4.3	0.5	3.8	0.1	0.1	0.0	0.00	0.0	562.7	0.0	0.0	0.6	1.4	564.7
Miscellaneous	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	962,367.9	66.4	9.1	53.1	2.9	2.9	0.1	0.00	0.2	10,984.2	0.4	0.1	11.1	26.6	11,021.9
Engines Only B02		66.4	8.2	53.1	2.9	2.9	0.1	0.00	0.2	10,984.2	0.4	0.1	11.1	26.6	11,021.9

OCS Emissions															
Activity Group	Fuel Consumption (gal)	Emissions (tons)													
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation Installation (FOU) B02	2,071,728.0	284.0	10.3	96.0	9.8	9.6	0.5	0.001	0.6	23,870.5	0.5	0.8	11.4	235.4	24,117.2
Offshore Substation Installation (OSS)	244,025.1	37.3	1.0	11.0	1.2	1.2	0.1	0.000	0.1	2,799.7	0.0	0.1	1.0	31.5	2,832.2
Scour Protection	244,025.1	73.1	1.7	17.4	2.5	2.5	0.5	0.000	0.2	4,860.4	0.0	0.2	0.8	70.3	4,931.4
Inter Array Cable Installation	498,752.3	83.0	1.9	19.6	2.9	2.8	0.5	0.000	0.2	5,528.3	0.0	0.3	0.9	80.0	5,609.1
WTG Installation	3,159,070.2	603.2	8.5	136.7	18.3	17.8	0.9	0.003	1.1	37,752.4	0.2	1.8	5.8	539.2	38,297.5
Export Cable Installation	1,171,744.1	196.8	4.0	47.4	6.7	6.5	0.9	0.001	0.5	13,045.1	0.1	0.6	2.0	187.9	13,235.0
Fuel Bunkering	223,160.3	30.0	1.0	9.9	1.1	1.1	0.1	0.000	0.1	2,510.9	0.0	0.1	1.1	26.7	2,538.7
Commissioning Generators	49,302.9	4.3	0.5	3.8	0.1	0.1	0.0	0.000	0.0	562.7	0.0	0.0	0.6	1.4	564.7
Miscellaneous	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total B02	7,661,808.0	1,311.7	29.8	341.7	42.7	41.5	3.5	0.006	2.7	90,930.0	0.9	3.9	23.5	1,172.3	92,125.8

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Trips	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Emissions During Construction																	
Offshore Substation Installation (OSS)																	
	Large HLV	Main Engine (Transit)	11	4,182	46,000	3 main	NJWP	2	91	365	10	36	0	0	0	36	7M
		Main Engine (Maneuvering)	11	4,182	46,000	3 main		0	91	0	10	0	18	24	432	432	7M
		Auxiliary Engine (Transit)	1	5,833	5,833	3 Auxiliary		2	91	365	10	36	0	0	0	36	7A
		Auxiliary Engine (Maneuvering)	1	5,833	5,833	3 Auxiliary		0	91	0	10	0	18	24	432	432	7A
	Bubble Curtain Support Vessel	Main Engine (Transit)	2	5,530	11,060	1 & 2 main	NJWP	2	91	365	10	36	0	0	0	36	11M
		Main Engine (Maneuvering)	2	5,530	11,060	1 & 2 main		0	91	0	10	0	18	24	432	432	11M
		Auxiliary Engine (Transit)	0	0	0	1 & 2 auxiliary		2	91	365	10	36	0	0	0	36	11A
		Auxiliary Engine (Maneuvering)	0	0	0	1 & 2 auxiliary		0	91	0	10	0	18	24	432	432	11A
Transport Barge 1	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	6	91	1,095	10	109	0	0	0	109	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	10	0	10	24	240	240	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		6	91	1,095	10	109	0	0	0	109	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	10	0	10	24	240	240	2A
Transport Barge 2	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	6	91	1,095	10	109	0	0	0	109	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	10	0	10	24	240	240	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		6	91	1,095	10	109	0	0	0	109	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	10	0	10	24	240	240	2A
Transport Barge 3	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	6	91	1,095	10	109	0	0	0	109	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	10	0	10	24	240	240	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		6	91	1,095	10	109	0	0	0	109	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	10	0	10	24	240	240	2A
Transport Barge 4	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	6	91	1,095	10	109	0	0	0	109	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	10	0	10	24	240	240	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		6	91	1,095	10	109	0	0	0	109	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	10	0	10	24	240	240	2A
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	6	91	1,095	10	109	0	0	0	109	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	10	0	10	24	240	240	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		6	91	1,095	10	109	0	0	0	109	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	10	0	10	24	240	240	11A
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	6	91	1,095	10	109	0	0	0	109	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	10	0	10	24	240	240	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		6	91	1,095	10	109	0	0	0	109	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	10	0	10	24	240	240	11A
US Towing Tug 3	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	6	91	1,095	10	109	0	0	0	109	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	10	0	10	24	240	240	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		6	91	1,095	10	109	0	0	0	109	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	10	0	10	24	240	240	11A
US Towing Tug 4	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	6	91	1,095	10	109	0	0	0	109	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	10	0	10	24	240	240	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		6	91	1,095	10	109	0	0	0	109	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	10	0	10	24	240	240	11A
	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	14	17	487	29	17	0	0	0	17	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	29	0	56	24	1,344	1,344	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		14	17	487	29	17	0	0	0	17	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	29	0	56	24	1,344	1,344	4A
	Bubble Curtain Power	Air Compressor	20	399	7,980	Tier 3 Non-Road	N/A	0	0	0	0	0	18	10	180	180	16
	Hydraulic Hammer Power	Hammer Engine	3	597	1,791	Tier 2 Non-Road	N/A	0	0	0	0	0	18	10	180	180	18
Scour Protection																	
	Fall Pipe Vessel	Main Engine (Transit)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main	Europe	2	250	1,000	10	100	0	0	0	100	3M
		Main Engine (Maneuvering)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main		0	250	0	10	0	92	24	2,208	2,208	3M
		Auxiliary Engine (Transit)	1	2,950	2,950	1 & 2 auxiliary		2	250	1,000	10	100	0	0	0	100	3A
		Auxiliary Engine (Maneuvering)	1	2,950	2,950	1 & 2 auxiliary		0	250	0	10	0	92	24	2,208	2,208	3A
	US Dredger	Main Engine (Transit)	2	641	1,283	1 & 2 main	NJWP	2	91	365	10	36	0	0	0	36	5M
		Main Engine (Maneuvering)	2	641	1,283	1 & 2 main		0	91	0	10	0	58	24	1,392	1,392	5M
		Auxiliary Engine (Transit)	0	0	954	1 & 2 auxiliary		2	91	365	10	36	0	0	0	36	5A
		Auxiliary Engine (Maneuvering)	0	0	954	1 & 2 auxiliary		0	91	0	10	0	58	24	1,392	1,392	5A

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Trips	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Inter Array Cable Installation																	
Cable Installation Vessel	Cable Installation Vessel	Main Engine (Transit)	0	0	7,280	1 & 2 main	Europe	2	250	1,000	10	100	0	0	0	100	3M
		Main Engine (Maneuvering)	0	0	7,280	1 & 2 main		0	250	0	10	0	220	24	5,280	5,280	3M
		Auxiliary Engine (Transit)	0	0	220	1 & 2 auxiliary		2	250	1,000	10	100	0	0	0	100	3A
		Auxiliary Engine (Maneuvering)	0	0	220	1 & 2 auxiliary		0	250	0	10	0	220	24	5,280	5,280	3A
Cable Installation Support Activities	Support Vessel/SOV	Main Engine (Transit)	4	1,200	4,800	1 & 2 main	Europe	2	250	1,000	10	100	0	0	0	100	3M
		Main Engine (Maneuvering)	4	1,200	4,800	1 & 2 main		0	250	0	10	0	138	24	3,307	3,307	3M
		Auxiliary Engine (Transit)	1	800	800	1 & 2 auxiliary		2	250	1,000	10	100	0	0	0	100	3A
		Auxiliary Engine (Maneuvering)	1	800	800	1 & 2 auxiliary		0	250	0	10	0	138	24	3,307	3,307	3A
Sand Wave Clearance	TSHD (Dredger)	Main Engine (Transit)	2	641	1,283	1 & 2 main	Europe	2	250	1,000	10	100	0	0	0	100	5M
		Main Engine (Maneuvering)	2	641	1,283	1 & 2 main		0	250	0	10	0	144	24	3,453	3,453	5M
		Auxiliary Engine (Transit)	0	0	954	1 & 2 auxiliary		2	250	1,000	10	100	0	0	0	100	5A
		Auxiliary Engine (Maneuvering)	0	0	954	1 & 2 auxiliary		0	250	0	10	0	144	24	3,453	3,453	5A
Pre Lay Grapnel Run AHTS 1	AHTS	Main Engine (Transit)	2	4,500	9,000	1 & 2 main	NJWP	2	91	365	10	36	0	0	0	36	11M
		Main Engine (Maneuvering)	2	4,500	9,000	1 & 2 main		0	91	0	10	0	21	24	507	507	11M
		Auxiliary Engine (Transit)	2	410	820	1 & 2 auxiliary		2	91	365	10	36	0	0	0	36	11A
		Auxiliary Engine (Maneuvering)	2	410	820	1 & 2 auxiliary		0	91	0	10	0	21	24	507	507	11A
Pre Lay Grapnel Run AHTS 2	AHTS	Main Engine (Transit)	2	4,500	9,000	1 & 2 main	NJWP	2	91	365	10	36	0	0	0	36	11M
		Main Engine (Maneuvering)	2	4,500	9,000	1 & 2 main		0	91	0	10	0	21	24	507	507	11M
		Auxiliary Engine (Transit)	2	410	820	1 & 2 auxiliary		2	91	365	10	36	0	0	0	36	11A
		Auxiliary Engine (Maneuvering)	2	410	820	1 & 2 auxiliary		0	91	0	10	0	21	24	507	507	11A
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main	Europe	2	250	1,000	10	100	0	0	0	100	3M
		Main Engine (Maneuvering)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main		0	250	0	10	0	3	24	67	67	3M
		Auxiliary Engine (Transit)	1	2,950	2,950	1 & 2 auxiliary		2	250	1,000	10	100	0	0	0	100	3A
		Auxiliary Engine (Maneuvering)	1	2,950	2,950	1 & 2 auxiliary		0	250	0	10	0	3	24	67	67	3A
WTG Installation																	
WTG Installation Vessel	Jackup Vessel	Main Engine (Transit)	7	4 x 3,535kW 3 x 2,650kW	22,090	3 main	NJWP	2	91	365	10	36	0	0	0	36	7M
		Main Engine (Maneuvering)	7	4 x 3,535kW 3 x 2,650kW	22,090	3 main		0	91	0	10	0	517	24	12,410	12,410	7M
		Auxiliary Engine (Transit)	1	2,650	2,650	3 Auxiliary		2	91	365	10	36	0	0	0	36	7A
		Auxiliary Engine (Maneuvering)	1	2,650	2,650	3 Auxiliary		0	91	0	10	0	517	24	12,410	12,410	7A
US Jack Up Feeder 1	Jack up	Main Engine (Transit)	2	2,500	5,000	3 main	NJWP	100	91	18,249	10	1,825	0	0	0	1,825	7M
		Main Engine (Maneuvering)	2	2,500	5,000	3 main		0	91	0	10	0	238	24	5,723	5,723	7M
		Auxiliary Engine (Transit)	1	2,500	2,500	1 & 2 auxiliary		100	91	18,249	10	1,825	0	0	0	1,825	7A
		Auxiliary Engine (Maneuvering)	1	2,500	2,500	1 & 2 auxiliary		0	91	0	10	0	238	24	5,723	5,723	7A
US Jack Up Feeder 2	Jack up	Main Engine (Transit)	2	2,500	5,000	3 main	NJWP	100	91	18,249	10	1,825	0	0	0	1,825	7M
		Main Engine (Maneuvering)	2	2,500	5,000	3 main		0	91	0	10	0	238	24	5,723	5,723	7M
		Auxiliary Engine (Transit)	1	2,500	2,500	1 & 2 auxiliary		100	91	18,249	10	1,825	0	0	0	1,825	7A
		Auxiliary Engine (Maneuvering)	1	2,500	2,500	1 & 2 auxiliary		0	91	0	10	0	238	24	5,723	5,723	7A
Crew Transfer	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	130	17	4,519	29	159	0	0	0	159	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	29	0	517	24	12,410	12,410	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		130	17	4,519	29	159	0	0	0	159	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	29	0	517	24	12,410	12,410	4A
WTG Commissioning SOV	Service Operation Vessel	Main Engine (Transit)	4	1,200	4,800	1 & 2 main	NJWP	2	91	365	10	36	0	0	0	36	3M
		Main Engine (Maneuvering)	4	1,200	4,800	1 & 2 main		0	91	0	10	0	517	24	12,410	12,410	3M
		Auxiliary Engine (Transit)	1	800	800	1 & 2 auxiliary		2	91	365	10	36	0	0	0	36	3A
		Auxiliary Engine (Maneuvering)	1	800	800	1 & 2 auxiliary		0	91	0	10	0	517	24	12,410	12,410	3A

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Trips	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Export Cable Installation																	
Cable Installation Vessel 1		Main Engine (Transit)	4	2 x 2560kW 2 x 1913kW	8,946	1 & 2 main	NJWP	2	91	365	10	36	0	0	0	36	3M
		Main Engine (Maneuvering)	4	2 x 2560kW 2 x 1913kW	8,946	1 & 2 main		0	91	0	10	0	348	24	8,352	8,352	3M
		Auxiliary Engine (Transit)	2	1,400	2,800	1 & 2 auxiliary		2	91	365	10	36	0	0	0	36	3A
		Auxiliary Engine (Maneuvering)	2	1,400	2,800	1 & 2 auxiliary		0	91	0	10	0	348	24	8,352	8,352	3A
Cable Installation Vessel 2		Main Engine (Transit)	4	2 x 2560kW 2 x 1913kW	8,946	1 & 2 main	NJWP	2	91	365	10	36	0	0	0	36	3M
		Main Engine (Maneuvering)	4	2 x 2560kW 2 x 1913kW	8,946	1 & 2 main		0	91	0	10	0	348	24	8,352	8,352	3M
		Auxiliary Engine (Transit)	2	1,400	2,800	1 & 2 auxiliary		2	91	365	10	36	0	0	0	36	3A
		Auxiliary Engine (Maneuvering)	2	1,400	2,800	1 & 2 auxiliary		0	91	0	10	0	348	24	8,352	8,352	3A
Support and Jointing Vessel		Main Engine (Transit)	3	2 x 2350kW 1 x 1786kW	6,486	1 & 2 main	NJWP	2	91	365	10	36	0	0	0	36	3M
		Main Engine (Maneuvering)	3	2 x 2350kW 1 x 1786kW	6,486	1 & 2 main		0	91	0	10	0	70	24	1,680	1,680	3M
		Auxiliary Engine (Transit)	2	994	1,988	1 & 2 auxiliary		2	91	365	10	36	0	0	0	36	3A
		Auxiliary Engine (Maneuvering)	2	994	1,988	1 & 2 auxiliary		0	91	0	10	0	70	24	1,680	1,680	3A
TSHD	Dredger	Main Engine (Transit)	2	641	1,283	1 & 2 main	NJWP	2	91	365	10	36	0	0	0	36	5M
		Main Engine (Maneuvering)	2	641	1,283	1 & 2 main		0	91	0	10	0	253	24	6,072	6,072	5M
		Auxiliary Engine (Transit)	0	0	954	1 & 2 auxiliary		2	91	365	10	36	0	0	0	36	5A
		Auxiliary Engine (Maneuvering)	0	0	954	1 & 2 auxiliary		0	91	0	10	0	253	24	6,072	6,072	5A
AHTS	Tug	Main Engine (Transit)	2	4,500	9,000	1 & 2 main	NJWP	2	91	365	10	36	0	0	0	36	11M
		Main Engine (Maneuvering)	2	4,500	9,000	1 & 2 main		0	91	0	10	0	103	24	2,472	2,472	11M
		Auxiliary Engine (Transit)	2	410	820	1 & 2 auxiliary		2	91	365	10	36	0	0	0	36	11A
		Auxiliary Engine (Maneuvering)	2	410	820	1 & 2 auxiliary		0	91	0	10	0	103	24	2,472	2,472	11A
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main	Europe	2	250	1,000	10	100	0	0	0	100	3M
		Main Engine (Maneuvering)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main		0	250	0	10	0	6	24	144	144	3M
		Auxiliary Engine (Transit)	1	2,950	2,950	1 & 2 auxiliary		2	250	1,000	10	100	0	0	0	100	3A
		Auxiliary Engine (Maneuvering)	1	2,950	2,950	1 & 2 auxiliary		0	250	0	10	0	6	24	144	144	3A
Fuel Bunkering																	
Towing Tug	Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	24	91	4,380	10	438	0	0	0	438	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	10	0	168	24	4,032	4,032	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		24	91	4,380	10	438	0	0	0	438	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	10	0	168	24	4,032	4,032	11A
Barge	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	24	91	4,380	10	438	0	0	0	438	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	10	0	168	24	4,032	4,032	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		24	91	4,380	10	438	0	0	0	438	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	10	0	168	24	4,032	4,032	2A
Motion Compensation	Motion Compensation	Motion Compensation Engine	1	500	500	Tier 3 Non-Road	NJWP	0	91	0	0	0	168	24	4,032	4,032	17
Commissioning Generators																	
OSS Commissioning Generators	Generator	Marine Tier 3 Generator	8	500	4,000	Marine Tier 3	N/A	0	0	0	0	0	56	12	672	672	31
WTG Commissioning Generators	Generator	Marine Tier 3 Generator	1	240	240	Marine Tier 3	N/A	0	0	0	0	0	517	12	6,205	6,205	32
Miscellaneous																	
Marine Paint	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fuel Evaporation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Construction																			
Offshore Substation Installation (OSS)																			
	Large HLV	Main Engine (Transit)	0.83	80,046	15.41	0.22	3.53	0.48	0.46	0.02	0.00	0.03	0.0009	993.93	0.01	0.05	0.15	14.19	1,008.27
		Main Engine (Maneuvering)	0.10	114,153	21.97	0.31	5.04	0.68	0.66	0.03	0.00	0.04	0.0013	1,417.44	0.01	0.07	0.22	20.24	1,437.89
		Auxiliary Engine (Transit)	0.56	8,033	1.52	0.02	0.33	0.04	0.04	0.00	0.00	0.00	0.0000	85.19	0.00	0.00	0.01	1.21	86.41
		Auxiliary Engine (Maneuvering)	0.56	95,088	17.97	0.22	3.86	0.50	0.48	0.01	0.00	0.03	0.0004	1,008.33	0.01	0.05	0.16	14.37	1,022.85
	Bubble Curtain Support Vessel	Main Engine (Transit)	0.83	21,278	3.52	0.07	0.85	0.12	0.12	0.01	0.00	0.01	0.0006	237.71	0.00	0.01	0.04	3.41	241.16
		Main Engine (Maneuvering)	0.10	30,344	5.01	0.09	1.21	0.17	0.17	0.02	0.00	0.01	0.0008	339.00	0.00	0.02	0.05	4.87	343.92
		Auxiliary Engine (Transit)	0.43	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Maneuvering)	0.43	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
Transport Barge 1	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	150	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.68	0.00	0.00	0.00	0.02	1.71
		Auxiliary Engine (Maneuvering)	0.43	328	0.07	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	3.69	0.00	0.00	0.00	0.05	3.74
Transport Barge 2	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	150	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.68	0.00	0.00	0.00	0.02	1.71
		Auxiliary Engine (Maneuvering)	0.43	328	0.07	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	3.69	0.00	0.00	0.00	0.05	3.74
Transport Barge 3	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	150	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.68	0.00	0.00	0.00	0.02	1.71
		Auxiliary Engine (Maneuvering)	0.43	328	0.07	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	3.69	0.00	0.00	0.00	0.05	3.74
Transport Barge 4	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	150	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.68	0.00	0.00	0.00	0.02	1.71
		Auxiliary Engine (Maneuvering)	0.43	328	0.07	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	3.69	0.00	0.00	0.00	0.05	3.74
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	0.83	29,145	4.82	0.09	1.16	0.17	0.16	0.02	0.00	0.01	0.0008	325.61	0.00	0.02	0.05	4.67	330.33
		Main Engine (Maneuvering)	0.10	7,697	1.27	0.02	0.31	0.04	0.04	0.00	0.00	0.00	0.0002	85.99	0.00	0.00	0.01	1.23	87.24
		Auxiliary Engine (Transit)	0.43	706	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	7.94	0.00	0.00	0.00	0.11	8.05
		Auxiliary Engine (Maneuvering)	0.43	1,547	0.27	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.0000	17.40	0.00	0.00	0.00	0.25	17.65
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	0.83	29,145	4.82	0.09	1.16	0.17	0.16	0.02	0.00	0.01	0.0008	325.61	0.00	0.02	0.05	4.67	330.33
		Main Engine (Maneuvering)	0.10	7,697	1.27	0.02	0.31	0.04	0.04	0.00	0.00	0.00	0.0002	85.99	0.00	0.00	0.01	1.23	87.24
		Auxiliary Engine (Transit)	0.43	706	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	7.94	0.00	0.00	0.00	0.11	8.05
		Auxiliary Engine (Maneuvering)	0.43	1,547	0.27	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.0000	17.40	0.00	0.00	0.00	0.25	17.65
US Towing Tug 3	US Towing Tug	Main Engine (Transit)	0.83	29,145	4.82	0.09	1.16	0.17	0.16	0.02	0.00	0.01	0.0008	325.61	0.00	0.02	0.05	4.67	330.33
		Main Engine (Maneuvering)	0.10	7,697	1.27	0.02	0.31	0.04	0.04	0.00	0.00	0.00	0.0002	85.99	0.00	0.00	0.01	1.23	87.24
		Auxiliary Engine (Transit)	0.43	706	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	7.94	0.00	0.00	0.00	0.11	8.05
		Auxiliary Engine (Maneuvering)	0.43	1,547	0.27	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.0000	17.40	0.00	0.00	0.00	0.25	17.65
US Towing Tug 4	US Towing Tug	Main Engine (Transit)	0.83	29,145	4.82	0.09	1.16	0.17	0.16	0.02	0.00	0.01	0.0008	325.61	0.00	0.02	0.05	4.67	330.33
		Main Engine (Maneuvering)	0.10	7,697	1.27	0.02	0.31	0.04	0.04	0.00	0.00	0.00	0.0002	85.99	0.00	0.00	0.01	1.23	87.24
		Auxiliary Engine (Transit)	0.43	706	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	7.94	0.00	0.00	0.00	0.11	8.05
		Auxiliary Engine (Maneuvering)	0.43	1,547	0.27	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.0000	17.40	0.00	0.00	0.00	0.25	17.65
	Crew Transfer Vessel	Main Engine (Transit)	0.83	1,879	0.30	0.00	0.08	0.01	0.01	0.00	0.00	0.00	0.0000	21.14	0.00	0.00	0.00	0.30	21.45
		Main Engine (Maneuvering)	0.10	17,822	2.83	0.04	0.71	0.10	0.09	0.00	0.00	0.01	0.0001	200.50	0.00	0.01	0.03	2.86	203.39
		Auxiliary Engine (Transit)	0.43	25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.28	0.00	0.00	0.00	0.00	0.29
		Auxiliary Engine (Maneuvering)	0.43	1,982	0.36	0.00	0.09	0.01	0.01	0.00	0.00	0.00	0.0000	22.30	0.00	0.00	0.00	0.32	22.62
	Bubble Curtain Power	Air Compressor	1.00	102,600	6.33	0.79	5.54	0.32	0.32	0.01	0.00	0.03	0.0005	1,171.05	0.05	0.01	1.19	2.83	1,175.07
	Hydraulic Hammer Power	Hammer Engine	1.00	23,027	2.27	0.28	1.24	0.07	0.07	0.00	0.00	0.00	0.0001	262.83	0.01	0.00	0.27	0.64	263.73
Scour Protection																			
	Fall Pipe Vessel	Main Engine (Transit)	0.83	112,804	18.58	0.49	4.31	0.67	0.65	0.17	0.00	0.05	0.0076	1,243.32	0.01	0.06	0.20	18.09	1,261.60
		Main Engine (Maneuvering)	0.20	600,172	98.86	2.60	22.92	3.54	3.44	0.89	0.00	0.28	0.0407	6,615.07	0.04	0.32	1.04	96.23	6,712.35
		Auxiliary Engine (Transit)	0.56	10,492	1.80	0.03	0.45	0.06	0.06	0.00	0.00	0.00	0.0001	118.04	0.00	0.01	0.02	1.68	119.74
		Auxiliary Engine (Maneuvering)	0.56	231,655	39.77	0.56	9.97	1.29	1.25	0.02	0.00	0.07	0.0011	2,606.29	0.02	0.12	0.40	37.14	2,643.83
	US Dredger	Main Engine (Transit)	0.83	2,468	0.41	0.01	0.09	0.02	0.01	0.00	0.00	0.00	0.0002	27.01	0.00	0.00	0.00	0.40	27.41
		Main Engine (Maneuvering)	0.20	22,677	3.78	0.11	0.84	0.14	0.13	0.04	0.00	0.01	0.0020	248.22	0.00	0.01	0.04	3.64	251.89
		Auxiliary Engine (Transit)	0.56	1,239	0.21	0.00	0.05	0.01	0.01	0.00	0.00	0.00	0.0000	13.94	0.00	0.00	0.00	0.20	14.14
		Auxiliary Engine (Maneuvering)	0.56	47,254	8.08	0.11	2.03	0.26	0.25	0.00	0.00	0.01	0.0002	531.64	0.00	0.03	0.08	7.58	539.30

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Inter Array Cable Installation																			
Cable Installation Vessel	Cable Installation Vessel	Main Engine (Transit)	0.83	38,374	6.32	0.17	1.47	0.23	0.22	0.06	0.00	0.02	0.0026	422.96	0.00	0.02	0.07	6.15	429.18
		Main Engine (Maneuvering)	0.20	488,234	80.42	2.12	18.64	2.88	2.80	0.72	0.00	0.23	0.0331	5,381.30	0.03	0.26	0.85	78.28	5,460.43
		Auxiliary Engine (Transit)	0.43	601	0.10	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	6.76	0.00	0.00	0.00	0.10	6.86
		Auxiliary Engine (Maneuvering)	0.43	31,722	5.45	0.08	1.37	0.18	0.17	0.00	0.00	0.01	0.0002	356.89	0.00	0.02	0.06	5.09	362.03
Cable Installation Support Activities	Support Vessel/SOV	Main Engine (Transit)	0.16	4,877	0.80	0.02	0.19	0.03	0.03	0.01	0.00	0.00	0.0003	53.76	0.00	0.00	0.01	0.78	54.55
		Main Engine (Maneuvering)	0.10	104,983	17.29	0.46	4.01	0.62	0.60	0.15	0.00	0.05	0.0071	1,157.12	0.01	0.06	0.18	16.83	1,174.13
		Auxiliary Engine (Transit)	0.16	813	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	9.15	0.00	0.00	0.00	0.13	9.28
		Auxiliary Engine (Maneuvering)	0.10	17,497	3.00	0.04	0.75	0.10	0.09	0.00	0.00	0.01	0.0001	196.86	0.00	0.01	0.03	2.81	199.69
Sand Wave Clearance	TSHD (Dredger)	Main Engine (Transit)	0.83	6,761	1.13	0.03	0.25	0.04	0.04	0.01	0.00	0.00	0.0006	74.00	0.00	0.00	0.01	1.08	75.10
		Main Engine (Maneuvering)	0.20	56,259	9.37	0.27	2.08	0.35	0.33	0.11	0.00	0.03	0.0050	615.79	0.00	0.03	0.10	9.02	624.91
		Auxiliary Engine (Transit)	0.56	3,395	0.58	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.0000	38.19	0.00	0.00	0.01	0.54	38.74
		Auxiliary Engine (Maneuvering)	0.56	117,229	20.04	0.28	5.05	0.65	0.63	0.01	0.00	0.04	0.0006	1,318.91	0.01	0.06	0.20	18.80	1,337.91
Pre Lay Grapnel Run AHTS 1	AHTS	Main Engine (Transit)	0.83	17,315	2.86	0.05	0.69	0.10	0.10	0.01	0.00	0.01	0.0005	193.44	0.00	0.01	0.03	2.78	196.24
		Main Engine (Maneuvering)	0.20	57,920	9.57	0.18	2.30	0.33	0.32	0.03	0.00	0.02	0.0015	647.08	0.00	0.03	0.10	9.29	656.46
		Auxiliary Engine (Transit)	0.43	817	0.14	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.0000	9.20	0.00	0.00	0.00	0.13	9.33
		Auxiliary Engine (Maneuvering)	0.43	11,346	1.99	0.03	0.49	0.06	0.06	0.00	0.00	0.00	0.0001	127.65	0.00	0.01	0.02	1.82	129.49
Pre Lay Grapnel Run AHTS 2	AHTS	Main Engine (Transit)	0.83	17,315	2.86	0.05	0.69	0.10	0.10	0.01	0.00	0.01	0.0005	193.44	0.00	0.01	0.03	2.78	196.24
		Main Engine (Maneuvering)	0.20	57,920	9.57	0.18	2.30	0.33	0.32	0.03	0.00	0.02	0.0015	647.08	0.00	0.03	0.10	9.29	656.46
		Auxiliary Engine (Transit)	0.43	817	0.14	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.0000	9.20	0.00	0.00	0.00	0.13	9.33
		Auxiliary Engine (Maneuvering)	0.43	11,346	1.99	0.03	0.49	0.06	0.06	0.00	0.00	0.00	0.0001	127.65	0.00	0.01	0.02	1.82	129.49
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	0.83	112,804	18.58	0.49	4.31	0.67	0.65	0.17	0.00	0.05	0.0076	1,243.32	0.01	0.06	0.20	18.09	1,261.60
		Main Engine (Maneuvering)	0.20	18,121	2.98	0.08	0.69	0.11	0.10	0.03	0.00	0.01	0.0012	199.73	0.00	0.01	0.03	2.91	202.67
		Auxiliary Engine (Transit)	0.56	10,492	1.80	0.03	0.45	0.06	0.06	0.00	0.00	0.00	0.0001	118.04	0.00	0.01	0.02	1.68	119.74
		Auxiliary Engine (Maneuvering)	0.56	6,994	1.20	0.02	0.30	0.04	0.04	0.00	0.00	0.00	0.0000	78.69	0.00	0.00	0.01	1.12	79.83
WTG Installation																			
WTG Installation Vessel	Jackup Vessel	Main Engine (Transit)	0.83	38,440	7.40	0.10	1.70	0.23	0.22	0.01	0.00	0.01	0.0004	477.30	0.00	0.02	0.07	6.81	484.19
		Main Engine (Maneuvering)	0.20	3,149,526	606.18	8.46	139.00	18.74	18.13	0.79	0.00	1.07	0.0361	39,107.47	0.24	1.87	6.04	558.32	39,671.83
		Auxiliary Engine (Transit)	0.43	2,802	0.53	0.01	0.11	0.01	0.01	0.00	0.00	0.00	0.0000	29.72	0.00	0.00	0.00	0.42	30.14
		Auxiliary Engine (Maneuvering)	0.43	952,844	180.04	2.18	38.66	4.99	4.83	0.09	0.00	0.28	0.0043	10,104.14	0.06	0.48	1.56	144.00	10,249.70
US Jack Up Feeder 1	Jack up	Main Engine (Transit)	0.83	435,034	83.73	1.17	19.20	2.59	2.50	0.11	0.00	0.15	0.0050	5,401.79	0.03	0.26	0.83	77.12	5,479.74
		Main Engine (Maneuvering)	0.20	328,773	63.28	0.88	14.51	1.96	1.89	0.08	0.00	0.11	0.0038	4,082.36	0.03	0.20	0.63	58.28	4,141.27
		Auxiliary Engine (Transit)	0.43	124,586	24.98	0.30	5.36	0.69	0.67	0.01	0.00	0.04	0.0006	1,401.68	0.01	0.07	0.22	19.98	1,421.87
		Auxiliary Engine (Maneuvering)	0.43	390,742	78.33	0.95	16.82	2.17	2.10	0.04	0.00	0.12	0.0019	4,396.13	0.03	0.21	0.68	62.65	4,459.46
US Jack Up Feeder 2	Jack up	Main Engine (Transit)	0.83	435,034	83.73	1.17	19.20	2.59	2.50	0.11	0.00	0.15	0.0050	5,401.79	0.03	0.26	0.83	77.12	5,479.74
		Main Engine (Maneuvering)	0.20	328,773	63.28	0.88	14.51	1.96	1.89	0.08	0.00	0.11	0.0038	4,082.36	0.03	0.20	0.63	58.28	4,141.27
		Auxiliary Engine (Transit)	0.43	124,586	24.98	0.30	5.36	0.69	0.67	0.01	0.00	0.04	0.0006	1,401.68	0.01	0.07	0.22	19.98	1,421.87
		Auxiliary Engine (Maneuvering)	0.43	390,742	78.33	0.95	16.82	2.17	2.10	0.04	0.00	0.12	0.0019	4,396.13	0.03	0.21	0.68	62.65	4,459.46
Crew Transfer	Crew Transfer Vessel	Main Engine (Transit)	0.83	17,450	2.77	0.04	0.70	0.09	0.09	0.00	0.00	0.01	0.0001	196.31	0.00	0.01	0.03	2.80	199.14
		Main Engine (Maneuvering)	0.20	329,122	52.27	0.80	13.14	1.77	1.71	0.03	0.00	0.10	0.0016	3,702.63	0.02	0.18	0.57	52.77	3,755.97
		Auxiliary Engine (Transit)	0.43	234	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	2.63	0.00	0.00	0.00	0.04	2.67
		Auxiliary Engine (Maneuvering)	0.43	18,301	3.30	0.04	0.79	0.10	0.10	0.00	0.00	0.01	0.0001	205.90	0.00	0.01	0.03	2.93	208.86
WTG Commissioning SOV	Service Operation Vessel	Main Engine (Transit)	0.16	1,780	0.29	0.01	0.07	0.01	0.01	0.00	0.00	0.00	0.0001	19.62	0.00	0.00	0.00	0.29	19.91
		Main Engine (Maneuvering)	0.10	394,004	64.90	1.71	15.05	2.33	2.26	0.58	0.00	0.19	0.0267	4,342.70	0.03	0.21	0.68	63.18	4,406.56
		Auxiliary Engine (Transit)	0.16	297	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	3.34	0.00	0.00	0.00	0.05	3.39
		Auxiliary Engine (Maneuvering)	0.10	65,667	11.27	0.16	2.83	0.36	0.35	0.01	0.00	0.02	0.0003	738.81	0.00	0.04	0.11	10.53	749.45

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Export Cable Installation																			
Cable Installation Vessel 1		Main Engine (Transit)	0.83	17,211	2.83	0.07	0.66	0.10	0.10	0.03	0.00	0.01	0.0012	189.69	0.00	0.01	0.03	2.76	192.48
		Main Engine (Maneuvering)	0.20	949,035	156.32	4.12	36.24	5.60	5.44	1.40	0.00	0.45	0.0643	10,460.23	0.07	0.51	1.65	152.17	10,614.04
		Auxiliary Engine (Transit)	0.56	3,634	0.62	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.0000	40.89	0.00	0.00	0.01	0.58	41.48
		Auxiliary Engine (Maneuvering)	0.56	831,706	142.77	2.02	35.80	4.62	4.48	0.09	0.00	0.26	0.0040	9,357.28	0.06	0.45	1.44	133.36	9,492.09
Cable Installation Vessel 2		Main Engine (Transit)	0.83	17,211	2.83	0.07	0.66	0.10	0.10	0.03	0.00	0.01	0.0012	189.69	0.00	0.01	0.03	2.76	192.48
		Main Engine (Maneuvering)	0.20	949,035	156.32	4.12	36.24	5.60	5.44	1.40	0.00	0.45	0.0643	10,460.23	0.07	0.51	1.65	152.17	10,614.04
		Auxiliary Engine (Transit)	0.56	3,634	0.62	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.0000	40.89	0.00	0.00	0.01	0.58	41.48
		Auxiliary Engine (Maneuvering)	0.56	831,706	142.77	2.02	35.80	4.62	4.48	0.09	0.00	0.26	0.0040	9,357.28	0.06	0.45	1.44	133.36	9,492.09
Support and Jointing Vessel		Main Engine (Transit)	0.83	12,478	2.06	0.05	0.48	0.07	0.07	0.02	0.00	0.01	0.0008	137.53	0.00	0.01	0.02	2.00	139.55
		Main Engine (Maneuvering)	0.20	138,404	22.80	0.60	5.28	0.82	0.79	0.20	0.00	0.07	0.0094	1,525.48	0.01	0.07	0.24	22.19	1,547.92
		Auxiliary Engine (Transit)	0.56	2,580	0.44	0.01	0.11	0.01	0.01	0.00	0.00	0.00	0.0000	29.03	0.00	0.00	0.00	0.41	29.45
		Auxiliary Engine (Maneuvering)	0.56	118,781	20.39	0.29	5.11	0.66	0.64	0.01	0.00	0.04	0.0006	1,336.37	0.01	0.06	0.21	19.05	1,355.62
TSHD	Dredger	Main Engine (Transit)	0.83	2,468	0.41	0.01	0.09	0.02	0.01	0.00	0.00	0.00	0.0002	27.01	0.00	0.00	0.00	0.40	27.41
		Main Engine (Maneuvering)	0.20	98,921	16.48	0.48	3.66	0.62	0.58	0.19	0.00	0.05	0.0088	1,082.75	0.01	0.05	0.17	15.86	1,098.78
		Auxiliary Engine (Transit)	0.56	1,239	0.21	0.00	0.05	0.01	0.01	0.00	0.00	0.00	0.0000	13.94	0.00	0.00	0.00	0.20	14.14
		Auxiliary Engine (Maneuvering)	0.56	206,123	35.24	0.50	8.87	1.14	1.11	0.02	0.00	0.06	0.0010	2,319.03	0.01	0.11	0.36	33.05	2,352.44
AHTS	Tug	Main Engine (Transit)	0.83	17,315	2.86	0.05	0.69	0.10	0.10	0.01	0.00	0.01	0.0005	193.44	0.00	0.01	0.03	2.78	196.24
		Main Engine (Maneuvering)	0.20	282,588	46.69	0.88	11.23	1.62	1.57	0.16	0.00	0.10	0.0074	3,157.05	0.02	0.15	0.49	45.31	3,202.85
		Auxiliary Engine (Transit)	0.43	817	0.14	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.0000	9.20	0.00	0.00	0.00	0.13	9.33
		Auxiliary Engine (Maneuvering)	0.43	55,356	9.70	0.13	2.38	0.31	0.30	0.01	0.00	0.02	0.0003	622.79	0.00	0.03	0.10	8.88	631.77
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	0.83	112,804	18.58	0.49	4.31	0.67	0.65	0.17	0.00	0.05	0.0076	1,243.32	0.01	0.06	0.20	18.09	1,261.60
		Main Engine (Maneuvering)	0.20	39,142	6.45	0.17	1.49	0.23	0.22	0.06	0.00	0.02	0.0027	431.42	0.00	0.02	0.07	6.28	437.76
		Auxiliary Engine (Transit)	0.56	10,492	1.80	0.03	0.45	0.06	0.06	0.00	0.00	0.00	0.0001	118.04	0.00	0.01	0.02	1.68	119.74
		Auxiliary Engine (Maneuvering)	0.56	15,108	2.59	0.04	0.65	0.08	0.08	0.00	0.00	0.00	0.0001	169.98	0.00	0.01	0.03	2.42	172.42
Fuel Bunkering																			
Towing Tug	Tug	Main Engine (Transit)	0.83	116,582	19.26	0.36	4.63	0.67	0.65	0.07	0.00	0.04	0.0031	1,302.44	0.01	0.06	0.20	18.69	1,321.34
		Main Engine (Maneuvering)	0.20	258,621	42.73	0.81	10.28	1.48	1.44	0.15	0.00	0.10	0.0068	2,889.30	0.02	0.14	0.45	41.47	2,931.21
		Auxiliary Engine (Transit)	0.43	2,823	0.49	0.01	0.12	0.02	0.02	0.00	0.00	0.00	0.0000	31.76	0.00	0.00	0.00	0.45	32.21
		Auxiliary Engine (Maneuvering)	0.43	25,986	4.56	0.06	1.12	0.14	0.14	0.00	0.00	0.01	0.0001	292.36	0.00	0.01	0.05	4.17	296.57
Barge	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.20	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	598	0.13	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	6.73	0.00	0.00	0.00	0.10	6.82
		Auxiliary Engine (Maneuvering)	0.43	5,505	1.20	0.01	0.24	0.03	0.03	0.00	0.00	0.00	0.0000	61.94	0.00	0.00	0.01	0.88	62.83
Motion Compensation	Motion Compensation	Motion Compensation Engine	1.00	144,000	8.89	1.10	7.78	0.44	0.44	0.02	0.00	0.02	0.0007	1,643.57	0.07	0.01	1.67	3.97	1,649.21
Commissioning Generators																			
OSS Commissioning Generators	Generator	Marine Tier 3 Generator	0.50	96,000	8.59	1.03	7.41	0.15	0.14	0.01	0.00	0.03	0.00	1,095.72	0.04	0.01	1.11	2.65	1,099.48
WTG Commissioning Generators	Generator	Marine Tier 3 Generator	0.50	53,186	4.43	0.53	4.10	0.10	0.10	0.01	0.00	0.01	0.00	607.05	0.02	0.00	0.62	1.47	609.13
Miscellaneous																			
Marine Paint	N/A	N/A	N/A	N/A	N/A	0.75	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fuel Evaporation	N/A	N/A	N/A	N/A	N/A	0.20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Construction																				
Offshore Substation Installation (OSS)																				
	Large HLV	Main Engine (Transit)	25	27%	21,932	4.22	0.06	0.97	0.13	0.13	0.01	0.00	0.01	0.00	272.33	0.00	0.01	0.04	3.89	276.26
		Main Engine (Maneuvering)	25	100%	114,153	21.97	0.31	5.04	0.68	0.66	0.03	0.00	0.04	0.00	1,417.44	0.01	0.07	0.22	20.24	1,437.89
		Auxiliary Engine (Transit)	25	27%	2,201	0.42	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	23.34	0.00	0.00	0.00	0.33	23.68
		Auxiliary Engine (Maneuvering)	25	100%	95,088	17.97	0.22	3.86	0.50	0.48	0.01	0.00	0.03	0.00	1,008.33	0.01	0.05	0.16	14.37	1,022.85
	Bubble Curtain Support Vessel	Main Engine (Transit)	25	27%	5,830	0.96	0.02	0.23	0.03	0.03	0.00	0.00	0.00	0.00	65.13	0.00	0.00	0.01	0.93	66.08
		Main Engine (Maneuvering)	25	100%	30,344	5.01	0.09	1.21	0.17	0.17	0.02	0.00	0.01	0.00	339.00	0.00	0.02	0.05	4.87	343.92
		Auxiliary Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transport Barge 1	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	41	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.01	0.47
		Auxiliary Engine (Maneuvering)	25	100%	328	0.07	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.69	0.00	0.00	0.00	0.05	3.74
Transport Barge 2	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	41	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.01	0.47
		Auxiliary Engine (Maneuvering)	25	100%	328	0.07	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.69	0.00	0.00	0.00	0.05	3.74
Transport Barge 3	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	41	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.01	0.47
		Auxiliary Engine (Maneuvering)	25	100%	328	0.07	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.69	0.00	0.00	0.00	0.05	3.74
Transport Barge 4	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	41	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.01	0.47
		Auxiliary Engine (Maneuvering)	25	100%	328	0.07	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.69	0.00	0.00	0.00	0.05	3.74
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	25	27%	7,986	1.32	0.02	0.32	0.05	0.04	0.00	0.00	0.00	0.00	89.22	0.00	0.00	0.01	1.28	90.51
		Main Engine (Maneuvering)	25	100%	7,697	1.27	0.02	0.31	0.04	0.04	0.00	0.00	0.00	0.00	85.99	0.00	0.00	0.01	1.23	87.24
		Auxiliary Engine (Transit)	25	27%	193	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	2.18	0.00	0.00	0.00	0.03	2.21
		Auxiliary Engine (Maneuvering)	25	100%	1,547	0.27	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	17.40	0.00	0.00	0.00	0.25	17.65
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	25	27%	7,986	1.32	0.02	0.32	0.05	0.04	0.00	0.00	0.00	0.00	89.22	0.00	0.00	0.01	1.28	90.51
		Main Engine (Maneuvering)	25	100%	7,697	1.27	0.02	0.31	0.04	0.04	0.00	0.00	0.00	0.00	85.99	0.00	0.00	0.01	1.23	87.24
		Auxiliary Engine (Transit)	25	27%	193	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	2.18	0.00	0.00	0.00	0.03	2.21
		Auxiliary Engine (Maneuvering)	25	100%	1,547	0.27	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	17.40	0.00	0.00	0.00	0.25	17.65
US Towing Tug 3	US Towing Tug	Main Engine (Transit)	25	27%	7,986	1.32	0.02	0.32	0.05	0.04	0.00	0.00	0.00	0.00	89.22	0.00	0.00	0.01	1.28	90.51
		Main Engine (Maneuvering)	25	100%	7,697	1.27	0.02	0.31	0.04	0.04	0.00	0.00	0.00	0.00	85.99	0.00	0.00	0.01	1.23	87.24
		Auxiliary Engine (Transit)	25	27%	193	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	2.18	0.00	0.00	0.00	0.03	2.21
		Auxiliary Engine (Maneuvering)	25	100%	1,547	0.27	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	17.40	0.00	0.00	0.00	0.25	17.65
US Towing Tug 4	US Towing Tug	Main Engine (Transit)	25	27%	7,986	1.32	0.02	0.32	0.05	0.04	0.00	0.00	0.00	0.00	89.22	0.00	0.00	0.01	1.28	90.51
		Main Engine (Maneuvering)	25	100%	7,697	1.27	0.02	0.31	0.04	0.04	0.00	0.00	0.00	0.00	85.99	0.00	0.00	0.01	1.23	87.24
		Auxiliary Engine (Transit)	25	27%	193	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	2.18	0.00	0.00	0.00	0.03	2.21
		Auxiliary Engine (Maneuvering)	25	100%	1,547	0.27	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	17.40	0.00	0.00	0.00	0.25	17.65
	Crew Transfer Vessel	Main Engine (Transit)	17	100%	1,879	0.30	0.00	0.08	0.01	0.01	0.00	0.00	0.00	0.00	21.14	0.00	0.00	0.00	0.30	21.45
		Main Engine (Maneuvering)	17	100%	17,822	2.83	0.04	0.71	0.10	0.09	0.00	0.00	0.01	0.00	200.50	0.00	0.01	0.03	2.86	203.39
		Auxiliary Engine (Transit)	17	100%	25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.29
		Auxiliary Engine (Maneuvering)	17	100%	1,982	0.36	0.00	0.09	0.01	0.01	0.00	0.00	0.00	0.00	22.30	0.00	0.00	0.00	0.32	22.62
	Bubble Curtain Power	Air Compressor	N/A	100%	102,600	6.33	0.79	5.54	0.32	0.32	0.01	0.00	0.03	0.00	1,171.05	0.05	0.01	1.19	2.83	1,175.07
	Hydraulic Hammer Power	Hammer Engine	N/A	100%	23,027	2.27	0.28	1.24	0.07	0.07	0.00	0.00	0.00	0.00	262.83	0.01	0.00	0.27	0.64	263.73
Scour Protection																				
	Fall Pipe Vessel	Main Engine (Transit)	25	10%	11,280	1.86	0.05	0.43	0.07	0.06	0.02	0.00	0.01	0.00	124.33	0.00	0.01	0.02	1.81	126.16
		Main Engine (Maneuvering)	25	100%	600,172	98.86	2.60	22.92	3.54	3.44	0.89	0.00	0.28	0.04	6,615.07	0.04	0.32	1.04	96.23	6,712.35
		Auxiliary Engine (Transit)	25	10%	1,049	0.18	0.00	0.05	0.01	0.01	0.00	0.00	0.00	0.00	11.80	0.00	0.00	0.00	0.17	11.97
		Auxiliary Engine (Maneuvering)	25	100%	231,655	39.77	0.56	9.97	1.29	1.25	0.02	0.00	0.07	0.00	2,606.29	0.02	0.12	0.40	37.14	2,643.83
	US Dredger	Main Engine (Transit)	25	27%	676	0.11	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	7.40	0.00	0.00	0.00	0.11	7.51
		Main Engine (Maneuvering)	25	100%	22,677	3.78	0.11	0.84	0.14	0.13	0.04	0.00	0.01	0.00	248.22	0.00	0.01	0.04	3.64	251.89
		Auxiliary Engine (Transit)	25	27%	339	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.82	0.00	0.00	0.00	0.05	3.87
		Auxiliary Engine (Maneuvering)	25	100%	47,254	8.08	0.11	2.03	0.26	0.25	0.00	0.00	0.01	0.00	531.64	0.00	0.03	0.08	7.58	539.30

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Inter Array Cable Installation																				
Cable Installation Vessel	Cable Installation Vessel	Main Engine (Transit)	25	10%	3,837	0.63	0.02	0.15	0.02	0.02	0.01	0.00	0.00	0.00	42.30	0.00	0.00	0.01	0.62	42.92
		Main Engine (Maneuvering)	25	100%	488,234	80.42	2.12	18.64	2.88	2.80	0.72	0.00	0.23	0.03	5,381.30	0.03	0.26	0.85	78.28	5,460.43
		Auxiliary Engine (Transit)	25	10%	60	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.01	0.69
		Auxiliary Engine (Maneuvering)	25	100%	31,722	5.45	0.08	1.37	0.18	0.17	0.00	0.00	0.01	0.00	356.89	0.00	0.02	0.06	5.09	362.03
Cable Installation Support Activities	Support Vessel/SOV	Main Engine (Transit)	25	10%	488	0.08	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	5.38	0.00	0.00	0.00	0.08	5.45
		Main Engine (Maneuvering)	25	100%	104,983	17.29	0.46	4.01	0.62	0.60	0.15	0.00	0.05	0.01	1,157.12	0.01	0.06	0.18	16.83	1,174.13
		Auxiliary Engine (Transit)	25	10%	81	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.91	0.00	0.00	0.00	0.01	0.93
		Auxiliary Engine (Maneuvering)	25	100%	17,497	3.00	0.04	0.75	0.10	0.09	0.00	0.00	0.01	0.00	196.86	0.00	0.01	0.03	2.81	199.69
Sand Wave Clearance	TSHD (Dredger)	Main Engine (Transit)	25	10%	676	0.11	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	7.40	0.00	0.00	0.00	0.11	7.51
		Main Engine (Maneuvering)	25	100%	56,259	9.37	0.27	2.08	0.35	0.33	0.11	0.00	0.03	0.01	615.79	0.00	0.03	0.10	9.02	624.91
		Auxiliary Engine (Transit)	25	10%	339	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.82	0.00	0.00	0.00	0.05	3.87
		Auxiliary Engine (Maneuvering)	25	100%	117,229	20.04	0.28	5.05	0.65	0.63	0.01	0.00	0.04	0.00	1,318.91	0.01	0.06	0.20	18.80	1,337.91
Pre Lay Grapnel Run AHTS 1	AHTS	Main Engine (Transit)	25	27%	4,744	0.78	0.01	0.19	0.03	0.03	0.00	0.00	0.00	0.00	53.00	0.00	0.00	0.01	0.76	53.77
		Main Engine (Maneuvering)	25	100%	57,920	9.57	0.18	2.30	0.33	0.32	0.03	0.00	0.02	0.00	647.08	0.00	0.03	0.10	9.29	656.46
		Auxiliary Engine (Transit)	25	27%	224	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	2.52	0.00	0.00	0.00	0.04	2.56
		Auxiliary Engine (Maneuvering)	25	100%	11,346	1.99	0.03	0.49	0.06	0.06	0.00	0.00	0.00	0.00	127.65	0.00	0.01	0.02	1.82	129.49
Pre Lay Grapnel Run AHTS 2	AHTS	Main Engine (Transit)	25	27%	4,744	0.78	0.01	0.19	0.03	0.03	0.00	0.00	0.00	0.00	53.00	0.00	0.00	0.01	0.76	53.77
		Main Engine (Maneuvering)	25	100%	57,920	9.57	0.18	2.30	0.33	0.32	0.03	0.00	0.02	0.00	647.08	0.00	0.03	0.10	9.29	656.46
		Auxiliary Engine (Transit)	25	27%	224	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	2.52	0.00	0.00	0.00	0.04	2.56
		Auxiliary Engine (Maneuvering)	25	100%	11,346	1.99	0.03	0.49	0.06	0.06	0.00	0.00	0.00	0.00	127.65	0.00	0.01	0.02	1.82	129.49
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	25	10%	11,280	1.86	0.05	0.43	0.07	0.06	0.02	0.00	0.01	0.00	124.33	0.00	0.01	0.02	1.81	126.16
		Main Engine (Maneuvering)	25	100%	18,121	2.98	0.08	0.69	0.11	0.10	0.03	0.00	0.01	0.00	199.73	0.00	0.01	0.03	2.91	202.67
		Auxiliary Engine (Transit)	25	10%	1,049	0.18	0.00	0.05	0.01	0.01	0.00	0.00	0.00	0.00	11.80	0.00	0.00	0.00	0.17	11.97
		Auxiliary Engine (Maneuvering)	25	100%	6,994	1.20	0.02	0.30	0.04	0.04	0.00	0.00	0.00	0.00	78.69	0.00	0.00	0.01	1.12	79.83
WTG Installation																				
WTG Installation Vessel	Jackup Vessel	Main Engine (Transit)	25	27%	10,532	2.03	0.03	0.46	0.06	0.06	0.00	0.00	0.00	0.00	130.78	0.00	0.01	0.02	1.87	132.67
		Main Engine (Maneuvering)	25	100%	3,149,526	606.18	8.46	139.00	18.74	18.13	0.79	0.00	1.07	0.04	39,107.47	0.24	1.87	6.04	558.32	39,671.83
		Auxiliary Engine (Transit)	25	27%	768	0.15	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	8.14	0.00	0.00	0.00	0.12	8.26
		Auxiliary Engine (Maneuvering)	25	100%	952,844	180.04	2.18	38.66	4.99	4.83	0.09	0.00	0.28	0.00	10,104.14	0.06	0.48	1.56	144.00	10,249.70
US Jack Up Feeder 1	Jack up	Main Engine (Transit)	25	27%	119,197	22.94	0.32	5.26	0.71	0.69	0.03	0.00	0.04	0.00	1,480.06	0.01	0.07	0.23	21.13	1,501.42
		Main Engine (Maneuvering)	25	100%	328,773	63.28	0.88	14.51	1.96	1.89	0.08	0.00	0.11	0.00	4,082.36	0.03	0.20	0.63	58.28	4,141.27
		Auxiliary Engine (Transit)	25	27%	34,136	6.84	0.08	1.47	0.19	0.18	0.00	0.00	0.01	0.00	384.05	0.00	0.02	0.06	5.47	389.59
		Auxiliary Engine (Maneuvering)	25	100%	390,742	78.33	0.95	16.82	2.17	2.10	0.04	0.00	0.12	0.00	4,396.13	0.03	0.21	0.68	62.65	4,459.46
US Jack Up Feeder 2	Jack up	Main Engine (Transit)	25	27%	119,197	22.94	0.32	5.26	0.71	0.69	0.03	0.00	0.04	0.00	1,480.06	0.01	0.07	0.23	21.13	1,501.42
		Main Engine (Maneuvering)	25	100%	328,773	63.28	0.88	14.51	1.96	1.89	0.08	0.00	0.11	0.00	4,082.36	0.03	0.20	0.63	58.28	4,141.27
		Auxiliary Engine (Transit)	25	27%	34,136	6.84	0.08	1.47	0.19	0.18	0.00	0.00	0.01	0.00	384.05	0.00	0.02	0.06	5.47	389.59
		Auxiliary Engine (Maneuvering)	25	100%	390,742	78.33	0.95	16.82	2.17	2.10	0.04	0.00	0.12	0.00	4,396.13	0.03	0.21	0.68	62.65	4,459.46
Crew Transfer	Crew Transfer Vessel	Main Engine (Transit)	17	100%	17,450	2.77	0.04	0.70	0.09	0.09	0.00	0.00	0.01	0.00	196.31	0.00	0.01	0.03	2.80	199.14
		Main Engine (Maneuvering)	17	100%	329,122	52.27	0.80	13.14	1.77	1.71	0.03	0.00	0.10	0.00	3,702.63	0.02	0.18	0.57	52.77	3,755.97
		Auxiliary Engine (Transit)	17	100%	234	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	2.63	0.00	0.00	0.00	0.04	2.67
		Auxiliary Engine (Maneuvering)	17	100%	18,301	3.30	0.04	0.79	0.10	0.10	0.00	0.00	0.01	0.00	205.90	0.00	0.01	0.03	2.93	208.86
WTG Commissioning SOV	Service Operation Vessel	Main Engine (Transit)	25	27%	488	0.08	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	5.38	0.00	0.00	0.00	0.08	5.45
		Main Engine (Maneuvering)	25	100%	394,004	64.90	1.71	15.05	2.33	2.26	0.58	0.00	0.19	0.03	4,342.70	0.03	0.21	0.68	63.18	4,406.56
		Auxiliary Engine (Transit)	25	27%	81	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.91	0.00	0.00	0.00	0.01	0.93
		Auxiliary Engine (Maneuvering)	25	100%	65,667	11.27	0.16	2.83	0.36	0.35	0.01	0.00	0.02	0.00	738.81	0.00	0.04	0.11	10.53	749.45

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Export Cable Installation																				
Cable Installation Vessel 1		Main Engine (Transit)	25	27%	4,716	0.78	0.02	0.18	0.03	0.03	0.01	0.00	0.00	0.00	51.98	0.00	0.00	0.01	0.76	52.74
		Main Engine (Maneuvering)	25	51%	484,895	79.87	2.10	18.52	2.86	2.78	0.72	0.00	0.23	0.03	5,344.50	0.03	0.26	0.84	77.75	5,423.09
		Auxiliary Engine (Transit)	25	27%	996	0.17	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	11.20	0.00	0.00	0.00	0.16	11.37
		Auxiliary Engine (Maneuvering)	25	51%	424,947	72.95	1.03	18.29	2.36	2.29	0.04	0.00	0.13	0.00	4,780.96	0.03	0.23	0.74	68.14	4,849.84
Cable Installation Vessel 2		Main Engine (Transit)	25	27%	4,716	0.78	0.02	0.18	0.03	0.03	0.01	0.00	0.00	0.00	51.98	0.00	0.00	0.01	0.76	52.74
		Main Engine (Maneuvering)	25	51%	484,895	79.87	2.10	18.52	2.86	2.78	0.72	0.00	0.23	0.03	5,344.50	0.03	0.26	0.84	77.75	5,423.09
		Auxiliary Engine (Transit)	25	27%	996	0.17	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	11.20	0.00	0.00	0.00	0.16	11.37
		Auxiliary Engine (Maneuvering)	25	51%	424,947	72.95	1.03	18.29	2.36	2.29	0.04	0.00	0.13	0.00	4,780.96	0.03	0.23	0.74	68.14	4,849.84
Support and Jointing Vessel		Main Engine (Transit)	25	27%	3,419	0.56	0.01	0.13	0.02	0.02	0.01	0.00	0.00	0.00	37.68	0.00	0.00	0.01	0.55	38.24
		Main Engine (Maneuvering)	25	51%	70,716	11.65	0.31	2.70	0.42	0.41	0.10	0.00	0.03	0.00	779.42	0.00	0.04	0.12	11.34	790.89
		Auxiliary Engine (Transit)	25	27%	707	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.95	0.00	0.00	0.00	0.11	8.07
		Auxiliary Engine (Maneuvering)	25	51%	60,689	10.42	0.15	2.61	0.34	0.33	0.01	0.00	0.02	0.00	682.80	0.00	0.03	0.11	9.73	692.64
TSHD	Dredger	Main Engine (Transit)	25	27%	676	0.11	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	7.40	0.00	0.00	0.00	0.11	7.51
		Main Engine (Maneuvering)	25	51%	50,542	8.42	0.25	1.87	0.32	0.30	0.10	0.00	0.03	0.00	553.21	0.00	0.03	0.09	8.10	561.40
		Auxiliary Engine (Transit)	25	27%	339	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.82	0.00	0.00	0.00	0.05	3.87
		Auxiliary Engine (Maneuvering)	25	51%	105,316	18.01	0.26	4.53	0.58	0.57	0.01	0.00	0.03	0.00	1,184.88	0.01	0.06	0.18	16.89	1,201.95
AHTS	Tug	Main Engine (Transit)	25	27%	4,744	0.78	0.01	0.19	0.03	0.03	0.00	0.00	0.00	0.00	53.00	0.00	0.00	0.01	0.76	53.77
		Main Engine (Maneuvering)	25	51%	144,384	23.86	0.45	5.74	0.83	0.80	0.08	0.00	0.05	0.00	1,613.05	0.01	0.08	0.25	23.15	1,636.45
		Auxiliary Engine (Transit)	25	27%	224	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	2.52	0.00	0.00	0.00	0.04	2.56
		Auxiliary Engine (Maneuvering)	25	51%	28,283	4.96	0.07	1.22	0.16	0.15	0.00	0.00	0.01	0.00	318.21	0.00	0.02	0.05	4.54	322.79
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	25	10%	11,280	1.86	0.05	0.43	0.07	0.06	0.02	0.00	0.01	0.00	124.33	0.00	0.01	0.02	1.81	126.16
		Main Engine (Maneuvering)	25	51%	19,999	3.29	0.09	0.76	0.12	0.11	0.03	0.00	0.01	0.00	220.43	0.00	0.01	0.03	3.21	223.67
		Auxiliary Engine (Transit)	25	10%	1,049	0.18	0.00	0.05	0.01	0.01	0.00	0.00	0.00	0.00	11.80	0.00	0.00	0.00	0.17	11.97
		Auxiliary Engine (Maneuvering)	25	51%	7,719	1.33	0.02	0.33	0.04	0.04	0.00	0.00	0.00	0.00	86.85	0.00	0.00	0.01	1.24	88.10
Fuel Bunkering																				
Towing Tug	Tug	Main Engine (Transit)	25	27%	31,943	5.28	0.10	1.27	0.18	0.18	0.02	0.00	0.01	0.00	356.86	0.00	0.02	0.06	5.12	362.04
		Main Engine (Maneuvering)	25	100%	258,621	42.73	0.81	10.28	1.48	1.44	0.15	0.00	0.10	0.01	2,889.30	0.02	0.14	0.45	41.47	2,931.21
		Auxiliary Engine (Transit)	25	27%	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	8.70	0.00	0.00	0.00	0.12	8.83
		Auxiliary Engine (Maneuvering)	25	100%	25,986	4.56	0.06	1.12	0.14	0.14	0.00	0.00	0.01	0.00	292.36	0.00	0.01	0.05	4.17	296.57
Barge	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.84	0.00	0.00	0.00	0.03	1.87
		Auxiliary Engine (Maneuvering)	25	100%	5,505	1.20	0.01	0.24	0.03	0.03	0.00	0.00	0.00	0.00	61.94	0.00	0.00	0.01	0.88	62.83
Motion Compensation	Motion Compensation	Motion Compensation Engine	N/A	100%	144,000	8.89	1.10	7.78	0.44	0.44	0.02	0.00	0.02	0.00	1,643.57	0.07	0.01	1.67	3.97	1,649.21
Commissioning Generators																				
OSS Commissioning Generators	Generator	Marine Tier 3 Generator	N/A	100%	96,000	8.59	1.03	7.41	0.15	0.14	0.01	0.00	0.03	0.00	1,095.72	0.04	0.01	1.11	2.65	1,099.48
WTG Commissioning Generators	Generator	Marine Tier 3 Generator	N/A	100%	53,186	4.43	0.53	4.10	0.10	0.10	0.01	0.00	0.01	0.00	607.05	0.02	0.00	0.62	1.47	609.13
Miscellaneous																				
Marine Paint	N/A	N/A	N/A	100%	N/A	N/A	0.75	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fuel Evaporation	N/A	N/A	N/A	100%	N/A	N/A	0.20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Trips	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit	Operating Days in WTA	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Emissions During Construction																	
Foundation Installation (FOU) B02																	
Medium HLV	Heavy Lift Vessel	Main Engine (Transit)	6	4 x 3840kW 2 x 4800kW	24,960	3 main	Europe	2	250	1,000	10	100	0	0	0	100	7M
		Main Engine (Maneuvering)	6	4 x 3840kW 2 x 4800kW	24,960	3 main		0	250	0	10	0	294	24	7,056	7,056	7M
		Auxiliary Engine (Transit)	1	1,110	1,110	3 Auxiliary		2	250	1,000	10	100	0	0	0	100	7A
		Auxiliary Engine (Maneuvering)	1	1,110	1,110	3 Auxiliary		0	250	0	10	0	294	24	7,056	7,056	7A
Bubble Curtain Support Vessel	Tug	Main Engine (Transit)	2	5,530	11,060	1 & 2 main	NJWP	2	91	365	10	36	0	0	0	36	11M
		Main Engine (Maneuvering)	2	5,530	11,060	1 & 2 main		0	91	0	10	0	294	24	7,056	7,056	11M
		Auxiliary Engine (Transit)	0	5,530	0	1 & 2 auxiliary		2	91	365	10	36	0	0	0	36	11A
		Auxiliary Engine (Maneuvering)	0	5,530	0	1 & 2 auxiliary		0	91	0	10	0	294	24	7,056	7,056	11A
Barge 1	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	50	91	9,124	7	1,303	0	0	0	1,303	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	7	0	294	24	7,056	7,056	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		50	91	9,124	7	1,303	0	0	0	1,303	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	7	0	294	24	7,056	7,056	2A
Barge 2	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	50	91	9,124	7	1,303	0	0	0	1,303	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	7	0	294	24	7,056	7,056	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		50	91	9,124	7	1,303	0	0	0	1,303	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	7	0	294	24	7,056	7,056	2A
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	50	91	9,124	7	1,303	0	0	0	1,303	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	7	0	294	24	7,056	7,056	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		50	91	9,124	7	1,303	0	0	0	1,303	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	7	0	294	24	7,056	7,056	11A
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	50	91	9,124	7	1,303	0	0	0	1,303	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	7	0	294	24	7,056	7,056	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		50	91	9,124	7	1,303	0	0	0	1,303	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	7	0	294	24	7,056	7,056	11A
Crew Transfer / PSO / Noise Monitoring Vessel	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	169	17	5,874	29	206	0	0	0	206	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	29	0	294	24	7,056	7,056	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		169	17	5,874	29	206	0	0	0	206	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	29	0	294	24	7,056	7,056	4A
Bubble Curtain Power	Air Compressor	Air Compressor	20	399	7,980	Tier 3 Non-Road	N/A	0	0	0	0	0	294	8	2,352	2,352	16
Hydraulic Hammer Power	Hydraulic Hammer Engine	Hammer Engine	3	597	1,791	Tier 2 Non-Road	N/A	0	0	0	0	0	294	8	2,352	2,352	18

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Construction																			
Foundation Installation (FOU) B02																			
Medium HLV	Heavy Lift Vessel	Main Engine (Transit)	0.83	119,006	22.90	0.32	5.25	0.71	0.69	0.03	0.00	0.04	0.0014	1,477.70	0.01	0.07	0.23	21.10	1,499.02
		Main Engine (Maneuvering)	0.10	1,011,698	194.72	2.72	44.65	6.02	5.82	0.25	0.00	0.34	0.01	12,562.19	0.08	0.60	1.94	179.34	12,743.48
		Auxiliary Engine (Transit)	0.56	4,188	0.79	0.01	0.17	0.02	0.02	0.00	0.00	0.00	0.00	44.41	0.00	0.00	0.01	0.63	45.05
		Auxiliary Engine (Maneuvering)	0.56	295,532	55.84	0.68	11.99	1.55	1.50	0.03	0.00	0.09	0.00	3,133.88	0.02	0.15	0.48	44.66	3,179.03
Bubble Curtain Support Vessel	Tug	Main Engine (Transit)	0.83	21,278	3.52	0.07	0.85	0.12	0.12	0.01	0.00	0.01	0.00	237.71	0.00	0.01	0.04	3.41	241.16
		Main Engine (Maneuvering)	0.10	495,618	81.89	1.55	19.70	2.84	2.75	0.28	0.00	0.18	0.01	5,537.00	0.03	0.27	0.86	79.47	5,617.33
		Auxiliary Engine (Transit)	0.43	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Maneuvering)	0.43	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barge 1	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	1,780	0.39	0.00	0.08	0.01	0.01	0.00	0.00	0.00	0.00	20.02	0.00	0.00	0.00	0.29	20.31
		Auxiliary Engine (Maneuvering)	0.43	9,635	2.10	0.02	0.41	0.05	0.05	0.00	0.00	0.00	0.00	108.40	0.00	0.01	0.02	1.54	109.96
Barge 2	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	1,780	0.39	0.00	0.08	0.01	0.01	0.00	0.00	0.00	0.00	20.02	0.00	0.00	0.00	0.29	20.31
		Auxiliary Engine (Maneuvering)	0.43	9,635	2.10	0.02	0.41	0.05	0.05	0.00	0.00	0.00	0.00	108.40	0.00	0.01	0.02	1.54	109.96
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	0.83	346,970	57.33	1.08	13.79	1.99	1.93	0.20	0.00	0.13	0.01	3,876.31	0.02	0.19	0.60	55.63	3,932.55
		Main Engine (Maneuvering)	0.10	226,294	37.39	0.71	8.99	1.30	1.26	0.13	0.00	0.08	0.01	2,528.14	0.02	0.12	0.39	36.28	2,564.81
		Auxiliary Engine (Transit)	0.43	8,401	1.47	0.02	0.36	0.05	0.05	0.00	0.00	0.00	0.00	94.51	0.00	0.00	0.01	1.35	95.87
		Auxiliary Engine (Maneuvering)	0.43	45,475	7.97	0.11	1.96	0.25	0.24	0.00	0.00	0.01	0.00	511.63	0.00	0.02	0.08	7.29	519.00
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	0.83	346,970	57.33	1.08	13.79	1.99	1.93	0.20	0.00	0.13	0.01	3,876.31	0.02	0.19	0.60	55.63	3,932.55
		Main Engine (Maneuvering)	0.10	226,294	37.39	0.71	8.99	1.30	1.26	0.13	0.00	0.08	0.01	2,528.14	0.02	0.12	0.39	36.28	2,564.81
		Auxiliary Engine (Transit)	0.43	8,401	1.47	0.02	0.36	0.05	0.05	0.00	0.00	0.00	0.00	94.51	0.00	0.00	0.01	1.35	95.87
		Auxiliary Engine (Maneuvering)	0.43	45,475	7.97	0.11	1.96	0.25	0.24	0.00	0.00	0.01	0.00	511.63	0.00	0.02	0.08	7.29	519.00
Crew Transfer / PSO / Noise Monitoring Vessel	Crew Transfer Vessel	Main Engine (Transit)	0.83	22,685	3.60	0.06	0.91	0.12	0.12	0.00	0.00	0.01	0.00	255.21	0.00	0.01	0.04	3.64	258.89
		Main Engine (Maneuvering)	0.10	93,565	14.86	0.23	3.74	0.50	0.49	0.01	0.00	0.03	0.00	1,052.61	0.01	0.05	0.16	15.00	1,067.77
		Auxiliary Engine (Transit)	0.43	304	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.42	0.00	0.00	0.00	0.05	3.47
		Auxiliary Engine (Maneuvering)	0.43	10,405	1.88	0.03	0.45	0.06	0.06	0.00	0.00	0.00	0.00	117.07	0.00	0.01	0.02	1.67	118.75
Bubble Curtain Power	Air Compressor	Air Compressor	1.00	1,340,640	82.76	10.34	72.41	4.14	4.14	0.14	0.00	0.36	0.01	15,301.68	0.62	0.12	15.52	36.99	15,354.19
Hydraulic Hammer Power	Hydraulic Hammer Engine	Hammer Engine	1.00	300,888	29.72	3.68	16.25	0.93	0.93	0.03	0.00	0.03	0.00	3,434.25	0.14	0.03	3.48	8.30	3,446.03

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Construction																				
Foundation Installation (FOU) B02																				
Medium HLV	Heavy Lift Vessel	Main Engine (Transit)	25	10%	11,901	2.29	0.03	0.53	0.07	0.07	0.00	0.00	0.00	0.0001	147.77	0.00	0.01	0.02	2.11	149.90
		Main Engine (Maneuvering)	25	100%	1,011,698	194.72	2.72	44.65	6.02	5.82	0.25	0.00	0.34	0.0116	12,562.19	0.08	0.60	1.94	179.34	12,743.48
		Auxiliary Engine (Transit)	25	10%	419	0.08	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	4.44	0.00	0.00	0.00	0.06	4.51
		Auxiliary Engine (Maneuvering)	25	100%	295,532	55.84	0.68	11.99	1.55	1.50	0.03	0.00	0.09	0.0013	3,133.88	0.02	0.15	0.48	44.66	3,179.03
Bubble Curtain Support Vessel	Tug	Main Engine (Transit)	25	27%	5,830	0.96	0.02	0.23	0.03	0.03	0.00	0.00	0.00	0.0002	65.13	0.00	0.00	0.01	0.93	66.08
		Main Engine (Maneuvering)	25	100%	495,618	81.89	1.55	19.70	2.84	2.75	0.28	0.00	0.18	0.0130	5,537.00	0.03	0.27	0.86	79.47	5,617.33
		Auxiliary Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
Barge 1	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	488	0.11	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	5.49	0.00	0.00	0.00	0.08	5.57
		Auxiliary Engine (Maneuvering)	25	100%	9,635	2.10	0.02	0.41	0.05	0.05	0.00	0.00	0.00	0.0000	108.40	0.00	0.01	0.02	1.54	109.96
Barge 2	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	488	0.11	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	5.49	0.00	0.00	0.00	0.08	5.57
		Auxiliary Engine (Maneuvering)	25	100%	9,635	2.10	0.02	0.41	0.05	0.05	0.00	0.00	0.00	0.0000	108.40	0.00	0.01	0.02	1.54	109.96
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	25	27%	95,068	15.71	0.30	3.78	0.54	0.53	0.05	0.00	0.04	0.0025	1,062.09	0.01	0.05	0.17	15.24	1,077.50
		Main Engine (Maneuvering)	25	100%	226,294	37.39	0.71	8.99	1.30	1.26	0.13	0.00	0.08	0.0060	2,528.14	0.02	0.12	0.39	36.28	2,564.81
		Auxiliary Engine (Transit)	25	27%	2,302	0.40	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.0000	25.90	0.00	0.00	0.00	0.37	26.27
		Auxiliary Engine (Maneuvering)	25	100%	45,475	7.97	0.11	1.96	0.25	0.24	0.00	0.00	0.01	0.0002	511.63	0.00	0.02	0.08	7.29	519.00
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	25	27%	95,068	15.71	0.30	3.78	0.54	0.53	0.05	0.00	0.04	0.0025	1,062.09	0.01	0.05	0.17	15.24	1,077.50
		Main Engine (Maneuvering)	25	100%	226,294	37.39	0.71	8.99	1.30	1.26	0.13	0.00	0.08	0.0060	2,528.14	0.02	0.12	0.39	36.28	2,564.81
		Auxiliary Engine (Transit)	25	27%	2,302	0.40	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.0000	25.90	0.00	0.00	0.00	0.37	26.27
		Auxiliary Engine (Maneuvering)	25	100%	45,475	7.97	0.11	1.96	0.25	0.24	0.00	0.00	0.01	0.0002	511.63	0.00	0.02	0.08	7.29	519.00
Crew Transfer / PSO / Noise Monitoring Vessel	Crew Transfer Vessel	Main Engine (Transit)	17	100%	22,685	3.60	0.06	0.91	0.12	0.12	0.00	0.00	0.01	0.0001	255.21	0.00	0.01	0.04	3.64	258.89
		Main Engine (Maneuvering)	17	100%	93,565	14.86	0.23	3.74	0.50	0.49	0.01	0.00	0.03	0.0004	1,052.61	0.01	0.05	0.16	15.00	1,067.77
		Auxiliary Engine (Transit)	17	100%	304	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	3.42	0.00	0.00	0.00	0.05	3.47
		Auxiliary Engine (Maneuvering)	17	100%	10,405	1.88	0.03	0.45	0.06	0.06	0.00	0.00	0.00	0.0000	117.07	0.00	0.01	0.02	1.67	118.75
Bubble Curtain Power	Air Compressor	Air Compressor	N/A	100%	1,340,640	82.76	10.34	72.41	4.14	4.14	0.14	0.00	0.36	0.0065	15,301.68	0.62	0.12	15.52	36.99	15,354.19
Hydraulic Hammer Power	Hydraulic Hammer Engine	Hammer Engine	N/A	100%	300,888	29.72	3.68	16.25	0.93	0.93	0.03	0.00	0.03	0.0015	3,434.25	0.14	0.03	3.48	8.30	3,446.03

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Trips	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Emissions During Construction																	
Offshore Substation Installation (OSS)																	
	Large HLV	Main Engine (Transit)	11	4,182	46,000	3 main	NJWP	1	91	182	10	18	0	0	0	18	7M
		Main Engine (Maneuvering)	11	4,182	46,000	3 main		0	91	0	10	0	9	24	216	216	7M
		Auxiliary Engine (Transit)	1	5,833	5,833	3 Auxiliary		1	91	182	10	18	0	0	0	18	7A
		Auxiliary Engine (Maneuvering)	1	5,833	5,833	3 Auxiliary		0	91	0	10	0	9	24	216	216	7A
	Bubble Curtain Support Vessel	Main Engine (Transit)	2	5,530	11,060	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	11M
		Main Engine (Maneuvering)	2	5,530	11,060	1 & 2 main		0	91	0	10	0	9	24	216	216	11M
		Auxiliary Engine (Transit)	0	0	0	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	11A
		Auxiliary Engine (Maneuvering)	0	0	0	1 & 2 auxiliary		0	91	0	10	0	9	24	216	216	11A
Transport Barge 1	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	3	91	547	10	55	0	0	0	55	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	10	0	5	24	120	120	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		3	91	547	10	55	0	0	0	55	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	10	0	5	24	120	120	2A
Transport Barge 2	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	3	91	547	10	55	0	0	0	55	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	10	0	5	24	120	120	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		3	91	547	10	55	0	0	0	55	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	10	0	5	24	120	120	2A
Transport Barge 3	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	3	91	547	10	55	0	0	0	55	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	10	0	5	24	120	120	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		3	91	547	10	55	0	0	0	55	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	10	0	5	24	120	120	2A
Transport Barge 4	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	3	91	547	10	55	0	0	0	55	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	10	0	5	24	120	120	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		3	91	547	10	55	0	0	0	55	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	10	0	5	24	120	120	2A
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	3	91	547	10	55	0	0	0	55	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	10	0	5	24	120	120	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		3	91	547	10	55	0	0	0	55	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	10	0	5	24	120	120	11A
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	3	91	547	10	55	0	0	0	55	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	10	0	5	24	120	120	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		3	91	547	10	55	0	0	0	55	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	10	0	5	24	120	120	11A
US Towing Tug 3	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	3	91	547	10	55	0	0	0	55	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	10	0	5	24	120	120	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		3	91	547	10	55	0	0	0	55	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	10	0	5	24	120	120	11A
US Towing Tug 4	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	3	91	547	10	55	0	0	0	55	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	10	0	5	24	120	120	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		3	91	547	10	55	0	0	0	55	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	10	0	5	24	120	120	11A
	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	7	17	243	29	9	0	0	0	9	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	29	0	28	24	672	672	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		7	17	243	29	9	0	0	0	9	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	29	0	28	24	672	672	4A
	Bubble Curtain Power	Air Compressor	20	399	7,980	Tier 3 Non-Road	N/A	0	0	0	0	0	9	10	90	90	16
	Hydraulic Hammer Power	Hammer Engine	3	597	1,791	Tier 2 Non-Road	N/A	0	0	0	0	0	9	10	90	90	18
Scour Protection																	
	Fall Pipe Vessel	Main Engine (Transit)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main	Europe	1	250	500	10	50	0	0	0	50	3M
		Main Engine (Maneuvering)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main		0	250	0	10	0	63	24	1,512	1,512	3M
		Auxiliary Engine (Transit)	1	2,950	2,950	1 & 2 auxiliary		1	250	500	10	50	0	0	0	50	3A
		Auxiliary Engine (Maneuvering)	1	2,950	2,950	1 & 2 auxiliary		0	250	0	10	0	63	24	1,512	1,512	3A
	US Dredger	Main Engine (Transit)	2	641	1,283	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	5M
		Main Engine (Maneuvering)	2	641	1,283	1 & 2 main		0	91	0	10	0	40	24	960	960	5M
		Auxiliary Engine (Transit)	0	0	954	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	5A
		Auxiliary Engine (Maneuvering)	0	0	954	1 & 2 auxiliary		0	91	0	10	0	40	24	960	960	5A

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Trips	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Inter Array Cable Installation																	
Cable Installation Vessel	Cable Installation Vessel	Main Engine (Transit)	0	0	7,280	1 & 2 main	Europe	1	250	500	10	50	0	0	0	50	3M
		Main Engine (Maneuvering)	0	0	7,280	1 & 2 main		0	250	0	10	0	150	24	3,600	3,600	3M
		Auxiliary Engine (Transit)	0	0	220	1 & 2 auxiliary		1	250	500	10	50	0	0	0	50	3A
		Auxiliary Engine (Maneuvering)	0	0	220	1 & 2 auxiliary		0	250	0	10	0	150	24	3,600	3,600	3A
Cable Installation Support Activities	Support Vessel/SOV	Main Engine (Transit)	4	1,200	4,800	1 & 2 main	Europe	1	250	500	10	50	0	0	0	50	3M
		Main Engine (Maneuvering)	4	1,200	4,800	1 & 2 main		0	250	0	10	0	94	24	2,256	2,256	3M
		Auxiliary Engine (Transit)	1	800	800	1 & 2 auxiliary		1	250	500	10	50	0	0	0	50	3A
		Auxiliary Engine (Maneuvering)	1	800	800	1 & 2 auxiliary		0	250	0	10	0	94	24	2,256	2,256	3A
Sand Wave Clearance	TSHD (Dredger)	Main Engine (Transit)	2	641	1,283	1 & 2 main	Europe	1	250	500	10	50	0	0	0	50	5M
		Main Engine (Maneuvering)	2	641	1,283	1 & 2 main		0	250	0	10	0	98	24	2,352	2,352	5M
		Auxiliary Engine (Transit)	0	0	954	1 & 2 auxiliary		1	250	500	10	50	0	0	0	50	5A
		Auxiliary Engine (Maneuvering)	0	0	954	1 & 2 auxiliary		0	250	0	10	0	98	24	2,352	2,352	5A
Pre Lay Grapnel Run AHTS 1	AHTS	Main Engine (Transit)	2	4,500	9,000	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	11M
		Main Engine (Maneuvering)	2	4,500	9,000	1 & 2 main		0	91	0	10	0	15	24	360	360	11M
		Auxiliary Engine (Transit)	2	410	820	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	11A
		Auxiliary Engine (Maneuvering)	2	410	820	1 & 2 auxiliary		0	91	0	10	0	15	24	360	360	11A
Pre Lay Grapnel Run AHTS 2	AHTS	Main Engine (Transit)	2	4,500	9,000	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	11M
		Main Engine (Maneuvering)	2	4,500	9,000	1 & 2 main		0	91	0	10	0	15	24	360	360	11M
		Auxiliary Engine (Transit)	2	410	820	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	11A
		Auxiliary Engine (Maneuvering)	2	410	820	1 & 2 auxiliary		0	91	0	10	0	15	24	360	360	11A
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main	Europe	1	250	500	10	50	0	0	0	50	3M
		Main Engine (Maneuvering)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main		0	250	0	10	0	2	24	48	48	3M
		Auxiliary Engine (Transit)	1	2,950	2,950	1 & 2 auxiliary		1	250	500	10	50	0	0	0	50	3A
		Auxiliary Engine (Maneuvering)	1	2,950	2,950	1 & 2 auxiliary		0	250	0	10	0	2	24	48	48	3A
WTG Installation																	
WTG Installation Vessel	Jackup Vessel	Main Engine (Transit)	7	4 x 3,535kW 3 x 2,650kW	22,090	3 main	NJWP	1	91	182	10	18	0	0	0	18	7M
		Main Engine (Maneuvering)	7	4 x 3,535kW 3 x 2,650kW	22,090	3 main		0	91	0	10	0	352	24	8,448	8,448	7M
		Auxiliary Engine (Transit)	1	2,650	2,650	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	7A
		Auxiliary Engine (Maneuvering)	1	2,650	2,650	1 & 2 auxiliary		0	91	0	10	0	352	24	8,448	8,448	7A
US Jack Up Feeder 1	Jack up	Main Engine (Transit)	2	2,500	5,000	3 main	NJWP	68	91	12,409	10	1,241	0	0	0	1,241	7M
		Main Engine (Maneuvering)	2	2,500	5,000	3 main		0	91	0	10	0	163	24	3,912	3,912	7M
		Auxiliary Engine (Transit)	1	2,500	2,500	1 & 2 auxiliary		68	91	12,409	10	1,241	0	0	0	1,241	7A
		Auxiliary Engine (Maneuvering)	1	2,500	2,500	1 & 2 auxiliary		0	91	0	10	0	163	24	3,912	3,912	7A
US Jack Up Feeder 2	Jack up	Main Engine (Transit)	2	2,500	5,000	3 main	NJWP	68	91	12,409	10	1,241	0	0	0	1,241	7M
		Main Engine (Maneuvering)	2	2,500	5,000	3 main		0	91	0	10	0	163	24	3,912	3,912	7M
		Auxiliary Engine (Transit)	1	2,500	2,500	1 & 2 auxiliary		68	91	12,409	10	1,241	0	0	0	1,241	7A
		Auxiliary Engine (Maneuvering)	1	2,500	2,500	1 & 2 auxiliary		0	91	0	10	0	163	24	3,912	3,912	7A
Crew Transfer	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	89	17	3,094	29	109	0	0	0	109	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	29	0	352	24	8,448	8,448	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		89	17	3,094	29	109	0	0	0	109	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	29	0	352	24	8,448	8,448	4A
WTG Commissioning SOV	Service Operation Vessel	Main Engine (Transit)	4	1,200	4,800	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	3M
		Main Engine (Maneuvering)	4	1,200	4,800	1 & 2 main		0	91	0	10	0	352	24	8,448	8,448	3M
		Auxiliary Engine (Transit)	1	800	800	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	3A
		Auxiliary Engine (Maneuvering)	1	800	800	1 & 2 auxiliary		0	91	0	10	0	352	24	8,448	8,448	3A

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Trips	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Export Cable Installation																	
Cable Installation Vessel 1		Main Engine (Transit)	4	2 x 2560kW 2 x 1913kW	8,946	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	3M
		Main Engine (Maneuvering)	4	2 x 2560kW 2 x 1913kW	8,946	1 & 2 main		0	91	0	10	0	174	24	4,176	4,176	3M
		Auxiliary Engine (Transit)	2	1,400	2,800	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	3A
		Auxiliary Engine (Maneuvering)	2	1,400	2,800	1 & 2 auxiliary		0	91	0	10	0	174	24	4,176	4,176	3A
Cable Installation Vessel 2		Main Engine (Transit)	4	2 x 2560kW 2 x 1913kW	8,946	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	3M
		Main Engine (Maneuvering)	4	2 x 2560kW 2 x 1913kW	8,946	1 & 2 main		0	91	0	10	0	174	24	4,176	4,176	3M
		Auxiliary Engine (Transit)	2	1,400	2,800	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	3A
		Auxiliary Engine (Maneuvering)	2	1,400	2,800	1 & 2 auxiliary		0	91	0	10	0	174	24	4,176	4,176	3A
Support and Jointing Vessel		Main Engine (Transit)	3	2 x 2350kW 1 x 1786kW	6,486	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	3M
		Main Engine (Maneuvering)	3	2 x 2350kW 1 x 1786kW	6,486	1 & 2 main		0	91	0	10	0	35	24	840	840	3M
		Auxiliary Engine (Transit)	2	994	1,988	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	3A
		Auxiliary Engine (Maneuvering)	2	994	1,988	1 & 2 auxiliary		0	91	0	10	0	35	24	840	840	3A
TSHD	Dredger	Main Engine (Transit)	2	641	1,283	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	5M
		Main Engine (Maneuvering)	2	641	1,283	1 & 2 main		0	91	0	10	0	127	24	3,048	3,048	5M
		Auxiliary Engine (Transit)	0	0	954	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	5A
		Auxiliary Engine (Maneuvering)	0	0	954	1 & 2 auxiliary		0	91	0	10	0	127	24	3,048	3,048	5A
AHTS	Tug	Main Engine (Transit)	2	4,500	9,000	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	11M
		Main Engine (Maneuvering)	2	4,500	9,000	1 & 2 main		0	91	0	10	0	52	24	1,248	1,248	11M
		Auxiliary Engine (Transit)	2	410	820	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	11A
		Auxiliary Engine (Maneuvering)	2	410	820	1 & 2 auxiliary		0	91	0	10	0	52	24	1,248	1,248	11A
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main	Europe	1	250	500	10	50	0	0	0	50	3M
		Main Engine (Maneuvering)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main		0	250	0	10	0	3	24	72	72	3M
		Auxiliary Engine (Transit)	1	2,950	2,950	1 & 2 auxiliary		1	250	500	10	50	0	0	0	50	3A
		Auxiliary Engine (Maneuvering)	1	2,950	2,950	1 & 2 auxiliary		0	250	0	10	0	3	24	72	72	3A
Fuel Bunkering																	
Towing Tug	Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	17	91	3,102	10	310	0	0	0	310	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	10	0	114	24	2,736	2,736	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		17	91	3,102	10	310	0	0	0	310	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	10	0	114	24	2,736	2,736	11A
Barge	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	17	91	3,102	10	310	0	0	0	310	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	10	0	114	24	2,736	2,736	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		17	91	3,102	10	310	0	0	0	310	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	10	0	114	24	2,736	2,736	2A
Motion Compensation	Motion Compensation	Motion Compensation Engine	1	500	500	Tier 3 Non-Road	NJWP	0	91	0	0	0	114	24	2,736	2,736	17
Commissioning Generators																	
OSS Commissioning Generators	Generator	Marine Tier 3 Generator	4	500	2,000	Tier 4 Non-Road	N/A	0	0	0	0	0	28	12	336	336	31
WTG Commissioning Generators	Generator	Marine Tier 3 Generator	1	240	240	Tier 4 Non-Road	N/A	0	0	0	0	0	352	12	4,224	4,224	32
Miscellaneous																	
Marine Paint	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fuel Evaporation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)													
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Construction																			
Offshore Substation Installation (OSS)																			
	Large HLV	Main Engine (Transit)	0.83	40,023	7.70	0.11	1.77	0.24	0.23	0.01	0.00	0.01	0.0005	496.96	0.00	0.02	0.08	7.09	504.14
		Main Engine (Maneuvering)	0.10	57,077	10.99	0.15	2.52	0.34	0.33	0.01	0.00	0.02	0.0007	708.72	0.00	0.03	0.11	10.12	718.95
		Auxiliary Engine (Transit)	0.56	4,017	0.76	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.0000	42.59	0.00	0.00	0.01	0.61	43.21
		Auxiliary Engine (Maneuvering)	0.56	47,544	8.98	0.11	1.93	0.25	0.24	0.00	0.00	0.01	0.0002	504.16	0.00	0.02	0.08	7.19	511.43
	Bubble Curtain Support Vessel	Main Engine (Transit)	0.83	10,639	1.76	0.03	0.42	0.06	0.06	0.01	0.00	0.00	0.0003	118.86	0.00	0.01	0.02	1.71	120.58
		Main Engine (Maneuvering)	0.10	15,172	2.51	0.05	0.60	0.09	0.08	0.01	0.00	0.01	0.0004	169.50	0.00	0.01	0.03	2.43	171.96
		Auxiliary Engine (Transit)	0.43	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Maneuvering)	0.43	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
Transport Barge 1	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	75	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.84	0.00	0.00	0.00	0.01	0.85
		Auxiliary Engine (Maneuvering)	0.43	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.84	0.00	0.00	0.00	0.03	1.87
Transport Barge 2	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	75	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.84	0.00	0.00	0.00	0.01	0.85
		Auxiliary Engine (Maneuvering)	0.43	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.84	0.00	0.00	0.00	0.03	1.87
Transport Barge 3	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	75	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.84	0.00	0.00	0.00	0.01	0.85
		Auxiliary Engine (Maneuvering)	0.43	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.84	0.00	0.00	0.00	0.03	1.87
Transport Barge 4	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	75	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.84	0.00	0.00	0.00	0.01	0.85
		Auxiliary Engine (Maneuvering)	0.43	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.84	0.00	0.00	0.00	0.03	1.87
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	0.83	14,573	2.41	0.05	0.58	0.08	0.08	0.01	0.00	0.01	0.0004	162.81	0.00	0.01	0.03	2.34	165.17
		Main Engine (Maneuvering)	0.10	3,849	0.64	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.0001	43.00	0.00	0.00	0.01	0.62	43.62
		Auxiliary Engine (Transit)	0.43	353	0.06	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	3.97	0.00	0.00	0.00	0.06	4.03
		Auxiliary Engine (Maneuvering)	0.43	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	8.70	0.00	0.00	0.00	0.12	8.83
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	0.83	14,573	2.41	0.05	0.58	0.08	0.08	0.01	0.00	0.01	0.0004	162.81	0.00	0.01	0.03	2.34	165.17
		Main Engine (Maneuvering)	0.10	3,849	0.64	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.0001	43.00	0.00	0.00	0.01	0.62	43.62
		Auxiliary Engine (Transit)	0.43	353	0.06	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	3.97	0.00	0.00	0.00	0.06	4.03
		Auxiliary Engine (Maneuvering)	0.43	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	8.70	0.00	0.00	0.00	0.12	8.83
US Towing Tug 3	US Towing Tug	Main Engine (Transit)	0.83	14,573	2.41	0.05	0.58	0.08	0.08	0.01	0.00	0.01	0.0004	162.81	0.00	0.01	0.03	2.34	165.17
		Main Engine (Maneuvering)	0.10	3,849	0.64	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.0001	43.00	0.00	0.00	0.01	0.62	43.62
		Auxiliary Engine (Transit)	0.43	353	0.06	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	3.97	0.00	0.00	0.00	0.06	4.03
		Auxiliary Engine (Maneuvering)	0.43	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	8.70	0.00	0.00	0.00	0.12	8.83
US Towing Tug 4	US Towing Tug	Main Engine (Transit)	0.83	14,573	2.41	0.05	0.58	0.08	0.08	0.01	0.00	0.01	0.0004	162.81	0.00	0.01	0.03	2.34	165.17
		Main Engine (Maneuvering)	0.10	3,849	0.64	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.0001	43.00	0.00	0.00	0.01	0.62	43.62
		Auxiliary Engine (Transit)	0.43	353	0.06	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	3.97	0.00	0.00	0.00	0.06	4.03
		Auxiliary Engine (Maneuvering)	0.43	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	8.70	0.00	0.00	0.00	0.12	8.83
	Crew Transfer Vessel	Main Engine (Transit)	0.83	940	0.15	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.0000	10.57	0.00	0.00	0.00	0.15	10.72
		Main Engine (Maneuvering)	0.10	8,911	1.42	0.02	0.36	0.05	0.05	0.00	0.00	0.00	0.0000	100.25	0.00	0.00	0.02	1.43	101.69
		Auxiliary Engine (Transit)	0.43	13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.14	0.00	0.00	0.00	0.00	0.14
		Auxiliary Engine (Maneuvering)	0.43	991	0.18	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.0000	11.15	0.00	0.00	0.00	0.16	11.31
	Bubble Curtain Power	Air Compressor	1.00	51,300	3.17	0.40	2.77	0.16	0.16	0.01	0.00	0.01	0.0002	585.52	0.02	0.00	0.59	1.42	587.53
	Hydraulic Hammer Power	Hammer Engine	1.00	11,514	1.14	0.14	0.62	0.04	0.04	0.00	0.00	0.00	0.0001	131.41	0.01	0.00	0.13	0.32	131.86
Scour Protection																			
	Fall Pipe Vessel	Main Engine (Transit)	0.83	56,402	9.29	0.24	2.15	0.33	0.32	0.08	0.00	0.03	0.0038	621.66	0.00	0.03	0.10	9.04	630.80
		Main Engine (Maneuvering)	0.20	410,987	67.70	1.78	15.69	2.43	2.35	0.61	0.00	0.19	0.0279	4,529.89	0.03	0.22	0.71	65.90	4,596.50
		Auxiliary Engine (Transit)	0.56	5,246	0.90	0.01	0.23	0.03	0.03	0.00	0.00	0.00	0.0000	59.02	0.00	0.00	0.01	0.84	59.87
		Auxiliary Engine (Maneuvering)	0.56	158,633	27.23	0.39	6.83	0.88	0.85	0.02	0.00	0.05	0.0008	1,784.74	0.01	0.09	0.28	25.44	1,810.45
	US Dredger	Main Engine (Transit)	0.83	1,234	0.21	0.01	0.05	0.01	0.01	0.00	0.00	0.00	0.0001	13.50	0.00	0.00	0.00	0.20	13.70
		Main Engine (Maneuvering)	0.20	15,640	2.61	0.08	0.58	0.10	0.09	0.03	0.00	0.01	0.0014	171.19	0.00	0.01	0.03	2.51	173.72
		Auxiliary Engine (Transit)	0.56	619	0.11	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	6.97	0.00	0.00	0.00	0.10	7.07
		Auxiliary Engine (Maneuvering)	0.56	32,589	5.57	0.08	1.40	0.18	0.18	0.00	0.00	0.01	0.0002	366.65	0.00	0.02	0.06	5.23	371.93

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Inter Array Cable Installation																			
Cable Installation Vessel	Cable Installation Vessel	Main Engine (Transit)	0.83	19,187	3.16	0.08	0.73	0.11	0.11	0.03	0.00	0.01	0.0013	211.48	0.00	0.01	0.03	3.08	214.59
		Main Engine (Maneuvering)	0.20	332,887	54.83	1.44	12.71	1.96	1.91	0.49	0.00	0.16	0.0226	3,669.07	0.02	0.18	0.58	53.38	3,723.02
		Auxiliary Engine (Transit)	0.56	391	0.07	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	4.40	0.00	0.00	0.00	0.06	4.46
		Auxiliary Engine (Maneuvering)	0.56	28,167	4.84	0.07	1.21	0.16	0.15	0.00	0.00	0.01	0.0001	316.90	0.00	0.02	0.05	4.52	321.47
Cable Installation Support Activities	Support Vessel/SOV	Main Engine (Transit)	0.16	2,439	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.0002	26.88	0.00	0.00	0.00	0.39	27.27
		Main Engine (Maneuvering)	0.10	71,626	11.80	0.31	2.74	0.42	0.41	0.11	0.00	0.03	0.0049	789.45	0.00	0.04	0.12	11.48	801.06
		Auxiliary Engine (Transit)	0.16	406	0.07	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	4.57	0.00	0.00	0.00	0.07	4.64
		Auxiliary Engine (Maneuvering)	0.10	11,938	2.05	0.03	0.51	0.07	0.06	0.00	0.00	0.00	0.0001	134.31	0.00	0.01	0.02	1.91	136.24
Sand Wave Clearance	TSHD (Dredger)	Main Engine (Transit)	0.83	3,380	0.56	0.02	0.12	0.02	0.02	0.01	0.00	0.00	0.0003	37.00	0.00	0.00	0.01	0.54	37.55
		Main Engine (Maneuvering)	0.20	38,317	6.38	0.19	1.42	0.24	0.23	0.07	0.00	0.02	0.0034	419.40	0.00	0.02	0.07	6.14	425.61
		Auxiliary Engine (Transit)	0.56	1,697	0.29	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.0000	19.10	0.00	0.00	0.00	0.27	19.37
		Auxiliary Engine (Maneuvering)	0.56	79,842	13.65	0.19	3.44	0.44	0.43	0.01	0.00	0.02	0.0004	898.28	0.01	0.04	0.14	12.80	911.22
Pre Lay Grapnel Run AHTS 1	AHTS	Main Engine (Transit)	0.83	8,657	1.43	0.03	0.34	0.05	0.05	0.00	0.00	0.00	0.0002	96.72	0.00	0.00	0.02	1.39	98.12
		Main Engine (Maneuvering)	0.20	41,154	6.80	0.13	1.64	0.24	0.23	0.02	0.00	0.02	0.0011	459.76	0.00	0.02	0.07	6.60	466.43
		Auxiliary Engine (Transit)	0.43	409	0.07	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	4.60	0.00	0.00	0.00	0.07	4.66
		Auxiliary Engine (Maneuvering)	0.43	8,062	1.41	0.02	0.35	0.04	0.04	0.00	0.00	0.00	0.0000	90.70	0.00	0.00	0.01	1.29	92.00
Pre Lay Grapnel Run AHTS 2	AHTS	Main Engine (Transit)	0.83	8,657	1.43	0.03	0.34	0.05	0.05	0.00	0.00	0.00	0.0002	96.72	0.00	0.00	0.02	1.39	98.12
		Main Engine (Maneuvering)	0.20	41,154	6.80	0.13	1.64	0.24	0.23	0.02	0.00	0.02	0.0011	459.76	0.00	0.02	0.07	6.60	466.43
		Auxiliary Engine (Transit)	0.43	409	0.07	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	4.60	0.00	0.00	0.00	0.07	4.66
		Auxiliary Engine (Maneuvering)	0.43	8,062	1.41	0.02	0.35	0.04	0.04	0.00	0.00	0.00	0.0000	90.70	0.00	0.00	0.01	1.29	92.00
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	0.83	56,402	9.29	0.24	2.15	0.33	0.32	0.08	0.00	0.03	0.0038	621.66	0.00	0.03	0.10	9.04	630.80
		Main Engine (Maneuvering)	0.20	13,047	2.15	0.06	0.50	0.08	0.07	0.02	0.00	0.01	0.0009	143.81	0.00	0.01	0.02	2.09	145.92
		Auxiliary Engine (Transit)	0.56	5,246	0.90	0.01	0.23	0.03	0.03	0.00	0.00	0.00	0.0000	59.02	0.00	0.00	0.01	0.84	59.87
		Auxiliary Engine (Maneuvering)	0.56	5,036	0.86	0.01	0.22	0.03	0.03	0.00	0.00	0.00	0.0000	56.66	0.00	0.00	0.01	0.81	57.47
WTG Installation																			
WTG Installation Vessel	Jackup Vessel	Main Engine (Transit)	0.83	19,220	3.70	0.05	0.85	0.11	0.11	0.00	0.00	0.01	0.0002	238.65	0.00	0.01	0.04	3.41	242.09
		Main Engine (Maneuvering)	0.20	2,144,012	412.65	5.76	94.63	12.75	12.34	0.53	0.00	0.73	0.0246	26,622.07	0.16	1.28	4.11	380.07	27,006.25
		Auxiliary Engine (Transit)	0.43	1,321	0.26	0.00	0.06	0.01	0.01	0.00	0.00	0.00	0.0000	14.86	0.00	0.00	0.00	0.21	15.07
		Auxiliary Engine (Maneuvering)	0.43	611,366	122.56	1.49	26.32	3.40	3.29	0.06	0.00	0.19	0.0029	6,878.31	0.04	0.33	1.06	98.03	6,977.40
US Jack Up Feeder 1	Jack up	Main Engine (Transit)	0.83	295,823	56.94	0.79	13.06	1.76	1.70	0.07	0.00	0.10	0.0034	3,673.22	0.02	0.18	0.57	52.44	3,726.22
		Main Engine (Maneuvering)	0.20	224,722	43.25	0.60	9.92	1.34	1.29	0.06	0.00	0.08	0.0026	2,790.37	0.02	0.13	0.43	39.84	2,830.63
		Auxiliary Engine (Transit)	0.43	84,718	16.98	0.21	3.65	0.47	0.46	0.01	0.00	0.03	0.0004	953.14	0.01	0.05	0.15	13.58	966.87
		Auxiliary Engine (Maneuvering)	0.43	267,079	53.54	0.65	11.50	1.48	1.44	0.03	0.00	0.08	0.0013	3,004.83	0.02	0.14	0.46	42.82	3,048.12
US Jack Up Feeder 2	Jack up	Main Engine (Transit)	0.83	295,823	56.94	0.79	13.06	1.76	1.70	0.07	0.00	0.10	0.0034	3,673.22	0.02	0.18	0.57	52.44	3,726.22
		Main Engine (Maneuvering)	0.20	224,722	43.25	0.60	9.92	1.34	1.29	0.06	0.00	0.08	0.0026	2,790.37	0.02	0.13	0.43	39.84	2,830.63
		Auxiliary Engine (Transit)	0.43	84,718	16.98	0.21	3.65	0.47	0.46	0.01	0.00	0.03	0.0004	953.14	0.01	0.05	0.15	13.58	966.87
		Auxiliary Engine (Maneuvering)	0.43	267,079	53.54	0.65	11.50	1.48	1.44	0.03	0.00	0.08	0.0013	3,004.83	0.02	0.14	0.46	42.82	3,048.12
Crew Transfer	Crew Transfer Vessel	Main Engine (Transit)	0.83	11,947	1.90	0.03	0.48	0.06	0.06	0.00	0.00	0.00	0.0001	134.40	0.00	0.01	0.02	1.92	136.34
		Main Engine (Maneuvering)	0.20	224,047	35.58	0.54	8.94	1.21	1.17	0.02	0.00	0.07	0.0011	2,520.53	0.02	0.12	0.39	35.92	2,556.85
		Auxiliary Engine (Transit)	0.43	160	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.80	0.00	0.00	0.00	0.03	1.83
		Auxiliary Engine (Maneuvering)	0.43	12,458	2.25	0.03	0.54	0.07	0.07	0.00	0.00	0.00	0.0001	140.16	0.00	0.01	0.02	2.00	142.18
WTG Commissioning SOV	Service Operation Vessel	Main Engine (Transit)	0.16	890	0.15	0.00	0.03	0.01	0.01	0.00	0.00	0.00	0.0001	9.81	0.00	0.00	0.00	0.14	9.95
		Main Engine (Maneuvering)	0.10	268,215	44.18	1.16	10.24	1.58	1.54	0.40	0.00	0.13	0.0182	2,956.25	0.02	0.14	0.47	43.01	2,999.73
		Auxiliary Engine (Transit)	0.16	148	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.67	0.00	0.00	0.00	0.02	1.69
		Auxiliary Engine (Maneuvering)	0.10	44,702	7.67	0.11	1.92	0.25	0.24	0.00	0.00	0.01	0.0002	502.94	0.00	0.02	0.08	7.17	510.18

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Export Cable Installation																			
Cable Installation Vessel 1		Main Engine (Transit)	0.83	8,605	1.42	0.04	0.33	0.05	0.05	0.01	0.00	0.00	0.0006	94.85	0.00	0.00	0.01	1.38	96.24
		Main Engine (Maneuvering)	0.20	474,518	78.16	2.06	18.12	2.80	2.72	0.70	0.00	0.22	0.0322	5,230.11	0.03	0.26	0.82	76.09	5,307.02
		Auxiliary Engine (Transit)	0.56	1,817	0.31	0.00	0.08	0.01	0.01	0.00	0.00	0.00	0.0000	20.44	0.00	0.00	0.00	0.29	20.74
		Auxiliary Engine (Maneuvering)	0.56	415,853	71.39	1.01	17.90	2.31	2.24	0.04	0.00	0.13	0.0020	4,678.64	0.03	0.22	0.72	66.68	4,746.04
Cable Installation Vessel 2		Main Engine (Transit)	0.83	8,605	1.42	0.04	0.33	0.05	0.05	0.01	0.00	0.00	0.0006	94.85	0.00	0.00	0.01	1.38	96.24
		Main Engine (Maneuvering)	0.20	474,518	78.16	2.06	18.12	2.80	2.72	0.70	0.00	0.22	0.0322	5,230.11	0.03	0.26	0.82	76.09	5,307.02
		Auxiliary Engine (Transit)	0.56	1,817	0.31	0.00	0.08	0.01	0.01	0.00	0.00	0.00	0.0000	20.44	0.00	0.00	0.00	0.29	20.74
		Auxiliary Engine (Maneuvering)	0.56	415,853	71.39	1.01	17.90	2.31	2.24	0.04	0.00	0.13	0.0020	4,678.64	0.03	0.22	0.72	66.68	4,746.04
Support and Jointing Vessel		Main Engine (Transit)	0.83	6,239	1.03	0.03	0.24	0.04	0.04	0.01	0.00	0.00	0.0004	68.77	0.00	0.00	0.01	1.00	69.78
		Main Engine (Maneuvering)	0.20	69,202	11.40	0.30	2.64	0.41	0.40	0.10	0.00	0.03	0.0047	762.74	0.00	0.04	0.12	11.10	773.96
		Auxiliary Engine (Transit)	0.56	1,290	0.22	0.00	0.06	0.01	0.01	0.00	0.00	0.00	0.0000	14.52	0.00	0.00	0.00	0.21	14.73
		Auxiliary Engine (Maneuvering)	0.56	59,390	10.19	0.14	2.56	0.33	0.32	0.01	0.00	0.02	0.0003	668.19	0.00	0.03	0.10	9.52	677.81
TSHD	Dredger	Main Engine (Transit)	0.83	1,234	0.21	0.01	0.05	0.01	0.01	0.00	0.00	0.00	0.0001	13.50	0.00	0.00	0.00	0.20	13.70
		Main Engine (Maneuvering)	0.20	49,656	8.27	0.24	1.84	0.31	0.29	0.10	0.00	0.03	0.0044	543.51	0.00	0.03	0.09	7.96	551.56
		Auxiliary Engine (Transit)	0.56	619	0.11	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	6.97	0.00	0.00	0.00	0.10	7.07
		Auxiliary Engine (Maneuvering)	0.56	103,469	17.69	0.25	4.45	0.57	0.56	0.01	0.00	0.03	0.0005	1,164.10	0.01	0.06	0.18	16.59	1,180.87
AHTS	Tug	Main Engine (Transit)	0.83	8,657	1.43	0.03	0.34	0.05	0.05	0.00	0.00	0.00	0.0002	96.72	0.00	0.00	0.02	1.39	98.12
		Main Engine (Maneuvering)	0.20	142,666	23.57	0.45	5.67	0.82	0.79	0.08	0.00	0.05	0.0038	1,593.85	0.01	0.08	0.25	22.88	1,616.97
		Auxiliary Engine (Transit)	0.43	409	0.07	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	4.60	0.00	0.00	0.00	0.07	4.66
		Auxiliary Engine (Maneuvering)	0.43	27,947	4.90	0.07	1.20	0.16	0.15	0.00	0.00	0.01	0.0001	314.42	0.00	0.02	0.05	4.48	318.95
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	0.83	56,402	9.29	0.24	2.15	0.33	0.32	0.08	0.00	0.03	0.0038	621.66	0.00	0.03	0.10	9.04	630.80
		Main Engine (Maneuvering)	0.20	19,571	3.22	0.08	0.75	0.12	0.11	0.03	0.00	0.01	0.0013	215.71	0.00	0.01	0.03	3.14	218.88
		Auxiliary Engine (Transit)	0.56	5,246	0.90	0.01	0.23	0.03	0.03	0.00	0.00	0.00	0.0000	59.02	0.00	0.00	0.01	0.84	59.87
		Auxiliary Engine (Maneuvering)	0.56	7,554	1.30	0.02	0.33	0.04	0.04	0.00	0.00	0.00	0.0000	84.99	0.00	0.00	0.01	1.21	86.21
Fuel Bunkering																			
Towing Tug	Tug	Main Engine (Transit)	0.83	82,579	13.65	0.26	3.28	0.47	0.46	0.05	0.00	0.03	0.0022	922.56	0.01	0.04	0.14	13.24	935.95
		Main Engine (Maneuvering)	0.20	175,493	29.00	0.55	6.98	1.01	0.97	0.10	0.00	0.06	0.0046	1,960.60	0.01	0.09	0.30	28.14	1,989.04
		Auxiliary Engine (Transit)	0.43	1,999	0.35	0.00	0.09	0.01	0.01	0.00	0.00	0.00	0.0000	22.49	0.00	0.00	0.00	0.32	22.82
		Auxiliary Engine (Maneuvering)	0.43	17,633	3.09	0.04	0.76	0.10	0.09	0.00	0.00	0.01	0.0001	198.39	0.00	0.01	0.03	2.83	201.24
Barge	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.20	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	424	0.09	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	4.77	0.00	0.00	0.00	0.07	4.83
		Auxiliary Engine (Maneuvering)	0.43	3,736	0.82	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.0000	42.03	0.00	0.00	0.01	0.60	42.64
Motion Compensation	Motion Compensation	Motion Compensation Engine	1.00	97,714	6.03	0.75	5.28	0.30	0.30	0.01	0.00	0.01	0.0005	1,115.28	0.05	0.01	1.13	2.70	1,119.11
Commissioning Generators																			
OSS Commissioning Generators	Generator	Marine Tier 3 Generator	0.50	24,000	2.15	0.26	1.85	0.04	0.04	0.00	0.00	0.01	0.00	273.93	0.01	0.00	0.28	0.66	274.87
WTG Commissioning Generators	Generator	Marine Tier 3 Generator	0.50	36,206	3.02	0.36	2.79	0.07	0.07	0.00	0.00	0.01	0.00	413.24	0.02	0.00	0.42	1.00	414.66
Miscellaneous																			
Marine Paint	N/A	N/A	N/A	N/A	N/A	0.75	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fuel Evaporation	N/A	N/A	N/A	N/A	N/A	0.13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Construction																				
Offshore Substation Installation (OSS)																				
	Large HLV	Main Engine (Transit)	25	27%	10,966	2.11	0.03	0.48	0.07	0.06	0.00	0.00	0.00	0.00	136.17	0.00	0.01	0.02	1.94	138.13
		Main Engine (Maneuvering)	25	100%	57,077	10.99	0.15	2.52	0.34	0.33	0.01	0.00	0.02	0.00	708.72	0.00	0.03	0.11	10.12	718.95
		Auxiliary Engine (Transit)	25	27%	1,101	0.21	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	11.67	0.00	0.00	0.00	0.17	11.84
		Auxiliary Engine (Maneuvering)	25	100%	47,544	8.98	0.11	1.93	0.25	0.24	0.00	0.00	0.01	0.00	504.16	0.00	0.02	0.08	7.19	511.43
	Bubble Curtain Support Vessel	Main Engine (Transit)	25	27%	2,915	0.48	0.01	0.12	0.02	0.02	0.00	0.00	0.00	0.00	32.57	0.00	0.00	0.01	0.47	33.04
		Main Engine (Maneuvering)	25	100%	15,172	2.51	0.05	0.60	0.09	0.08	0.01	0.00	0.01	0.00	169.50	0.00	0.01	0.03	2.43	171.96
		Auxiliary Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transport Barge 1	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.23
		Auxiliary Engine (Maneuvering)	25	100%	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.84	0.00	0.00	0.00	0.03	1.87
Transport Barge 2	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.23
		Auxiliary Engine (Maneuvering)	25	100%	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.84	0.00	0.00	0.00	0.03	1.87
Transport Barge 3	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.23
		Auxiliary Engine (Maneuvering)	25	100%	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.84	0.00	0.00	0.00	0.03	1.87
Transport Barge 4	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.23
		Auxiliary Engine (Maneuvering)	25	100%	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.84	0.00	0.00	0.00	0.03	1.87
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	25	27%	3,993	0.66	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	44.61	0.00	0.00	0.01	0.64	45.25
		Main Engine (Maneuvering)	25	100%	3,849	0.64	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.00	43.00	0.00	0.00	0.01	0.62	43.62
		Auxiliary Engine (Transit)	25	27%	97	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.09	0.00	0.00	0.00	0.02	1.10
		Auxiliary Engine (Maneuvering)	25	100%	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	8.70	0.00	0.00	0.00	0.12	8.83
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	25	27%	3,993	0.66	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	44.61	0.00	0.00	0.01	0.64	45.25
		Main Engine (Maneuvering)	25	100%	3,849	0.64	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.00	43.00	0.00	0.00	0.01	0.62	43.62
		Auxiliary Engine (Transit)	25	27%	97	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.09	0.00	0.00	0.00	0.02	1.10
		Auxiliary Engine (Maneuvering)	25	100%	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	8.70	0.00	0.00	0.00	0.12	8.83
US Towing Tug 3	US Towing Tug	Main Engine (Transit)	25	27%	3,993	0.66	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	44.61	0.00	0.00	0.01	0.64	45.25
		Main Engine (Maneuvering)	25	100%	3,849	0.64	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.00	43.00	0.00	0.00	0.01	0.62	43.62
		Auxiliary Engine (Transit)	25	27%	97	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.09	0.00	0.00	0.00	0.02	1.10
		Auxiliary Engine (Maneuvering)	25	100%	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	8.70	0.00	0.00	0.00	0.12	8.83
US Towing Tug 4	US Towing Tug	Main Engine (Transit)	25	27%	3,993	0.66	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	44.61	0.00	0.00	0.01	0.64	45.25
		Main Engine (Maneuvering)	25	100%	3,849	0.64	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.00	43.00	0.00	0.00	0.01	0.62	43.62
		Auxiliary Engine (Transit)	25	27%	97	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.09	0.00	0.00	0.00	0.02	1.10
		Auxiliary Engine (Maneuvering)	25	100%	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	8.70	0.00	0.00	0.00	0.12	8.83
	Crew Transfer Vessel	Main Engine (Transit)	17	100%	940	0.15	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.00	10.57	0.00	0.00	0.00	0.15	10.72
		Main Engine (Maneuvering)	17	100%	8,911	1.42	0.02	0.36	0.05	0.05	0.00	0.00	0.00	0.00	100.25	0.00	0.00	0.02	1.43	101.69
		Auxiliary Engine (Transit)	17	100%	13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.14
		Auxiliary Engine (Maneuvering)	17	100%	991	0.18	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	11.15	0.00	0.00	0.00	0.16	11.31
	Bubble Curtain Power	Air Compressor	N/A	100%	51,300	3.17	0.40	2.77	0.16	0.16	0.01	0.00	0.01	0.00	585.52	0.02	0.00	0.59	1.42	587.53
	Hydraulic Hammer Power	Hammer Engine	N/A	100%	11,514	1.14	0.14	0.62	0.04	0.04	0.00	0.00	0.00	0.00	131.41	0.01	0.00	0.13	0.32	131.86
Scour Protection																				
	Fall Pipe Vessel	Main Engine (Transit)	25	10%	5,640	0.93	0.02	0.22	0.03	0.03	0.01	0.00	0.00	0.00	62.17	0.00	0.00	0.01	0.90	63.08
		Main Engine (Maneuvering)	25	100%	410,987	67.70	1.78	15.69	2.43	2.35	0.61	0.00	0.19	0.03	4,529.89	0.03	0.22	0.71	65.90	4,596.50
		Auxiliary Engine (Transit)	25	10%	525	0.09	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	5.90	0.00	0.00	0.00	0.08	5.99
		Auxiliary Engine (Maneuvering)	25	100%	158,633	27.23	0.39	6.83	0.88	0.85	0.02	0.00	0.05	0.00	1,784.74	0.01	0.09	0.28	25.44	1,810.45
	US Dredger	Main Engine (Transit)	25	27%	338	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	0.00	0.05	3.75
		Main Engine (Maneuvering)	25	100%	15,640	2.61	0.08	0.58	0.10	0.09	0.03	0.00	0.01	0.00	171.19	0.00	0.01	0.03	2.51	173.72
		Auxiliary Engine (Transit)	25	27%	170	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.91	0.00	0.00	0.00	0.03	1.94
		Auxiliary Engine (Maneuvering)	25	100%	32,589	5.57	0.08	1.40	0.18	0.18	0.00	0.00	0.01	0.00	366.65	0.00	0.02	0.06	5.23	371.93

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Inter Array Cable Installation																				
Cable Installation Vessel	Cable Installation Vessel	Main Engine (Transit)	25	10%	1,919	0.32	0.01	0.07	0.01	0.01	0.00	0.00	0.00	0.00	21.15	0.00	0.00	0.00	0.31	21.46
		Main Engine (Maneuvering)	25	100%	332,887	54.83	1.44	12.71	1.96	1.91	0.49	0.00	0.16	0.02	3,669.07	0.02	0.18	0.58	53.38	3,723.02
		Auxiliary Engine (Transit)	25	10%	39	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.01	0.45
		Auxiliary Engine (Maneuvering)	25	100%	28,167	4.84	0.07	1.21	0.16	0.15	0.00	0.00	0.01	0.00	316.90	0.00	0.02	0.05	4.52	321.47
Cable Installation Support Activities	Support Vessel/SOV	Main Engine (Transit)	25	10%	244	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	2.69	0.00	0.00	0.00	0.04	2.73
		Main Engine (Maneuvering)	25	100%	71,626	11.80	0.31	2.74	0.42	0.41	0.11	0.00	0.03	0.00	789.45	0.00	0.04	0.12	11.48	801.06
		Auxiliary Engine (Transit)	25	10%	41	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.01	0.46
		Auxiliary Engine (Maneuvering)	25	100%	11,938	2.05	0.03	0.51	0.07	0.06	0.00	0.00	0.00	0.00	134.31	0.00	0.01	0.02	1.91	136.24
Sand Wave Clearance	TSHD (Dredger)	Main Engine (Transit)	25	10%	338	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	0.00	0.05	3.75
		Main Engine (Maneuvering)	25	100%	38,317	6.38	0.19	1.42	0.24	0.23	0.07	0.00	0.02	0.00	419.40	0.00	0.02	0.07	6.14	425.61
		Auxiliary Engine (Transit)	25	10%	170	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.91	0.00	0.00	0.00	0.03	1.94
		Auxiliary Engine (Maneuvering)	25	100%	79,842	13.65	0.19	3.44	0.44	0.43	0.01	0.00	0.02	0.00	898.28	0.01	0.04	0.14	12.80	911.22
Pre Lay Grapnel Run AHTS 1	AHTS	Main Engine (Transit)	25	27%	2,372	0.39	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	26.50	0.00	0.00	0.00	0.38	26.88
		Main Engine (Maneuvering)	25	100%	41,154	6.80	0.13	1.64	0.24	0.23	0.02	0.00	0.02	0.00	459.76	0.00	0.02	0.07	6.60	466.43
		Auxiliary Engine (Transit)	25	27%	112	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.26	0.00	0.00	0.00	0.02	1.28
		Auxiliary Engine (Maneuvering)	25	100%	8,062	1.41	0.02	0.35	0.04	0.04	0.00	0.00	0.00	0.00	90.70	0.00	0.00	0.01	1.29	92.00
Pre Lay Grapnel Run AHTS 2	AHTS	Main Engine (Transit)	25	27%	2,372	0.39	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	26.50	0.00	0.00	0.00	0.38	26.88
		Main Engine (Maneuvering)	25	100%	41,154	6.80	0.13	1.64	0.24	0.23	0.02	0.00	0.02	0.00	459.76	0.00	0.02	0.07	6.60	466.43
		Auxiliary Engine (Transit)	25	27%	112	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.26	0.00	0.00	0.00	0.02	1.28
		Auxiliary Engine (Maneuvering)	25	100%	8,062	1.41	0.02	0.35	0.04	0.04	0.00	0.00	0.00	0.00	90.70	0.00	0.00	0.01	1.29	92.00
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	25	10%	5,640	0.93	0.02	0.22	0.03	0.03	0.01	0.00	0.00	0.00	62.17	0.00	0.00	0.01	0.90	63.08
		Main Engine (Maneuvering)	25	100%	13,047	2.15	0.06	0.50	0.08	0.07	0.02	0.00	0.01	0.00	143.81	0.00	0.01	0.02	2.09	145.92
		Auxiliary Engine (Transit)	25	10%	525	0.09	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	5.90	0.00	0.00	0.00	0.08	5.99
		Auxiliary Engine (Maneuvering)	25	100%	5,036	0.86	0.01	0.22	0.03	0.03	0.00	0.00	0.00	0.00	56.66	0.00	0.00	0.01	0.81	57.47
WTG Installation																				
WTG Installation Vessel	Jackup Vessel	Main Engine (Transit)	25	27%	5,266	1.01	0.01	0.23	0.03	0.03	0.00	0.00	0.00	0.00	65.39	0.00	0.00	0.01	0.93	66.33
		Main Engine (Maneuvering)	25	100%	2,144,012	412.65	5.76	94.63	12.75	12.34	0.53	0.00	0.73	0.02	26,622.07	0.16	1.28	4.11	380.07	27,006.25
		Auxiliary Engine (Transit)	25	27%	362	0.07	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	4.07	0.00	0.00	0.00	0.06	4.13
		Auxiliary Engine (Maneuvering)	25	100%	611,366	122.56	1.49	26.32	3.40	3.29	0.06	0.00	0.19	0.00	6,878.31	0.04	0.33	1.06	98.03	6,977.40
US Jack Up Feeder 1	Jack up	Main Engine (Transit)	25	27%	81,054	15.60	0.22	3.58	0.48	0.47	0.02	0.00	0.03	0.00	1,006.44	0.01	0.05	0.16	14.37	1,020.97
		Main Engine (Maneuvering)	25	100%	224,722	43.25	0.60	9.92	1.34	1.29	0.06	0.00	0.08	0.00	2,790.37	0.02	0.13	0.43	39.84	2,830.63
		Auxiliary Engine (Transit)	25	27%	23,212	4.65	0.06	1.00	0.13	0.12	0.00	0.00	0.01	0.00	261.16	0.00	0.01	0.04	3.72	264.92
		Auxiliary Engine (Maneuvering)	25	100%	267,079	53.54	0.65	11.50	1.48	1.44	0.03	0.00	0.08	0.00	3,004.83	0.02	0.14	0.46	42.82	3,048.12
US Jack Up Feeder 2	Jack up	Main Engine (Transit)	25	27%	81,054	15.60	0.22	3.58	0.48	0.47	0.02	0.00	0.03	0.00	1,006.44	0.01	0.05	0.16	14.37	1,020.97
		Main Engine (Maneuvering)	25	100%	224,722	43.25	0.60	9.92	1.34	1.29	0.06	0.00	0.08	0.00	2,790.37	0.02	0.13	0.43	39.84	2,830.63
		Auxiliary Engine (Transit)	25	27%	23,212	4.65	0.06	1.00	0.13	0.12	0.00	0.00	0.01	0.00	261.16	0.00	0.01	0.04	3.72	264.92
		Auxiliary Engine (Maneuvering)	25	100%	267,079	53.54	0.65	11.50	1.48	1.44	0.03	0.00	0.08	0.00	3,004.83	0.02	0.14	0.46	42.82	3,048.12
Crew Transfer	Crew Transfer Vessel	Main Engine (Transit)	17	100%	11,947	1.90	0.03	0.48	0.06	0.06	0.00	0.00	0.00	0.00	134.40	0.00	0.01	0.02	1.92	136.34
		Main Engine (Maneuvering)	17	100%	224,047	35.58	0.54	8.94	1.21	1.17	0.02	0.00	0.07	0.00	2,520.53	0.02	0.12	0.39	35.92	2,556.85
		Auxiliary Engine (Transit)	17	100%	160	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.80	0.00	0.00	0.00	0.03	1.83
		Auxiliary Engine (Maneuvering)	17	100%	12,458	2.25	0.03	0.54	0.07	0.07	0.00	0.00	0.00	0.00	140.16	0.00	0.01	0.02	2.00	142.18
WTG Commissioning SOV	Service Operation Vessel	Main Engine (Transit)	25	27%	244	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	2.69	0.00	0.00	0.00	0.04	2.73
		Main Engine (Maneuvering)	25	100%	268,215	44.18	1.16	10.24	1.58	1.54	0.40	0.00	0.13	0.02	2,956.25	0.02	0.14	0.47	43.01	2,999.73
		Auxiliary Engine (Transit)	25	27%	41	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.01	0.46
		Auxiliary Engine (Maneuvering)	25	100%	44,702	7.67	0.11	1.92	0.25	0.24	0.00	0.00	0.01	0.00	502.94	0.00	0.02	0.08	7.17	510.18

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Export Cable Installation																				
Cable Installation Vessel 1		Main Engine (Transit)	25	27%	2,358	0.39	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	25.99	0.00	0.00	0.00	0.38	26.37
		Main Engine (Maneuvering)	25	51%	242,448	39.94	1.05	9.26	1.43	1.39	0.36	0.00	0.11	0.02	2,672.25	0.02	0.13	0.42	38.87	2,711.54
		Auxiliary Engine (Transit)	25	27%	498	0.09	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	5.60	0.00	0.00	0.00	0.08	5.68
		Auxiliary Engine (Maneuvering)	25	51%	212,474	36.47	0.52	9.15	1.18	1.14	0.02	0.00	0.07	0.00	2,390.48	0.01	0.11	0.37	34.07	2,424.92
Cable Installation Vessel 2		Main Engine (Transit)	25	27%	2,358	0.39	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	25.99	0.00	0.00	0.00	0.38	26.37
		Main Engine (Maneuvering)	25	51%	242,448	39.94	1.05	9.26	1.43	1.39	0.36	0.00	0.11	0.02	2,672.25	0.02	0.13	0.42	38.87	2,711.54
		Auxiliary Engine (Transit)	25	27%	498	0.09	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	5.60	0.00	0.00	0.00	0.08	5.68
		Auxiliary Engine (Maneuvering)	25	51%	212,474	36.47	0.52	9.15	1.18	1.14	0.02	0.00	0.07	0.00	2,390.48	0.01	0.11	0.37	34.07	2,424.92
Support and Jointing Vessel		Main Engine (Transit)	25	27%	1,709	0.28	0.01	0.07	0.01	0.01	0.00	0.00	0.00	0.00	18.84	0.00	0.00	0.00	0.27	19.12
		Main Engine (Maneuvering)	25	51%	35,358	5.82	0.15	1.35	0.21	0.20	0.05	0.00	0.02	0.00	389.71	0.00	0.02	0.06	5.67	395.44
		Auxiliary Engine (Transit)	25	27%	354	0.06	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	3.98	0.00	0.00	0.00	0.06	4.03
		Auxiliary Engine (Maneuvering)	25	51%	30,345	5.21	0.07	1.31	0.17	0.16	0.00	0.00	0.01	0.00	341.40	0.00	0.02	0.05	4.87	346.32
TSHD	Dredger	Main Engine (Transit)	25	27%	338	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	0.00	0.05	3.75
		Main Engine (Maneuvering)	25	51%	25,371	4.23	0.12	0.94	0.16	0.15	0.05	0.00	0.01	0.00	277.70	0.00	0.01	0.04	4.07	281.81
		Auxiliary Engine (Transit)	25	27%	170	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.91	0.00	0.00	0.00	0.03	1.94
		Auxiliary Engine (Maneuvering)	25	51%	52,866	9.04	0.13	2.28	0.29	0.28	0.01	0.00	0.02	0.00	594.78	0.00	0.03	0.09	8.48	603.35
AHTS	Tug	Main Engine (Transit)	25	27%	2,372	0.39	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	26.50	0.00	0.00	0.00	0.38	26.88
		Main Engine (Maneuvering)	25	51%	72,893	12.04	0.23	2.90	0.42	0.40	0.04	0.00	0.03	0.00	814.35	0.01	0.04	0.13	11.69	826.17
		Auxiliary Engine (Transit)	25	27%	112	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.26	0.00	0.00	0.00	0.02	1.28
		Auxiliary Engine (Maneuvering)	25	51%	14,279	2.50	0.03	0.61	0.08	0.08	0.00	0.00	0.00	0.00	160.65	0.00	0.01	0.02	2.29	162.96
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	25	10%	5,640	0.93	0.02	0.22	0.03	0.03	0.01	0.00	0.00	0.00	62.17	0.00	0.00	0.01	0.90	63.08
		Main Engine (Maneuvering)	25	51%	9,999	1.65	0.04	0.38	0.06	0.06	0.01	0.00	0.00	0.00	110.21	0.00	0.01	0.02	1.60	111.83
		Auxiliary Engine (Transit)	25	10%	525	0.09	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	5.90	0.00	0.00	0.00	0.08	5.99
		Auxiliary Engine (Maneuvering)	25	51%	3,860	0.66	0.01	0.17	0.02	0.02	0.00	0.00	0.00	0.00	43.42	0.00	0.00	0.01	0.62	44.05
Fuel Bunkering																				
Towing Tug	Tug	Main Engine (Transit)	25	27%	22,626	3.74	0.07	0.90	0.13	0.13	0.01	0.00	0.01	0.00	252.78	0.00	0.01	0.04	3.63	256.44
		Main Engine (Maneuvering)	25	100%	175,493	29.00	0.55	6.98	1.01	0.97	0.10	0.00	0.06	0.00	1,960.60	0.01	0.09	0.30	28.14	1,989.04
		Auxiliary Engine (Transit)	25	27%	548	0.10	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	6.16	0.00	0.00	0.00	0.09	6.25
		Auxiliary Engine (Maneuvering)	25	100%	17,633	3.09	0.04	0.76	0.10	0.09	0.00	0.00	0.01	0.00	198.39	0.00	0.01	0.03	2.83	201.24
Barge	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	116	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.31	0.00	0.00	0.00	0.02	1.32
		Auxiliary Engine (Maneuvering)	25	100%	3,736	0.82	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	42.03	0.00	0.00	0.01	0.60	42.64
Motion Compensation	Motion Compensation	Motion Compensation Engine	N/A	100%	97,714	6.03	0.75	5.28	0.30	0.30	0.01	0.00	0.01	0.00	1,115.28	0.05	0.01	1.13	2.70	1,119.11
Commissioning Generators																				
OSS Commissioning Generators	Generator	Marine Tier 3 Generator	N/A	100%	24,000	2.15	0.26	1.85	0.04	0.04	0.00	0.00	0.01	0.00	273.93	0.01	0.00	0.28	0.66	274.87
WTG Commissioning Generators	Generator	Marine Tier 3 Generator	N/A	100%	36,206	3.02	0.36	2.79	0.07	0.07	0.00	0.00	0.01	0.00	413.24	0.02	0.00	0.42	1.00	414.66
Miscellaneous																				
Marine Paint	N/A	N/A	N/A	100%	N/A	N/A	0.75	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fuel Evaporation	N/A	N/A	N/A	100%	N/A	N/A	0.13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Trips	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit	Operating Days in WTA	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Emissions During Construction																	
Foundation Installation (FOU) B02																	
Medium HLV	Heavy Lift Vessel	Main Engine (Transit)	6	4 x 3840kW 2 x 4800kW	24,960	3 main	Europe	1	250	500	10	50	0	0	0	50	7M
		Main Engine (Maneuvering)	6	4 x 3840kW 2 x 4800kW	24,960	3 main		0	250	0	10	0	200	24	4,800	4,800	7M
		Auxiliary Engine (Transit)	1	1,110	1,110	3 Auxiliary		1	250	500	10	50	0	0	0	50	7A
		Auxiliary Engine (Maneuvering)	1	1,110	1,110	3 Auxiliary		0	250	0	10	0	200	24	4,800	4,800	7A
Bubble Curtain Support Vessel	Tug	Main Engine (Transit)	2	5,530	11,060	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	11M
		Main Engine (Maneuvering)	2	5,530	11,060	1 & 2 main		0	91	0	10	0	200	24	4,800	4,800	11M
		Auxiliary Engine (Transit)	0	5,530	0	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	11A
		Auxiliary Engine (Maneuvering)	0	5,530	0	1 & 2 auxiliary		0	91	0	10	0	200	24	4,800	4,800	11A
Barge 1	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	34	91	6,204	7	886	0	0	0	886	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	7	0	200	24	4,800	4,800	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		34	91	6,204	7	886	0	0	0	886	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	7	0	200	24	4,800	4,800	2A
Barge 2	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	34	91	6,204	7	886	0	0	0	886	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	7	0	200	24	4,800	4,800	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		34	91	6,204	7	886	0	0	0	886	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	7	0	200	24	4,800	4,800	2A
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	34	91	6,204	7	886	0	0	0	886	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	7	0	200	24	4,800	4,800	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		34	91	6,204	7	886	0	0	0	886	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	7	0	200	24	4,800	4,800	11A
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	34	91	6,204	7	886	0	0	0	886	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	7	0	200	24	4,800	4,800	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		34	91	6,204	7	886	0	0	0	886	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	7	0	200	24	4,800	4,800	11A
Crew Transfer / PSO / Noise Monitoring Vessel	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	115	17	3,997	29	140	0	0	0	140	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	29	0	200	24	4,800	4,800	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		115	17	3,997	29	140	0	0	0	140	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	29	0	200	24	4,800	4,800	4A
Bubble Curtain Power	Air Compressor	Air Compressor	20	399	7,980	Tier 3 Non-Road	N/A	0	0	0	0	0	200	8	1,600	1,600	16
Hydraulic Hammer Power	Hydraulic Hammer Engine	Hammer Engine	3	597	1,791	Tier 2 Non-Road	N/A	0	0	0	0	0	200	8	1,600	1,600	18

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Construction																			
Foundation Installation (FOU) B02																			
Medium HLV	Heavy Lift Vessel	Main Engine (Transit)	0.83	59,503	11.45	0.16	2.63	0.35	0.34	0.01	0.00	0.02	0.0007	738.85	0.00	0.04	0.11	10.55	749.51
		Main Engine (Maneuvering)	0.10	688,230	132.46	1.85	30.38	4.09	3.96	0.17	0.00	0.23	0.0079	8,545.71	0.05	0.41	1.32	122.00	8,669.03
		Auxiliary Engine (Transit)	0.56	2,094	0.40	0.00	0.08	0.01	0.01	0.00	0.00	0.00	0.0000	22.21	0.00	0.00	0.00	0.32	22.53
		Auxiliary Engine (Maneuvering)	0.56	201,043	37.99	0.46	8.16	1.05	1.02	0.02	0.00	0.06	0.0009	2,131.89	0.01	0.10	0.33	30.38	2,162.61
Bubble Curtain Support Vessel	Tug	Main Engine (Transit)	0.83	10,639	1.76	0.03	0.42	0.06	0.06	0.01	0.00	0.00	0.0003	118.86	0.00	0.01	0.02	1.71	120.58
		Main Engine (Maneuvering)	0.10	337,155	55.71	1.05	13.40	1.93	1.87	0.19	0.00	0.12	0.0089	3,766.67	0.02	0.18	0.59	54.06	3,821.31
		Auxiliary Engine (Transit)	0.43	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Maneuvering)	0.43	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
Barge 1	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	1,210	0.26	0.00	0.05	0.01	0.01	0.00	0.00	0.00	0.0000	13.62	0.00	0.00	0.00	0.19	13.81
		Auxiliary Engine (Maneuvering)	0.43	6,554	1.43	0.02	0.28	0.04	0.04	0.00	0.00	0.00	0.0000	73.74	0.00	0.00	0.01	1.05	74.80
Barge 2	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	1,210	0.26	0.00	0.05	0.01	0.01	0.00	0.00	0.00	0.0000	13.62	0.00	0.00	0.00	0.19	13.81
		Auxiliary Engine (Maneuvering)	0.43	6,554	1.43	0.02	0.28	0.04	0.04	0.00	0.00	0.00	0.0000	73.74	0.00	0.00	0.01	1.05	74.80
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	0.83	235,939	38.99	0.74	9.38	1.35	1.31	0.14	0.00	0.09	0.0062	2,635.89	0.02	0.13	0.41	37.83	2,674.13
		Main Engine (Maneuvering)	0.10	153,941	25.44	0.48	6.12	0.88	0.86	0.09	0.00	0.06	0.0041	1,719.82	0.01	0.08	0.27	24.68	1,744.77
		Auxiliary Engine (Transit)	0.43	5,712	1.00	0.01	0.25	0.03	0.03	0.00	0.00	0.00	0.0000	64.27	0.00	0.00	0.01	0.92	65.19
		Auxiliary Engine (Maneuvering)	0.43	30,935	5.42	0.08	1.33	0.17	0.17	0.00	0.00	0.01	0.0001	348.04	0.00	0.02	0.05	4.96	353.06
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	0.83	235,939	38.99	0.74	9.38	1.35	1.31	0.14	0.00	0.09	0.0062	2,635.89	0.02	0.13	0.41	37.83	2,674.13
		Main Engine (Maneuvering)	0.10	153,941	25.44	0.48	6.12	0.88	0.86	0.09	0.00	0.06	0.0041	1,719.82	0.01	0.08	0.27	24.68	1,744.77
		Auxiliary Engine (Transit)	0.43	5,712	1.00	0.01	0.25	0.03	0.03	0.00	0.00	0.00	0.0000	64.27	0.00	0.00	0.01	0.92	65.19
		Auxiliary Engine (Maneuvering)	0.43	30,935	5.42	0.08	1.33	0.17	0.17	0.00	0.00	0.01	0.0001	348.04	0.00	0.02	0.05	4.96	353.06
Crew Transfer / PSO / Noise Monitoring Vessel	Crew Transfer Vessel	Main Engine (Transit)	0.83	15,437	2.45	0.04	0.62	0.08	0.08	0.00	0.00	0.00	0.0001	173.66	0.00	0.01	0.03	2.48	176.17
		Main Engine (Maneuvering)	0.10	63,650	10.11	0.15	2.54	0.34	0.33	0.01	0.00	0.02	0.0003	716.06	0.00	0.03	0.11	10.21	726.38
		Auxiliary Engine (Transit)	0.43	207	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	2.33	0.00	0.00	0.00	0.03	2.36
		Auxiliary Engine (Maneuvering)	0.43	7,078	1.28	0.02	0.30	0.04	0.04	0.00	0.00	0.00	0.0000	79.64	0.00	0.00	0.01	1.13	80.78
Bubble Curtain Power	Air Compressor	Air Compressor	1.00	912,000	56.30	7.04	49.26	2.81	2.81	0.10	0.00	0.25	0.0044	10,409.31	0.42	0.08	10.56	25.16	10,445.03
Hydraulic Hammer Power	Hydraulic Hammer Engine	Hammer Engine	1.00	204,686	20.22	2.50	11.06	0.63	0.63	0.02	0.00	0.02	0.0010	2,336.22	0.09	0.02	2.37	5.65	2,344.24

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Construction																				
Foundation Installation (FOU) B02																				
Medium HLV	Heavy Lift Vessel	Main Engine (Transit)	25	10%	5,950	1.15	0.02	0.26	0.04	0.03	0.00	0.00	0.00	0.0001	73.88	0.00	0.00	0.01	1.05	74.95
		Main Engine (Maneuvering)	25	100%	688,230	132.46	1.85	30.38	4.09	3.96	0.17	0.00	0.23	0.0079	8,545.71	0.05	0.41	1.32	122.00	8,669.03
		Auxiliary Engine (Transit)	25	10%	209	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	2.22	0.00	0.00	0.00	0.03	2.25
		Auxiliary Engine (Maneuvering)	25	100%	201,043	37.99	0.46	8.16	1.05	1.02	0.02	0.00	0.06	0.0009	2,131.89	0.01	0.10	0.33	30.38	2,162.61
Bubble Curtain Support Vessel	Tug	Main Engine (Transit)	25	27%	2,915	0.48	0.01	0.12	0.02	0.02	0.00	0.00	0.00	0.0001	32.57	0.00	0.00	0.01	0.47	33.04
		Main Engine (Maneuvering)	25	100%	337,155	55.71	1.05	13.40	1.93	1.87	0.19	0.00	0.12	0.0089	3,766.67	0.02	0.18	0.59	54.06	3,821.31
		Auxiliary Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
Barge 1	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	332	0.07	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	3.73	0.00	0.00	0.00	0.05	3.78
		Auxiliary Engine (Maneuvering)	25	100%	6,554	1.43	0.02	0.28	0.04	0.04	0.00	0.00	0.00	0.0000	73.74	0.00	0.00	0.01	1.05	74.80
Barge 2	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	332	0.07	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	3.73	0.00	0.00	0.00	0.05	3.78
		Auxiliary Engine (Maneuvering)	25	100%	6,554	1.43	0.02	0.28	0.04	0.04	0.00	0.00	0.00	0.0000	73.74	0.00	0.00	0.01	1.05	74.80
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	25	27%	64,646	10.68	0.20	2.57	0.37	0.36	0.04	0.00	0.02	0.0017	722.22	0.00	0.03	0.11	10.37	732.70
		Main Engine (Maneuvering)	25	100%	153,941	25.44	0.48	6.12	0.88	0.86	0.09	0.00	0.06	0.0041	1,719.82	0.01	0.08	0.27	24.68	1,744.77
		Auxiliary Engine (Transit)	25	27%	1,565	0.27	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.0000	17.61	0.00	0.00	0.00	0.25	17.86
		Auxiliary Engine (Maneuvering)	25	100%	30,935	5.42	0.08	1.33	0.17	0.17	0.00	0.00	0.01	0.0001	348.04	0.00	0.02	0.05	4.96	353.06
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	25	27%	64,646	10.68	0.20	2.57	0.37	0.36	0.04	0.00	0.02	0.0017	722.22	0.00	0.03	0.11	10.37	732.70
		Main Engine (Maneuvering)	25	100%	153,941	25.44	0.48	6.12	0.88	0.86	0.09	0.00	0.06	0.0041	1,719.82	0.01	0.08	0.27	24.68	1,744.77
		Auxiliary Engine (Transit)	25	27%	1,565	0.27	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.0000	17.61	0.00	0.00	0.00	0.25	17.86
		Auxiliary Engine (Maneuvering)	25	100%	30,935	5.42	0.08	1.33	0.17	0.17	0.00	0.00	0.01	0.0001	348.04	0.00	0.02	0.05	4.96	353.06
Crew Transfer / PSO / Noise Monitoring Vessel	Crew Transfer Vessel	Main Engine (Transit)	17	100%	15,437	2.45	0.04	0.62	0.08	0.08	0.00	0.00	0.00	0.0001	173.66	0.00	0.01	0.03	2.48	176.17
		Main Engine (Maneuvering)	17	100%	63,650	10.11	0.15	2.54	0.34	0.33	0.01	0.00	0.02	0.0003	716.06	0.00	0.03	0.11	10.21	726.38
		Auxiliary Engine (Transit)	17	100%	207	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	2.33	0.00	0.00	0.00	0.03	2.36
		Auxiliary Engine (Maneuvering)	17	100%	7,078	1.28	0.02	0.30	0.04	0.04	0.00	0.00	0.00	0.0000	79.64	0.00	0.00	0.01	1.13	80.78
Bubble Curtain Power	Air Compressor	Air Compressor	N/A	100%	912,000	56.30	7.04	49.26	2.81	2.81	0.10	0.00	0.25	0.0044	10,409.31	0.42	0.08	10.56	25.16	10,445.03
Hydraulic Hammer Power	Hydraulic Hammer Engine	Hammer Engine	N/A	100%	204,686	20.22	2.50	11.06	0.63	0.63	0.02	0.00	0.02	0.0010	2,336.22	0.09	0.02	2.37	5.65	2,344.24

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Trips	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Emissions During Construction																	
Offshore Substation Installation (OSS)																	
	Large HLV	Main Engine (Transit)	11	4,182	46,000	3 main	NJWP	1	91	182	10	18	0	0	0	18	7M
		Main Engine (Maneuvering)	11	4,182	46,000	3 main		0	91	0	10	0	9	24	216	216	7M
		Auxiliary Engine (Transit)	1	5,833	5,833	3 Auxiliary		1	91	182	10	18	0	0	0	18	7A
		Auxiliary Engine (Maneuvering)	1	5,833	5,833	3 Auxiliary		0	91	0	10	0	9	24	216	216	7A
	Bubble Curtain Support Vessel	Main Engine (Transit)	2	5,530	11,060	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	11M
		Main Engine (Maneuvering)	2	5,530	11,060	1 & 2 main		0	91	0	10	0	9	24	216	216	11M
		Auxiliary Engine (Transit)	0	0	0	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	11A
		Auxiliary Engine (Maneuvering)	0	0	0	1 & 2 auxiliary		0	91	0	10	0	9	24	216	216	11A
Transport Barge 1	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	3	91	547	10	55	0	0	0	55	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	10	0	5	24	120	120	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		3	91	547	10	55	0	0	0	55	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	10	0	5	24	120	120	2A
Transport Barge 2	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	3	91	547	10	55	0	0	0	55	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	10	0	5	24	120	120	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		3	91	547	10	55	0	0	0	55	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	10	0	5	24	120	120	2A
Transport Barge 3	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	3	91	547	10	55	0	0	0	55	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	10	0	5	24	120	120	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		3	91	547	10	55	0	0	0	55	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	10	0	5	24	120	120	2A
Transport Barge 4	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	3	91	547	10	55	0	0	0	55	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	10	0	5	24	120	120	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		3	91	547	10	55	0	0	0	55	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	10	0	5	24	120	120	2A
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	3	91	547	10	55	0	0	0	55	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	10	0	5	24	120	120	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		3	91	547	10	55	0	0	0	55	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	10	0	5	24	120	120	11A
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	3	91	547	10	55	0	0	0	55	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	10	0	5	24	120	120	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		3	91	547	10	55	0	0	0	55	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	10	0	5	24	120	120	11A
US Towing Tug 3	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	3	91	547	10	55	0	0	0	55	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	10	0	5	24	120	120	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		3	91	547	10	55	0	0	0	55	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	10	0	5	24	120	120	11A
US Towing Tug 4	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	3	91	547	10	55	0	0	0	55	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	10	0	5	24	120	120	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		3	91	547	10	55	0	0	0	55	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	10	0	5	24	120	120	11A
	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	7	17	243	29	9	0	0	0	9	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	29	0	28	24	672	672	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		7	17	243	29	9	0	0	0	9	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	29	0	28	24	672	672	4A
	Bubble Curtain Power	Air Compressor	20	399	7,980	Tier 3 Non-Road	N/A	0	0	0	0	0	9	10	90	90	16
	Hydraulic Hammer Power	Hammer Engine	3	597	1,791	Tier 2 Non-Road	N/A	0	0	0	0	0	9	10	90	90	18
Scour Protection																	
	Fall Pipe Vessel	Main Engine (Transit)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main	Europe	1	250	500	10	50	0	0	0	50	3M
		Main Engine (Maneuvering)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main		0	250	0	10	0	44	24	1,056	1,056	3M
		Auxiliary Engine (Transit)	1	2,950	2,950	1 & 2 auxiliary		1	250	500	10	50	0	0	0	50	3A
		Auxiliary Engine (Maneuvering)	1	2,950	2,950	1 & 2 auxiliary		0	250	0	10	0	44	24	1,056	1,056	3A
	US Dredger	Main Engine (Transit)	2	641	1,283	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	5M
		Main Engine (Maneuvering)	2	641	1,283	1 & 2 main		0	91	0	10	0	28	24	672	672	5M
		Auxiliary Engine (Transit)	0	0	954	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	5A
		Auxiliary Engine (Maneuvering)	0	0	954	1 & 2 auxiliary		0	91	0	10	0	28	24	672	672	5A

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Trips	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Inter Array Cable Installation																	
Cable Installation Vessel	Cable Installation Vessel	Main Engine (Transit)	0	0	7,280	1 & 2 main	Europe	1	250	500	10	50	0	0	0	50	3M
		Main Engine (Maneuvering)	0	0	7,280	1 & 2 main		0	250	0	10	0	105	24	2,520	2,520	3M
		Auxiliary Engine (Transit)	0	0	220	1 & 2 auxiliary		1	250	500	10	50	0	0	0	50	3A
		Auxiliary Engine (Maneuvering)	0	0	220	1 & 2 auxiliary		0	250	0	10	0	105	24	2,520	2,520	3A
Cable Installation Support Activities	Support Vessel/SOV	Main Engine (Transit)	4	1,200	4,800	1 & 2 main	Europe	1	250	500	10	50	0	0	0	50	3M
		Main Engine (Maneuvering)	4	1,200	4,800	1 & 2 main		0	250	0	10	0	66	24	1,584	1,584	3M
		Auxiliary Engine (Transit)	1	800	800	1 & 2 auxiliary		1	250	500	10	50	0	0	0	50	3A
		Auxiliary Engine (Maneuvering)	1	800	800	1 & 2 auxiliary		0	250	0	10	0	66	24	1,584	1,584	3A
Sand Wave Clearance	TSHD (Dredger)	Main Engine (Transit)	2	641	1,283	1 & 2 main	Europe	1	250	500	10	50	0	0	0	50	5M
		Main Engine (Maneuvering)	2	641	1,283	1 & 2 main		0	250	0	10	0	69	24	1,656	1,656	5M
		Auxiliary Engine (Transit)	0	0	954	1 & 2 auxiliary		1	250	500	10	50	0	0	0	50	5A
		Auxiliary Engine (Maneuvering)	0	0	954	1 & 2 auxiliary		0	250	0	10	0	69	24	1,656	1,656	5A
Pre Lay Grapnel Run AHTS 1	AHTS	Main Engine (Transit)	2	4,500	9,000	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	11M
		Main Engine (Maneuvering)	2	4,500	9,000	1 & 2 main		0	91	0	10	0	11	24	264	264	11M
		Auxiliary Engine (Transit)	2	410	820	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	11A
		Auxiliary Engine (Maneuvering)	2	410	820	1 & 2 auxiliary		0	91	0	10	0	11	24	264	264	11A
Pre Lay Grapnel Run AHTS 2	AHTS	Main Engine (Transit)	2	4,500	9,000	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	11M
		Main Engine (Maneuvering)	2	4,500	9,000	1 & 2 main		0	91	0	10	0	11	24	264	264	11M
		Auxiliary Engine (Transit)	2	410	820	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	11A
		Auxiliary Engine (Maneuvering)	2	410	820	1 & 2 auxiliary		0	91	0	10	0	11	24	264	264	11A
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main	Europe	1	250	500	10	50	0	0	0	50	3M
		Main Engine (Maneuvering)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main		0	250	0	10	0	2	24	48	48	3M
		Auxiliary Engine (Transit)	1	2,950	2,950	1 & 2 auxiliary		1	250	500	10	50	0	0	0	50	3A
		Auxiliary Engine (Maneuvering)	1	2,950	2,950	1 & 2 auxiliary		0	250	0	10	0	2	24	48	48	3A
WTG Installation																	
WTG Installation Vessel	Jackup Vessel	Main Engine (Transit)	7	4 x 3,535kW 3 x 2,650kW	22,090	3 main	NJWP	1	91	182	10	18	0	0	0	18	7M
		Main Engine (Maneuvering)	7	4 x 3,535kW 3 x 2,650kW	22,090	3 main		0	91	0	10	0	246	24	5,904	5,904	7M
		Auxiliary Engine (Transit)	1	2,650	2,650	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	7A
		Auxiliary Engine (Maneuvering)	1	2,650	2,650	1 & 2 auxiliary		0	91	0	10	0	246	24	5,904	5,904	7A
US Jack Up Feeder 1	Jack up	Main Engine (Transit)	2	2,500	5,000	3 main	NJWP	48	91	8,759	10	876	0	0	0	876	7M
		Main Engine (Maneuvering)	2	2,500	5,000	3 main		0	91	0	10	0	114	24	2,736	2,736	7M
		Auxiliary Engine (Transit)	1	2,500	2,500	1 & 2 auxiliary		48	91	8,759	10	876	0	0	0	876	7A
		Auxiliary Engine (Maneuvering)	1	2,500	2,500	1 & 2 auxiliary		0	91	0	10	0	114	24	2,736	2,736	7A
US Jack Up Feeder 2	Jack up	Main Engine (Transit)	2	2,500	5,000	3 main	NJWP	48	91	8,759	10	876	0	0	0	876	7M
		Main Engine (Maneuvering)	2	2,500	5,000	3 main		0	91	0	10	0	114	24	2,736	2,736	7M
		Auxiliary Engine (Transit)	1	2,500	2,500	1 & 2 auxiliary		48	91	8,759	10	876	0	0	0	876	7A
		Auxiliary Engine (Maneuvering)	1	2,500	2,500	1 & 2 auxiliary		0	91	0	10	0	114	24	2,736	2,736	7A
Crew Transfer	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	62	17	2,155	29	76	0	0	0	76	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	29	0	246	24	5,904	5,904	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		62	17	2,155	29	76	0	0	0	76	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	29	0	246	24	5,904	5,904	4A
WTG Commissioning SOV	Service Operation Vessel	Main Engine (Transit)	4	1,200	4,800	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	3M
		Main Engine (Maneuvering)	4	1,200	4,800	1 & 2 main		0	91	0	10	0	246	24	5,904	5,904	3M
		Auxiliary Engine (Transit)	1	800	800	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	3A
		Auxiliary Engine (Maneuvering)	1	800	800	1 & 2 auxiliary		0	91	0	10	0	246	24	5,904	5,904	3A

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Trips	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Export Cable Installation																	
Cable Installation Vessel 1		Main Engine (Transit)	4	2 x 2560kW 2 x 1913kW	8,946	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	3M
		Main Engine (Maneuvering)	4	2 x 2560kW 2 x 1913kW	8,946	1 & 2 main		0	91	0	10	0	174	24	4,176	4,176	3M
		Auxiliary Engine (Transit)	2	1,400	2,800	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	3A
		Auxiliary Engine (Maneuvering)	2	1,400	2,800	1 & 2 auxiliary		0	91	0	10	0	174	24	4,176	4,176	3A
Cable Installation Vessel 2		Main Engine (Transit)	4	2 x 2560kW 2 x 1913kW	8,946	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	3M
		Main Engine (Maneuvering)	4	2 x 2560kW 2 x 1913kW	8,946	1 & 2 main		0	91	0	10	0	174	24	4,176	4,176	3M
		Auxiliary Engine (Transit)	2	1,400	2,800	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	3A
		Auxiliary Engine (Maneuvering)	2	1,400	2,800	1 & 2 auxiliary		0	91	0	10	0	174	24	4,176	4,176	3A
Support and Jointing Vessel		Main Engine (Transit)	3	2 x 2350kW 1 x 1786kW	6,486	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	3M
		Main Engine (Maneuvering)	3	2 x 2350kW 1 x 1786kW	6,486	1 & 2 main		0	91	0	10	0	35	24	840	840	3M
		Auxiliary Engine (Transit)	2	994	1,988	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	3A
		Auxiliary Engine (Maneuvering)	2	994	1,988	1 & 2 auxiliary		0	91	0	10	0	35	24	840	840	3A
TSHD	Dredger	Main Engine (Transit)	2	641	1,283	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	5M
		Main Engine (Maneuvering)	2	641	1,283	1 & 2 main		0	91	0	10	0	127	24	3,048	3,048	5M
		Auxiliary Engine (Transit)	0	0	954	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	5A
		Auxiliary Engine (Maneuvering)	0	0	954	1 & 2 auxiliary		0	91	0	10	0	127	24	3,048	3,048	5A
AHTS	Tug	Main Engine (Transit)	2	4,500	9,000	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	11M
		Main Engine (Maneuvering)	2	4,500	9,000	1 & 2 main		0	91	0	10	0	52	24	1,248	1,248	11M
		Auxiliary Engine (Transit)	2	410	820	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	11A
		Auxiliary Engine (Maneuvering)	2	410	820	1 & 2 auxiliary		0	91	0	10	0	52	24	1,248	1,248	11A
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main	Europe	1	250	500	10	50	0	0	0	50	3M
		Main Engine (Maneuvering)	8	4 x 3350kW 4 x 2000kW	21,400	1 & 2 main		0	250	0	10	0	3	24	72	72	3M
		Auxiliary Engine (Transit)	1	2,950	2,950	1 & 2 auxiliary		1	250	500	10	50	0	0	0	50	3A
		Auxiliary Engine (Maneuvering)	1	2,950	2,950	1 & 2 auxiliary		0	250	0	10	0	3	24	72	72	3A
Fuel Bunkering																	
Towing Tug	Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	12	91	2,190	10	219	0	0	0	219	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	10	0	80	24	1,920	1,920	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		12	91	2,190	10	219	0	0	0	219	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	10	0	80	24	1,920	1,920	11A
Barge	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	12	91	2,190	10	219	0	0	0	219	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	10	0	80	24	1,920	1,920	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		12	91	2,190	10	219	0	0	0	219	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	10	0	80	24	1,920	1,920	2A
Motion Compensation	Motion Compensation	Motion Compensation Engine	1	500	500	Tier 3 Non-Road	NJWP	0	91	0	0	0	80	24	1,920	1,920	17
Commissioning Generators																	
OSS Commissioning Generators	Generator	Marine Tier 3 Generator	4	500	2,000	Tier 4 Non-Road	N/A	0	0	0	0	0	28	12	336	336	31
WTG Commissioning Generators	Generator	Marine Tier 3 Generator	1	240	240	Tier 4 Non-Road	N/A	0	0	0	0	0	246	12	2,952	2,952	32
Miscellaneous																	
Marine Paint	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fuel Evaporation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)													
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Construction																			
Offshore Substation Installation (OSS)																			
	Large HLV	Main Engine (Transit)	0.83	40,023	7.70	0.11	1.77	0.24	0.23	0.01	0.00	0.01	0.0005	496.96	0.00	0.02	0.08	7.09	504.14
		Main Engine (Maneuvering)	0.10	57,077	10.99	0.15	2.52	0.34	0.33	0.01	0.00	0.02	0.0007	708.72	0.00	0.03	0.11	10.12	718.95
		Auxiliary Engine (Transit)	0.56	4,017	0.76	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.0000	42.59	0.00	0.00	0.01	0.61	43.21
		Auxiliary Engine (Maneuvering)	0.56	47,544	8.98	0.11	1.93	0.25	0.24	0.00	0.00	0.01	0.0002	504.16	0.00	0.02	0.08	7.19	511.43
	Bubble Curtain Support Vessel	Main Engine (Transit)	0.83	10,639	1.76	0.03	0.42	0.06	0.06	0.01	0.00	0.00	0.0003	118.86	0.00	0.01	0.02	1.71	120.58
		Main Engine (Maneuvering)	0.10	15,172	2.51	0.05	0.60	0.09	0.08	0.01	0.00	0.01	0.0004	169.50	0.00	0.01	0.03	2.43	171.96
		Auxiliary Engine (Transit)	0.43	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Maneuvering)	0.43	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
Transport Barge 1	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	75	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.84	0.00	0.00	0.00	0.01	0.85
		Auxiliary Engine (Maneuvering)	0.43	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.84	0.00	0.00	0.00	0.03	1.87
Transport Barge 2	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	75	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.84	0.00	0.00	0.00	0.01	0.85
		Auxiliary Engine (Maneuvering)	0.43	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.84	0.00	0.00	0.00	0.03	1.87
Transport Barge 3	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	75	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.84	0.00	0.00	0.00	0.01	0.85
		Auxiliary Engine (Maneuvering)	0.43	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.84	0.00	0.00	0.00	0.03	1.87
Transport Barge 4	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	75	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.84	0.00	0.00	0.00	0.01	0.85
		Auxiliary Engine (Maneuvering)	0.43	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.84	0.00	0.00	0.00	0.03	1.87
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	0.83	14,573	2.41	0.05	0.58	0.08	0.08	0.01	0.00	0.01	0.0004	162.81	0.00	0.01	0.03	2.34	165.17
		Main Engine (Maneuvering)	0.10	3,849	0.64	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.0001	43.00	0.00	0.00	0.01	0.62	43.62
		Auxiliary Engine (Transit)	0.43	353	0.06	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	3.97	0.00	0.00	0.00	0.06	4.03
		Auxiliary Engine (Maneuvering)	0.43	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	8.70	0.00	0.00	0.00	0.12	8.83
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	0.83	14,573	2.41	0.05	0.58	0.08	0.08	0.01	0.00	0.01	0.0004	162.81	0.00	0.01	0.03	2.34	165.17
		Main Engine (Maneuvering)	0.10	3,849	0.64	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.0001	43.00	0.00	0.00	0.01	0.62	43.62
		Auxiliary Engine (Transit)	0.43	353	0.06	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	3.97	0.00	0.00	0.00	0.06	4.03
		Auxiliary Engine (Maneuvering)	0.43	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	8.70	0.00	0.00	0.00	0.12	8.83
US Towing Tug 3	US Towing Tug	Main Engine (Transit)	0.83	14,573	2.41	0.05	0.58	0.08	0.08	0.01	0.00	0.01	0.0004	162.81	0.00	0.01	0.03	2.34	165.17
		Main Engine (Maneuvering)	0.10	3,849	0.64	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.0001	43.00	0.00	0.00	0.01	0.62	43.62
		Auxiliary Engine (Transit)	0.43	353	0.06	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	3.97	0.00	0.00	0.00	0.06	4.03
		Auxiliary Engine (Maneuvering)	0.43	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	8.70	0.00	0.00	0.00	0.12	8.83
US Towing Tug 4	US Towing Tug	Main Engine (Transit)	0.83	14,573	2.41	0.05	0.58	0.08	0.08	0.01	0.00	0.01	0.0004	162.81	0.00	0.01	0.03	2.34	165.17
		Main Engine (Maneuvering)	0.10	3,849	0.64	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.0001	43.00	0.00	0.00	0.01	0.62	43.62
		Auxiliary Engine (Transit)	0.43	353	0.06	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	3.97	0.00	0.00	0.00	0.06	4.03
		Auxiliary Engine (Maneuvering)	0.43	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	8.70	0.00	0.00	0.00	0.12	8.83
	Crew Transfer Vessel	Main Engine (Transit)	0.83	940	0.15	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.0000	10.57	0.00	0.00	0.00	0.15	10.72
		Main Engine (Maneuvering)	0.10	8,911	1.42	0.02	0.36	0.05	0.05	0.00	0.00	0.00	0.0000	100.25	0.00	0.00	0.02	1.43	101.69
		Auxiliary Engine (Transit)	0.43	13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.14	0.00	0.00	0.00	0.00	0.14
		Auxiliary Engine (Maneuvering)	0.43	991	0.18	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.0000	11.15	0.00	0.00	0.00	0.16	11.31
	Bubble Curtain Power	Air Compressor	1.00	51,300	3.17	0.40	2.77	0.16	0.16	0.01	0.00	0.01	0.0002	585.52	0.02	0.00	0.59	1.42	587.53
	Hydraulic Hammer Power	Hammer Engine	1.00	11,514	1.14	0.14	0.62	0.04	0.04	0.00	0.00	0.00	0.0001	131.41	0.01	0.00	0.13	0.32	131.86
Scour Protection																			
	Fall Pipe Vessel	Main Engine (Transit)	0.83	56,402	9.29	0.24	2.15	0.33	0.32	0.08	0.00	0.03	0.0038	621.66	0.00	0.03	0.10	9.04	630.80
		Main Engine (Maneuvering)	0.20	287,039	47.28	1.25	10.96	1.69	1.64	0.42	0.00	0.14	0.0195	3,163.73	0.02	0.15	0.50	46.02	3,210.25
		Auxiliary Engine (Transit)	0.56	5,246	0.90	0.01	0.23	0.03	0.03	0.00	0.00	0.00	0.0000	59.02	0.00	0.00	0.01	0.84	59.87
		Auxiliary Engine (Maneuvering)	0.56	110,792	19.02	0.27	4.77	0.62	0.60	0.01	0.00	0.03	0.0005	1,246.49	0.01	0.06	0.19	17.76	1,264.44
	US Dredger	Main Engine (Transit)	0.83	1,234	0.21	0.01	0.05	0.01	0.01	0.00	0.00	0.00	0.0001	13.50	0.00	0.00	0.00	0.20	13.70
		Main Engine (Maneuvering)	0.20	10,948	1.82	0.05	0.40	0.07	0.06	0.02	0.00	0.01	0.0010	119.83	0.00	0.01	0.02	1.76	121.60
		Auxiliary Engine (Transit)	0.56	619	0.11	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	6.97	0.00	0.00	0.00	0.10	7.07
		Auxiliary Engine (Maneuvering)	0.56	22,812	3.90	0.06	0.98	0.13	0.12	0.00	0.00	0.01	0.0001	256.65	0.00	0.01	0.04	3.66	260.35

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Inter Array Cable Installation																			
Cable Installation Vessel	Cable Installation Vessel	Main Engine (Transit)	0.83	19,187	3.16	0.08	0.73	0.11	0.11	0.03	0.00	0.01	0.0013	211.48	0.00	0.01	0.03	3.08	214.59
		Main Engine (Maneuvering)	0.20	233,021	38.38	1.01	8.90	1.38	1.33	0.34	0.00	0.11	0.0158	2,568.35	0.02	0.13	0.40	37.36	2,606.11
		Auxiliary Engine (Transit)	0.56	391	0.07	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	4.40	0.00	0.00	0.00	0.06	4.46
		Auxiliary Engine (Maneuvering)	0.56	19,717	3.38	0.05	0.85	0.11	0.11	0.00	0.00	0.01	0.0001	221.83	0.00	0.01	0.03	3.16	225.03
Cable Installation Support Activities	Support Vessel/SOV	Main Engine (Transit)	0.16	2,439	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.0002	26.88	0.00	0.00	0.00	0.39	27.27
		Main Engine (Maneuvering)	0.10	50,290	8.28	0.22	1.92	0.30	0.29	0.07	0.00	0.02	0.0034	554.30	0.00	0.03	0.09	8.06	562.45
		Auxiliary Engine (Transit)	0.16	406	0.07	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	4.57	0.00	0.00	0.00	0.07	4.64
		Auxiliary Engine (Maneuvering)	0.10	8,382	1.44	0.02	0.36	0.05	0.05	0.00	0.00	0.00	0.0000	94.30	0.00	0.00	0.01	1.34	95.66
Sand Wave Clearance	TSHD (Dredger)	Main Engine (Transit)	0.83	3,380	0.56	0.02	0.12	0.02	0.02	0.01	0.00	0.00	0.0003	37.00	0.00	0.00	0.01	0.54	37.55
		Main Engine (Maneuvering)	0.20	26,978	4.50	0.13	1.00	0.17	0.16	0.05	0.00	0.01	0.0024	295.29	0.00	0.01	0.05	4.33	299.67
		Auxiliary Engine (Transit)	0.56	1,697	0.29	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.0000	19.10	0.00	0.00	0.00	0.27	19.37
		Auxiliary Engine (Maneuvering)	0.56	56,215	9.61	0.14	2.42	0.31	0.30	0.01	0.00	0.02	0.0003	632.46	0.00	0.03	0.10	9.01	641.58
Pre Lay Grapnel Run AHTS 1	AHTS	Main Engine (Transit)	0.83	8,657	1.43	0.03	0.34	0.05	0.05	0.00	0.00	0.00	0.0002	96.72	0.00	0.00	0.02	1.39	98.12
		Main Engine (Maneuvering)	0.20	30,179	4.99	0.09	1.20	0.17	0.17	0.02	0.00	0.01	0.0008	337.16	0.00	0.02	0.05	4.84	342.05
		Auxiliary Engine (Transit)	0.43	409	0.07	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	4.60	0.00	0.00	0.00	0.07	4.66
		Auxiliary Engine (Maneuvering)	0.43	5,912	1.04	0.01	0.25	0.03	0.03	0.00	0.00	0.00	0.0000	66.51	0.00	0.00	0.01	0.95	67.47
Pre Lay Grapnel Run AHTS 2	AHTS	Main Engine (Transit)	0.83	8,657	1.43	0.03	0.34	0.05	0.05	0.00	0.00	0.00	0.0002	96.72	0.00	0.00	0.02	1.39	98.12
		Main Engine (Maneuvering)	0.20	30,179	4.99	0.09	1.20	0.17	0.17	0.02	0.00	0.01	0.0008	337.16	0.00	0.02	0.05	4.84	342.05
		Auxiliary Engine (Transit)	0.43	409	0.07	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	4.60	0.00	0.00	0.00	0.07	4.66
		Auxiliary Engine (Maneuvering)	0.43	5,912	1.04	0.01	0.25	0.03	0.03	0.00	0.00	0.00	0.0000	66.51	0.00	0.00	0.01	0.95	67.47
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	0.83	56,402	9.29	0.24	2.15	0.33	0.32	0.08	0.00	0.03	0.0038	621.66	0.00	0.03	0.10	9.04	630.80
		Main Engine (Maneuvering)	0.20	13,047	2.15	0.06	0.50	0.08	0.07	0.02	0.00	0.01	0.0009	143.81	0.00	0.01	0.02	2.09	145.92
		Auxiliary Engine (Transit)	0.56	5,246	0.90	0.01	0.23	0.03	0.03	0.00	0.00	0.00	0.0000	59.02	0.00	0.00	0.01	0.84	59.87
		Auxiliary Engine (Maneuvering)	0.56	5,036	0.86	0.01	0.22	0.03	0.03	0.00	0.00	0.00	0.0000	56.66	0.00	0.00	0.01	0.81	57.47
WTG Installation																			
WTG Installation Vessel	Jackup Vessel	Main Engine (Transit)	0.83	19,220	3.70	0.05	0.85	0.11	0.11	0.00	0.00	0.01	0.0002	238.65	0.00	0.01	0.04	3.41	242.09
		Main Engine (Maneuvering)	0.20	1,498,372	288.39	4.03	66.13	8.91	8.63	0.37	0.00	0.51	0.0172	18,605.20	0.12	0.89	2.88	265.62	18,873.69
		Auxiliary Engine (Transit)	0.43	1,321	0.26	0.00	0.06	0.01	0.01	0.00	0.00	0.00	0.0000	14.86	0.00	0.00	0.00	0.21	15.07
		Auxiliary Engine (Maneuvering)	0.43	427,261	85.65	1.04	18.39	2.37	2.30	0.04	0.00	0.13	0.0020	4,807.00	0.03	0.23	0.74	68.51	4,876.25
US Jack Up Feeder 1	Jack up	Main Engine (Transit)	0.83	208,816	40.19	0.56	9.22	1.24	1.20	0.05	0.00	0.07	0.0024	2,592.86	0.02	0.12	0.40	37.02	2,630.28
		Main Engine (Maneuvering)	0.20	157,168	30.25	0.42	6.94	0.93	0.90	0.04	0.00	0.05	0.0018	1,951.54	0.01	0.09	0.30	27.86	1,979.71
		Auxiliary Engine (Transit)	0.43	59,801	11.99	0.15	2.57	0.33	0.32	0.01	0.00	0.02	0.0003	672.81	0.00	0.03	0.10	9.59	682.50
		Auxiliary Engine (Maneuvering)	0.43	186,792	37.45	0.45	8.04	1.04	1.01	0.02	0.00	0.06	0.0009	2,101.54	0.01	0.10	0.32	29.95	2,131.82
US Jack Up Feeder 2	Jack up	Main Engine (Transit)	0.83	208,816	40.19	0.56	9.22	1.24	1.20	0.05	0.00	0.07	0.0024	2,592.86	0.02	0.12	0.40	37.02	2,630.28
		Main Engine (Maneuvering)	0.20	157,168	30.25	0.42	6.94	0.93	0.90	0.04	0.00	0.05	0.0018	1,951.54	0.01	0.09	0.30	27.86	1,979.71
		Auxiliary Engine (Transit)	0.43	59,801	11.99	0.15	2.57	0.33	0.32	0.01	0.00	0.02	0.0003	672.81	0.00	0.03	0.10	9.59	682.50
		Auxiliary Engine (Maneuvering)	0.43	186,792	37.45	0.45	8.04	1.04	1.01	0.02	0.00	0.06	0.0009	2,101.54	0.01	0.10	0.32	29.95	2,131.82
Crew Transfer	Crew Transfer Vessel	Main Engine (Transit)	0.83	8,322	1.32	0.02	0.33	0.04	0.04	0.00	0.00	0.00	0.0000	93.63	0.00	0.00	0.01	1.33	94.98
		Main Engine (Maneuvering)	0.20	156,578	24.87	0.38	6.25	0.84	0.82	0.02	0.00	0.05	0.0007	1,761.51	0.01	0.08	0.27	25.11	1,786.89
		Auxiliary Engine (Transit)	0.43	112	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	1.25	0.00	0.00	0.00	0.02	1.27
		Auxiliary Engine (Maneuvering)	0.43	8,706	1.57	0.02	0.37	0.05	0.05	0.00	0.00	0.00	0.0000	97.95	0.00	0.00	0.02	1.40	99.37
WTG Commissioning SOV	Service Operation Vessel	Main Engine (Transit)	0.16	890	0.15	0.00	0.03	0.01	0.01	0.00	0.00	0.00	0.0001	9.81	0.00	0.00	0.00	0.14	9.95
		Main Engine (Maneuvering)	0.10	187,446	30.88	0.81	7.16	1.11	1.07	0.28	0.00	0.09	0.0127	2,066.02	0.01	0.10	0.33	30.06	2,096.40
		Auxiliary Engine (Transit)	0.16	148	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.67	0.00	0.00	0.00	0.02	1.69
		Auxiliary Engine (Maneuvering)	0.10	31,241	5.36	0.08	1.34	0.17	0.17	0.00	0.00	0.01	0.0001	351.48	0.00	0.02	0.05	5.01	356.55

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Export Cable Installation																			
Cable Installation Vessel 1		Main Engine (Transit)	0.83	8,605	1.42	0.04	0.33	0.05	0.05	0.01	0.00	0.00	0.0006	94.85	0.00	0.00	0.01	1.38	96.24
		Main Engine (Maneuvering)	0.20	474,518	78.16	2.06	18.12	2.80	2.72	0.70	0.00	0.22	0.0322	5,230.11	0.03	0.26	0.82	76.09	5,307.02
		Auxiliary Engine (Transit)	0.56	1,817	0.31	0.00	0.08	0.01	0.01	0.00	0.00	0.00	0.0000	20.44	0.00	0.00	0.00	0.29	20.74
		Auxiliary Engine (Maneuvering)	0.56	415,853	71.39	1.01	17.90	2.31	2.24	0.04	0.00	0.13	0.0020	4,678.64	0.03	0.22	0.72	66.68	4,746.04
Cable Installation Vessel 2		Main Engine (Transit)	0.83	8,605	1.42	0.04	0.33	0.05	0.05	0.01	0.00	0.00	0.0006	94.85	0.00	0.00	0.01	1.38	96.24
		Main Engine (Maneuvering)	0.20	474,518	78.16	2.06	18.12	2.80	2.72	0.70	0.00	0.22	0.0322	5,230.11	0.03	0.26	0.82	76.09	5,307.02
		Auxiliary Engine (Transit)	0.56	1,817	0.31	0.00	0.08	0.01	0.01	0.00	0.00	0.00	0.0000	20.44	0.00	0.00	0.00	0.29	20.74
		Auxiliary Engine (Maneuvering)	0.56	415,853	71.39	1.01	17.90	2.31	2.24	0.04	0.00	0.13	0.0020	4,678.64	0.03	0.22	0.72	66.68	4,746.04
Support and Jointing Vessel		Main Engine (Transit)	0.83	6,239	1.03	0.03	0.24	0.04	0.04	0.01	0.00	0.00	0.0004	68.77	0.00	0.00	0.01	1.00	69.78
		Main Engine (Maneuvering)	0.20	69,202	11.40	0.30	2.64	0.41	0.40	0.10	0.00	0.03	0.0047	762.74	0.00	0.04	0.12	11.10	773.96
		Auxiliary Engine (Transit)	0.56	1,290	0.22	0.00	0.06	0.01	0.01	0.00	0.00	0.00	0.0000	14.52	0.00	0.00	0.00	0.21	14.73
		Auxiliary Engine (Maneuvering)	0.56	59,390	10.19	0.14	2.56	0.33	0.32	0.01	0.00	0.02	0.0003	668.19	0.00	0.03	0.10	9.52	677.81
TSHD	Dredger	Main Engine (Transit)	0.83	1,234	0.21	0.01	0.05	0.01	0.01	0.00	0.00	0.00	0.0001	13.50	0.00	0.00	0.00	0.20	13.70
		Main Engine (Maneuvering)	0.20	49,656	8.27	0.24	1.84	0.31	0.29	0.10	0.00	0.03	0.0044	543.51	0.00	0.03	0.09	7.96	551.56
		Auxiliary Engine (Transit)	0.56	619	0.11	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.0000	6.97	0.00	0.00	0.00	0.10	7.07
		Auxiliary Engine (Maneuvering)	0.56	103,469	17.69	0.25	4.45	0.57	0.56	0.01	0.00	0.03	0.0005	1,164.10	0.01	0.06	0.18	16.59	1,180.87
AHTS	Tug	Main Engine (Transit)	0.83	8,657	1.43	0.03	0.34	0.05	0.05	0.00	0.00	0.00	0.0002	96.72	0.00	0.00	0.02	1.39	98.12
		Main Engine (Maneuvering)	0.20	142,666	23.57	0.45	5.67	0.82	0.79	0.08	0.00	0.05	0.0038	1,593.85	0.01	0.08	0.25	22.88	1,616.97
		Auxiliary Engine (Transit)	0.43	409	0.07	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.0000	4.60	0.00	0.00	0.00	0.07	4.66
		Auxiliary Engine (Maneuvering)	0.43	27,947	4.90	0.07	1.20	0.16	0.15	0.00	0.00	0.01	0.0001	314.42	0.00	0.02	0.05	4.48	318.95
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	0.83	56,402	9.29	0.24	2.15	0.33	0.32	0.08	0.00	0.03	0.0038	621.66	0.00	0.03	0.10	9.04	630.80
		Main Engine (Maneuvering)	0.20	19,571	3.22	0.08	0.75	0.12	0.11	0.03	0.00	0.01	0.0013	215.71	0.00	0.01	0.03	3.14	218.88
		Auxiliary Engine (Transit)	0.56	5,246	0.90	0.01	0.23	0.03	0.03	0.00	0.00	0.00	0.0000	59.02	0.00	0.00	0.01	0.84	59.87
		Auxiliary Engine (Maneuvering)	0.56	7,554	1.30	0.02	0.33	0.04	0.04	0.00	0.00	0.00	0.0000	84.99	0.00	0.00	0.01	1.21	86.21
Fuel Bunkering																			
Towing Tug	Tug	Main Engine (Transit)	0.83	58,291	9.63	0.18	2.32	0.33	0.32	0.03	0.00	0.02	0.0015	651.22	0.00	0.03	0.10	9.35	660.67
		Main Engine (Maneuvering)	0.20	123,153	20.35	0.38	4.89	0.71	0.68	0.07	0.00	0.05	0.0032	1,375.86	0.01	0.07	0.21	19.75	1,395.82
		Auxiliary Engine (Transit)	0.43	1,411	0.25	0.00	0.06	0.01	0.01	0.00	0.00	0.00	0.0000	15.88	0.00	0.00	0.00	0.23	16.11
		Auxiliary Engine (Maneuvering)	0.43	12,374	2.17	0.03	0.53	0.07	0.07	0.00	0.00	0.00	0.0001	139.22	0.00	0.01	0.02	1.98	141.22
Barge	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.20	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	299	0.07	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	3.36	0.00	0.00	0.00	0.05	3.41
		Auxiliary Engine (Maneuvering)	0.43	2,622	0.57	0.01	0.11	0.01	0.01	0.00	0.00	0.00	0.0000	29.50	0.00	0.00	0.00	0.42	29.92
Motion Compensation	Motion Compensation	Motion Compensation Engine	1.00	68,571	4.23	0.52	3.70	0.21	0.21	0.01	0.00	0.01	0.0003	782.65	0.03	0.01	0.79	1.89	785.34
Commissioning Generators																			
OSS Commissioning Generators	Generator	Marine Tier 3 Generator	0.50	24,000	2.15	0.26	1.85	0.04	0.04	0.00	0.00	0.01	0.0001	273.93	0.01	0.00	0.28	0.66	274.87
WTG Commissioning Generators	Generator	Marine Tier 3 Generator	0.50	25,303	2.11	0.25	1.95	0.05	0.05	0.00	0.00	0.01	0.00	288.80	0.01	0.00	0.29	0.70	289.79
Miscellaneous																			
Marine Paint	N/A	N/A	N/A	N/A	N/A	0.75	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fuel Evaporation	N/A	N/A	N/A	N/A	N/A	0.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Construction																				
Offshore Substation Installation (OSS)																				
	Large HLV	Main Engine (Transit)	25	27%	10,966	2.11	0.03	0.48	0.07	0.06	0.00	0.00	0.00	0.00	136.17	0.00	0.01	0.02	1.94	138.13
		Main Engine (Maneuvering)	25	100%	57,077	10.99	0.15	2.52	0.34	0.33	0.01	0.00	0.02	0.00	708.72	0.00	0.03	0.11	10.12	718.95
		Auxiliary Engine (Transit)	25	27%	1,101	0.21	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	11.67	0.00	0.00	0.00	0.17	11.84
		Auxiliary Engine (Maneuvering)	25	100%	47,544	8.98	0.11	1.93	0.25	0.24	0.00	0.00	0.01	0.00	504.16	0.00	0.02	0.08	7.19	511.43
	Bubble Curtain Support Vessel	Main Engine (Transit)	25	27%	2,915	0.48	0.01	0.12	0.02	0.02	0.00	0.00	0.00	0.00	32.57	0.00	0.00	0.01	0.47	33.04
		Main Engine (Maneuvering)	25	100%	15,172	2.51	0.05	0.60	0.09	0.08	0.01	0.00	0.01	0.00	169.50	0.00	0.01	0.03	2.43	171.96
		Auxiliary Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transport Barge 1	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.23
		Auxiliary Engine (Maneuvering)	25	100%	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.84	0.00	0.00	0.00	0.03	1.87
Transport Barge 2	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.23
		Auxiliary Engine (Maneuvering)	25	100%	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.84	0.00	0.00	0.00	0.03	1.87
Transport Barge 3	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.23
		Auxiliary Engine (Maneuvering)	25	100%	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.84	0.00	0.00	0.00	0.03	1.87
Transport Barge 4	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.23
		Auxiliary Engine (Maneuvering)	25	100%	164	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.84	0.00	0.00	0.00	0.03	1.87
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	25	27%	3,993	0.66	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	44.61	0.00	0.00	0.01	0.64	45.25
		Main Engine (Maneuvering)	25	100%	3,849	0.64	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.00	43.00	0.00	0.00	0.01	0.62	43.62
		Auxiliary Engine (Transit)	25	27%	97	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.09	0.00	0.00	0.00	0.02	1.10
		Auxiliary Engine (Maneuvering)	25	100%	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	8.70	0.00	0.00	0.00	0.12	8.83
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	25	27%	3,993	0.66	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	44.61	0.00	0.00	0.01	0.64	45.25
		Main Engine (Maneuvering)	25	100%	3,849	0.64	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.00	43.00	0.00	0.00	0.01	0.62	43.62
		Auxiliary Engine (Transit)	25	27%	97	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.09	0.00	0.00	0.00	0.02	1.10
		Auxiliary Engine (Maneuvering)	25	100%	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	8.70	0.00	0.00	0.00	0.12	8.83
US Towing Tug 3	US Towing Tug	Main Engine (Transit)	25	27%	3,993	0.66	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	44.61	0.00	0.00	0.01	0.64	45.25
		Main Engine (Maneuvering)	25	100%	3,849	0.64	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.00	43.00	0.00	0.00	0.01	0.62	43.62
		Auxiliary Engine (Transit)	25	27%	97	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.09	0.00	0.00	0.00	0.02	1.10
		Auxiliary Engine (Maneuvering)	25	100%	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	8.70	0.00	0.00	0.00	0.12	8.83
US Towing Tug 4	US Towing Tug	Main Engine (Transit)	25	27%	3,993	0.66	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	44.61	0.00	0.00	0.01	0.64	45.25
		Main Engine (Maneuvering)	25	100%	3,849	0.64	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.00	43.00	0.00	0.00	0.01	0.62	43.62
		Auxiliary Engine (Transit)	25	27%	97	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.09	0.00	0.00	0.00	0.02	1.10
		Auxiliary Engine (Maneuvering)	25	100%	773	0.14	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	8.70	0.00	0.00	0.00	0.12	8.83
	Crew Transfer Vessel	Main Engine (Transit)	17	100%	940	0.15	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.00	10.57	0.00	0.00	0.00	0.15	10.72
		Main Engine (Maneuvering)	17	100%	8,911	1.42	0.02	0.36	0.05	0.05	0.00	0.00	0.00	0.00	100.25	0.00	0.00	0.02	1.43	101.69
		Auxiliary Engine (Transit)	17	100%	13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.14
		Auxiliary Engine (Maneuvering)	17	100%	991	0.18	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	11.15	0.00	0.00	0.00	0.16	11.31
	Bubble Curtain Power	Air Compressor	N/A	100%	51,300	3.17	0.40	2.77	0.16	0.16	0.01	0.00	0.01	0.00	585.52	0.02	0.00	0.59	1.42	587.53
	Hydraulic Hammer Power	Hammer Engine	N/A	100%	11,514	1.14	0.14	0.62	0.04	0.04	0.00	0.00	0.00	0.00	131.41	0.01	0.00	0.13	0.32	131.86
Scour Protection																				
	Fall Pipe Vessel	Main Engine (Transit)	25	10%	5,640	0.93	0.02	0.22	0.03	0.03	0.01	0.00	0.00	0.00	62.17	0.00	0.00	0.01	0.90	63.08
		Main Engine (Maneuvering)	25	100%	287,039	47.28	1.25	10.96	1.69	1.64	0.42	0.00	0.14	0.02	3,163.73	0.02	0.15	0.50	46.02	3,210.25
		Auxiliary Engine (Transit)	25	10%	525	0.09	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	5.90	0.00	0.00	0.00	0.08	5.99
		Auxiliary Engine (Maneuvering)	25	100%	110,792	19.02	0.27	4.77	0.62	0.60	0.01	0.00	0.03	0.00	1,246.49	0.01	0.06	0.19	17.76	1,264.44
	US Dredger	Main Engine (Transit)	25	27%	338	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	0.00	0.05	3.75
		Main Engine (Maneuvering)	25	100%	10,948	1.82	0.05	0.40	0.07	0.06	0.02	0.00	0.01	0.00	119.83	0.00	0.01	0.02	1.76	121.60
		Auxiliary Engine (Transit)	25	27%	170	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.91	0.00	0.00	0.00	0.03	1.94
		Auxiliary Engine (Maneuvering)	25	100%	22,812	3.90	0.06	0.98	0.13	0.12	0.00	0.00	0.01	0.00	256.65	0.00	0.01	0.04	3.66	260.35

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Inter Array Cable Installation																				
Cable Installation Vessel	Cable Installation Vessel	Main Engine (Transit)	25	10%	1,919	0.32	0.01	0.07	0.01	0.01	0.00	0.00	0.00	0.00	21.15	0.00	0.00	0.00	0.31	21.46
		Main Engine (Maneuvering)	25	100%	233,021	38.38	1.01	8.90	1.38	1.33	0.34	0.00	0.11	0.02	2,568.35	0.02	0.13	0.40	37.36	2,606.11
		Auxiliary Engine (Transit)	25	10%	39	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.01	0.45
		Auxiliary Engine (Maneuvering)	25	100%	19,717	3.38	0.05	0.85	0.11	0.11	0.00	0.00	0.01	0.00	221.83	0.00	0.01	0.03	3.16	225.03
Cable Installation Support Activities	Support Vessel/SOV	Main Engine (Transit)	25	10%	244	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	2.69	0.00	0.00	0.00	0.04	2.73
		Main Engine (Maneuvering)	25	100%	50,290	8.28	0.22	1.92	0.30	0.29	0.07	0.00	0.02	0.00	554.30	0.00	0.03	0.09	8.06	562.45
		Auxiliary Engine (Transit)	25	10%	41	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.01	0.46
		Auxiliary Engine (Maneuvering)	25	100%	8,382	1.44	0.02	0.36	0.05	0.05	0.00	0.00	0.00	0.00	94.30	0.00	0.00	0.01	1.34	95.66
Sand Wave Clearance	TSHD (Dredger)	Main Engine (Transit)	25	10%	338	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	0.00	0.05	3.75
		Main Engine (Maneuvering)	25	100%	26,978	4.50	0.13	1.00	0.17	0.16	0.05	0.00	0.01	0.00	295.29	0.00	0.01	0.05	4.33	299.67
		Auxiliary Engine (Transit)	25	10%	170	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.91	0.00	0.00	0.00	0.03	1.94
		Auxiliary Engine (Maneuvering)	25	100%	56,215	9.61	0.14	2.42	0.31	0.30	0.01	0.00	0.02	0.00	632.46	0.00	0.03	0.10	9.01	641.58
Pre Lay Grapnel Run AHTS 1	AHTS	Main Engine (Transit)	25	27%	2,372	0.39	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	26.50	0.00	0.00	0.00	0.38	26.88
		Main Engine (Maneuvering)	25	100%	30,179	4.99	0.09	1.20	0.17	0.17	0.02	0.00	0.01	0.00	337.16	0.00	0.02	0.05	4.84	342.05
		Auxiliary Engine (Transit)	25	27%	112	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.26	0.00	0.00	0.00	0.02	1.28
		Auxiliary Engine (Maneuvering)	25	100%	5,912	1.04	0.01	0.25	0.03	0.03	0.00	0.00	0.00	0.00	66.51	0.00	0.00	0.01	0.95	67.47
Pre Lay Grapnel Run AHTS 2	AHTS	Main Engine (Transit)	25	27%	2,372	0.39	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	26.50	0.00	0.00	0.00	0.38	26.88
		Main Engine (Maneuvering)	25	100%	30,179	4.99	0.09	1.20	0.17	0.17	0.02	0.00	0.01	0.00	337.16	0.00	0.02	0.05	4.84	342.05
		Auxiliary Engine (Transit)	25	27%	112	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.26	0.00	0.00	0.00	0.02	1.28
		Auxiliary Engine (Maneuvering)	25	100%	5,912	1.04	0.01	0.25	0.03	0.03	0.00	0.00	0.00	0.00	66.51	0.00	0.00	0.01	0.95	67.47
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	25	10%	5,640	0.93	0.02	0.22	0.03	0.03	0.01	0.00	0.00	0.00	62.17	0.00	0.00	0.01	0.90	63.08
		Main Engine (Maneuvering)	25	100%	13,047	2.15	0.06	0.50	0.08	0.07	0.02	0.00	0.01	0.00	143.81	0.00	0.01	0.02	2.09	145.92
		Auxiliary Engine (Transit)	25	10%	525	0.09	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	5.90	0.00	0.00	0.00	0.08	5.99
		Auxiliary Engine (Maneuvering)	25	100%	5,036	0.86	0.01	0.22	0.03	0.03	0.00	0.00	0.00	0.00	56.66	0.00	0.00	0.01	0.81	57.47
WTG Installation																				
WTG Installation Vessel	Jackup Vessel	Main Engine (Transit)	25	27%	5,266	1.01	0.01	0.23	0.03	0.03	0.00	0.00	0.00	0.00	65.39	0.00	0.00	0.01	0.93	66.33
		Main Engine (Maneuvering)	25	100%	1,498,372	288.39	4.03	66.13	8.91	8.63	0.37	0.00	0.51	0.02	18,605.20	0.12	0.89	2.88	265.62	18,873.69
		Auxiliary Engine (Transit)	25	27%	362	0.07	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	4.07	0.00	0.00	0.00	0.06	4.13
		Auxiliary Engine (Maneuvering)	25	100%	427,261	85.65	1.04	18.39	2.37	2.30	0.04	0.00	0.13	0.00	4,807.00	0.03	0.23	0.74	68.51	4,876.25
US Jack Up Feeder 1	Jack up	Main Engine (Transit)	25	27%	57,215	11.01	0.15	2.53	0.34	0.33	0.01	0.00	0.02	0.00	710.43	0.00	0.03	0.11	10.14	720.68
		Main Engine (Maneuvering)	25	100%	157,168	30.25	0.42	6.94	0.93	0.90	0.04	0.00	0.05	0.00	1,951.54	0.01	0.09	0.30	27.86	1,979.71
		Auxiliary Engine (Transit)	25	27%	16,385	3.28	0.04	0.71	0.09	0.09	0.00	0.00	0.01	0.00	184.35	0.00	0.01	0.03	2.63	187.00
		Auxiliary Engine (Maneuvering)	25	100%	186,792	37.45	0.45	8.04	1.04	1.01	0.02	0.00	0.06	0.00	2,101.54	0.01	0.10	0.32	29.95	2,131.82
US Jack Up Feeder 2	Jack up	Main Engine (Transit)	25	27%	57,215	11.01	0.15	2.53	0.34	0.33	0.01	0.00	0.02	0.00	710.43	0.00	0.03	0.11	10.14	720.68
		Main Engine (Maneuvering)	25	100%	157,168	30.25	0.42	6.94	0.93	0.90	0.04	0.00	0.05	0.00	1,951.54	0.01	0.09	0.30	27.86	1,979.71
		Auxiliary Engine (Transit)	25	27%	16,385	3.28	0.04	0.71	0.09	0.09	0.00	0.00	0.01	0.00	184.35	0.00	0.01	0.03	2.63	187.00
		Auxiliary Engine (Maneuvering)	25	100%	186,792	37.45	0.45	8.04	1.04	1.01	0.02	0.00	0.06	0.00	2,101.54	0.01	0.10	0.32	29.95	2,131.82
Crew Transfer	Crew Transfer Vessel	Main Engine (Transit)	17	100%	8,322	1.32	0.02	0.33	0.04	0.04	0.00	0.00	0.00	0.00	93.63	0.00	0.00	0.01	1.33	94.98
		Main Engine (Maneuvering)	17	100%	156,578	24.87	0.38	6.25	0.84	0.82	0.02	0.00	0.05	0.00	1,761.51	0.01	0.08	0.27	25.11	1,786.89
		Auxiliary Engine (Transit)	17	100%	112	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.25	0.00	0.00	0.00	0.02	1.27
		Auxiliary Engine (Maneuvering)	17	100%	8,706	1.57	0.02	0.37	0.05	0.05	0.00	0.00	0.00	0.00	97.95	0.00	0.00	0.02	1.40	99.37
WTG Commissioning SOV	Service Operation Vessel	Main Engine (Transit)	25	27%	244	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	2.69	0.00	0.00	0.00	0.04	2.73
		Main Engine (Maneuvering)	25	100%	187,446	30.88	0.81	7.16	1.11	1.07	0.28	0.00	0.09	0.01	2,066.02	0.01	0.10	0.33	30.06	2,096.40
		Auxiliary Engine (Transit)	25	27%	41	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.01	0.46
		Auxiliary Engine (Maneuvering)	25	100%	31,241	5.36	0.08	1.34	0.17	0.17	0.00	0.00	0.01	0.00	351.48	0.00	0.02	0.05	5.01	356.55

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Export Cable Installation																				
Cable Installation Vessel 1		Main Engine (Transit)	25	27%	2,358	0.39	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	25.99	0.00	0.00	0.00	0.38	26.37
		Main Engine (Maneuvering)	25	51%	242,448	39.94	1.05	9.26	1.43	1.39	0.36	0.00	0.11	0.02	2,672.25	0.02	0.13	0.42	38.87	2,711.54
		Auxiliary Engine (Transit)	25	27%	498	0.09	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	5.60	0.00	0.00	0.00	0.08	5.68
		Auxiliary Engine (Maneuvering)	25	51%	212,474	36.47	0.52	9.15	1.18	1.14	0.02	0.00	0.07	0.00	2,390.48	0.01	0.11	0.37	34.07	2,424.92
Cable Installation Vessel 2		Main Engine (Transit)	25	27%	2,358	0.39	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	25.99	0.00	0.00	0.00	0.38	26.37
		Main Engine (Maneuvering)	25	51%	242,448	39.94	1.05	9.26	1.43	1.39	0.36	0.00	0.11	0.02	2,672.25	0.02	0.13	0.42	38.87	2,711.54
		Auxiliary Engine (Transit)	25	27%	498	0.09	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	5.60	0.00	0.00	0.00	0.08	5.68
		Auxiliary Engine (Maneuvering)	25	51%	212,474	36.47	0.52	9.15	1.18	1.14	0.02	0.00	0.07	0.00	2,390.48	0.01	0.11	0.37	34.07	2,424.92
Support and Jointing Vessel		Main Engine (Transit)	25	27%	1,709	0.28	0.01	0.07	0.01	0.01	0.00	0.00	0.00	0.00	18.84	0.00	0.00	0.00	0.27	19.12
		Main Engine (Maneuvering)	25	51%	35,358	5.82	0.15	1.35	0.21	0.20	0.05	0.00	0.02	0.00	389.71	0.00	0.02	0.06	5.67	395.44
		Auxiliary Engine (Transit)	25	27%	354	0.06	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	3.98	0.00	0.00	0.00	0.06	4.03
		Auxiliary Engine (Maneuvering)	25	51%	30,345	5.21	0.07	1.31	0.17	0.16	0.00	0.00	0.01	0.00	341.40	0.00	0.02	0.05	4.87	346.32
TSHD	Dredger	Main Engine (Transit)	25	27%	338	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	0.00	0.05	3.75
		Main Engine (Maneuvering)	25	51%	25,371	4.23	0.12	0.94	0.16	0.15	0.05	0.00	0.01	0.00	277.70	0.00	0.01	0.04	4.07	281.81
		Auxiliary Engine (Transit)	25	27%	170	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.91	0.00	0.00	0.00	0.03	1.94
		Auxiliary Engine (Maneuvering)	25	51%	52,866	9.04	0.13	2.28	0.29	0.28	0.01	0.00	0.02	0.00	594.78	0.00	0.03	0.09	8.48	603.35
AHTS	Tug	Main Engine (Transit)	25	27%	2,372	0.39	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	26.50	0.00	0.00	0.00	0.38	26.88
		Main Engine (Maneuvering)	25	51%	72,893	12.04	0.23	2.90	0.42	0.40	0.04	0.00	0.03	0.00	814.35	0.01	0.04	0.13	11.69	826.17
		Auxiliary Engine (Transit)	25	27%	112	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.26	0.00	0.00	0.00	0.02	1.28
		Auxiliary Engine (Maneuvering)	25	51%	14,279	2.50	0.03	0.61	0.08	0.08	0.00	0.00	0.00	0.00	160.65	0.00	0.01	0.02	2.29	162.96
Post-Install Rock Protection	Rock Dumping Vessel (Fall Pipe Vessel)	Main Engine (Transit)	25	10%	5,640	0.93	0.02	0.22	0.03	0.03	0.01	0.00	0.00	0.00	62.17	0.00	0.00	0.01	0.90	63.08
		Main Engine (Maneuvering)	25	51%	9,999	1.65	0.04	0.38	0.06	0.06	0.01	0.00	0.00	0.00	110.21	0.00	0.01	0.02	1.60	111.83
		Auxiliary Engine (Transit)	25	10%	525	0.09	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	5.90	0.00	0.00	0.00	0.08	5.99
		Auxiliary Engine (Maneuvering)	25	51%	3,860	0.66	0.01	0.17	0.02	0.02	0.00	0.00	0.00	0.00	43.42	0.00	0.00	0.01	0.62	44.05
Fuel Bunkering																				
Towing Tug	Tug	Main Engine (Transit)	25	27%	15,971	2.64	0.05	0.63	0.09	0.09	0.01	0.00	0.01	0.00	178.43	0.00	0.01	0.03	2.56	181.02
		Main Engine (Maneuvering)	25	100%	123,153	20.35	0.38	4.89	0.71	0.68	0.07	0.00	0.05	0.00	1,375.86	0.01	0.07	0.21	19.75	1,395.82
		Auxiliary Engine (Transit)	25	27%	387	0.07	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	4.35	0.00	0.00	0.00	0.06	4.41
		Auxiliary Engine (Maneuvering)	25	100%	12,374	2.17	0.03	0.53	0.07	0.07	0.00	0.00	0.00	0.00	139.22	0.00	0.01	0.02	1.98	141.22
Barge	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	82	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.92	0.00	0.00	0.00	0.01	0.94
		Auxiliary Engine (Maneuvering)	25	100%	2,622	0.57	0.01	0.11	0.01	0.01	0.00	0.00	0.00	0.00	29.50	0.00	0.00	0.00	0.42	29.92
Motion Compensation	Motion Compensation	Motion Compensation Engine	N/A	100%	68,571	4.23	0.52	3.70	0.21	0.21	0.01	0.00	0.01	0.00	782.65	0.03	0.01	0.79	1.89	785.34
Commissioning Generators																				
OSS Commissioning Generators	Generator	Marine Tier 3 Generator	N/A	100%	24,000	2.15	0.26	1.85	0.04	0.04	0.00	0.00	0.01	0.00	273.93	0.01	0.00	0.28	0.66	274.87
WTG Commissioning Generators	Generator	Marine Tier 3 Generator	N/A	100%	25,303	2.11	0.25	1.95	0.05	0.05	0.00	0.00	0.01	0.00	288.80	0.01	0.00	0.29	0.70	289.79
Miscellaneous																				
Marine Paint	N/A	N/A	N/A	100%	N/A	N/A	0.75	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fuel Evaporation	N/A	N/A	N/A	100%	N/A	N/A	0.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Trips	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit	Operating Days in WTA	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Emissions During Construction																	
Foundation Installation (FOU) B02																	
Medium HLV	Heavy Lift Vessel	Main Engine (Transit)	6	4 x 3840kW 2 x 4800kW	24,960	3 main	Europe	1	250	500	10	50	0	0	0	50	7M
		Main Engine (Maneuvering)	6	4 x 3840kW 2 x 4800kW	24,960	3 main		0	250	0	10	0	140	24	3,360	3,360	7M
		Auxiliary Engine (Transit)	1	1,110	1,110	3 Auxiliary		1	250	500	10	50	0	0	0	50	7A
		Auxiliary Engine (Maneuvering)	1	1,110	1,110	3 Auxiliary		0	250	0	10	0	140	24	3,360	3,360	7A
Bubble Curtain Support Vessel	Tug	Main Engine (Transit)	2	5,530	11,060	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	11M
		Main Engine (Maneuvering)	2	5,530	11,060	1 & 2 main		0	91	0	10	0	140	24	3,360	3,360	11M
		Auxiliary Engine (Transit)	0	5,530	0	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	11A
		Auxiliary Engine (Maneuvering)	0	5,530	0	1 & 2 auxiliary		0	91	0	10	0	140	24	3,360	3,360	11A
Barge 1	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	24	91	4,380	7	626	0	0	0	626	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	7	0	140	24	3,360	3,360	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		24	91	4,380	7	626	0	0	0	626	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	7	0	140	24	3,360	3,360	2A
Barge 2	Barge	Main Engine (Transit)	0	0	0	1 & 2 main	NJWP	24	91	4,380	7	626	0	0	0	626	2M
		Main Engine (Maneuvering)	0	0	0	1 & 2 main		0	91	0	7	0	140	24	3,360	3,360	2M
		Auxiliary Engine (Transit)	1	50	50	1 & 2 auxiliary		24	91	4,380	7	626	0	0	0	626	2A
		Auxiliary Engine (Maneuvering)	1	50	50	1 & 2 auxiliary		0	91	0	7	0	140	24	3,360	3,360	2A
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	24	91	4,380	7	626	0	0	0	626	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	7	0	140	24	3,360	3,360	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		24	91	4,380	7	626	0	0	0	626	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	7	0	140	24	3,360	3,360	11A
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	2	2,525	5,050	1 & 2 main	NJWP	24	91	4,380	7	626	0	0	0	626	11M
		Main Engine (Maneuvering)	2	2,525	5,050	1 & 2 main		0	91	0	7	0	140	24	3,360	3,360	11M
		Auxiliary Engine (Transit)	3	79	236	1 & 2 auxiliary		24	91	4,380	7	626	0	0	0	626	11A
		Auxiliary Engine (Maneuvering)	3	79	236	1 & 2 auxiliary		0	91	0	7	0	140	24	3,360	3,360	11A
Crew Transfer / PSO / Noise Monitoring Vessel	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	81	17	2,815	29	99	0	0	0	99	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	29	0	140	24	3,360	3,360	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		81	17	2,815	29	99	0	0	0	99	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	29	0	140	24	3,360	3,360	4A
Bubble Curtain Power	Air Compressor	Air Compressor	20	399	7,980	Tier 3 Non-Road	N/A	0	0	0	0	0	140	8	1,120	1,120	16
Hydraulic Hammer Power	Hydraulic Hammer Engine	Hammer Engine	3	597	1,791	Tier 2 Non-Road	N/A	0	0	0	0	0	140	8	1,120	1,120	18

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Construction																			
Foundation Installation (FOU) B02																			
Medium HLV	Heavy Lift Vessel	Main Engine (Transit)	0.83	59,503	11.45	0.16	2.63	0.35	0.34	0.01	0.00	0.02	0.0007	738.85	0.00	0.04	0.11	10.55	749.51
		Main Engine (Maneuvering)	0.10	481,761	92.72	1.29	21.26	2.87	2.77	0.12	0.00	0.16	0.0055	5,982.00	0.04	0.29	0.92	85.40	6,068.32
		Auxiliary Engine (Transit)	0.56	2,094	0.40	0.00	0.08	0.01	0.01	0.00	0.00	0.00	0.0000	22.21	0.00	0.00	0.00	0.32	22.53
		Auxiliary Engine (Maneuvering)	0.56	140,730	26.59	0.32	5.71	0.74	0.71	0.01	0.00	0.04	0.0006	1,492.33	0.01	0.07	0.23	21.27	1,513.82
Bubble Curtain Support Vessel	Tug	Main Engine (Transit)	0.83	10,639	1.76	0.03	0.42	0.06	0.06	0.01	0.00	0.00	0.0003	118.86	0.00	0.01	0.02	1.71	120.58
		Main Engine (Maneuvering)	0.10	236,008	39.00	0.74	9.38	1.35	1.31	0.14	0.00	0.09	0.0062	2,636.67	0.02	0.13	0.41	37.84	2,674.92
		Auxiliary Engine (Transit)	0.43	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Maneuvering)	0.43	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
Barge 1	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	854	0.19	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.0000	9.61	0.00	0.00	0.00	0.14	9.75
		Auxiliary Engine (Maneuvering)	0.43	4,588	1.00	0.01	0.20	0.03	0.02	0.00	0.00	0.00	0.0000	51.62	0.00	0.00	0.01	0.74	52.36
Barge 2	Barge	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.10	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	0.43	854	0.19	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.0000	9.61	0.00	0.00	0.00	0.14	9.75
		Auxiliary Engine (Maneuvering)	0.43	4,588	1.00	0.01	0.20	0.03	0.02	0.00	0.00	0.00	0.0000	51.62	0.00	0.00	0.01	0.74	52.36
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	0.83	166,545	27.52	0.52	6.62	0.95	0.93	0.10	0.00	0.06	0.0044	1,860.63	0.01	0.09	0.29	26.70	1,887.62
		Main Engine (Maneuvering)	0.10	107,759	17.81	0.34	4.28	0.62	0.60	0.06	0.00	0.04	0.0028	1,203.87	0.01	0.06	0.19	17.28	1,221.34
		Auxiliary Engine (Transit)	0.43	4,032	0.71	0.01	0.17	0.02	0.02	0.00	0.00	0.00	0.0000	45.37	0.00	0.00	0.01	0.65	46.02
		Auxiliary Engine (Maneuvering)	0.43	21,655	3.80	0.05	0.93	0.12	0.12	0.00	0.00	0.01	0.0001	243.63	0.00	0.01	0.04	3.47	247.14
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	0.83	166,545	27.52	0.52	6.62	0.95	0.93	0.10	0.00	0.06	0.0044	1,860.63	0.01	0.09	0.29	26.70	1,887.62
		Main Engine (Maneuvering)	0.10	107,759	17.81	0.34	4.28	0.62	0.60	0.06	0.00	0.04	0.0028	1,203.87	0.01	0.06	0.19	17.28	1,221.34
		Auxiliary Engine (Transit)	0.43	4,032	0.71	0.01	0.17	0.02	0.02	0.00	0.00	0.00	0.0000	45.37	0.00	0.00	0.01	0.65	46.02
		Auxiliary Engine (Maneuvering)	0.43	21,655	3.80	0.05	0.93	0.12	0.12	0.00	0.00	0.01	0.0001	243.63	0.00	0.01	0.04	3.47	247.14
Crew Transfer / PSO / Noise Monitoring Vessel	Crew Transfer Vessel	Main Engine (Transit)	0.83	10,873	1.73	0.03	0.43	0.06	0.06	0.00	0.00	0.00	0.0001	122.32	0.00	0.01	0.02	1.74	124.08
		Main Engine (Maneuvering)	0.10	44,555	7.08	0.11	1.78	0.24	0.23	0.00	0.00	0.01	0.0002	501.24	0.00	0.02	0.08	7.14	508.46
		Auxiliary Engine (Transit)	0.43	146	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.64	0.00	0.00	0.00	0.02	1.66
		Auxiliary Engine (Maneuvering)	0.43	4,955	0.89	0.01	0.21	0.03	0.03	0.00	0.00	0.00	0.0000	55.75	0.00	0.00	0.01	0.79	56.55
Bubble Curtain Power	Air Compressor	Air Compressor	1.00	638,400	39.41	4.93	34.48	1.97	1.97	0.07	0.00	0.17	0.0031	7,286.51	0.30	0.06	7.39	17.62	7,311.52
Hydraulic Hammer Power	Hydraulic Hammer Engine	Hammer Engine	1.00	143,280	14.15	1.75	7.74	0.44	0.44	0.02	0.00	0.02	0.0007	1,635.36	0.07	0.01	1.66	3.95	1,640.97

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Construction																				
Foundation Installation (FOU) B02																				
Medium HLV	Heavy Lift Vessel	Main Engine (Transit)	25	10%	5,950	1.15	0.02	0.26	0.04	0.03	0.00	0.00	0.00	0.0001	73.88	0.00	0.00	0.01	1.05	74.95
		Main Engine (Maneuvering)	25	100%	481,761	92.72	1.29	21.26	2.87	2.77	0.12	0.00	0.16	0.0055	5,982.00	0.04	0.29	0.92	85.40	6,068.32
		Auxiliary Engine (Transit)	25	10%	209	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	2.22	0.00	0.00	0.00	0.03	2.25
		Auxiliary Engine (Maneuvering)	25	100%	140,730	26.59	0.32	5.71	0.74	0.71	0.01	0.00	0.04	0.0006	1,492.33	0.01	0.07	0.23	21.27	1,513.82
Bubble Curtain Support Vessel	Tug	Main Engine (Transit)	25	27%	2,915	0.48	0.01	0.12	0.02	0.02	0.00	0.00	0.00	0.0001	32.57	0.00	0.00	0.01	0.47	33.04
		Main Engine (Maneuvering)	25	100%	236,008	39.00	0.74	9.38	1.35	1.31	0.14	0.00	0.09	0.0062	2,636.67	0.02	0.13	0.41	37.84	2,674.92
		Auxiliary Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
Barge 1	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	234	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	2.63	0.00	0.00	0.00	0.04	2.67
		Auxiliary Engine (Maneuvering)	25	100%	4,588	1.00	0.01	0.20	0.03	0.02	0.00	0.00	0.00	0.0000	51.62	0.00	0.00	0.01	0.74	52.36
Barge 2	Barge	Main Engine (Transit)	25	27%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	25	100%	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Transit)	25	27%	234	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	2.63	0.00	0.00	0.00	0.04	2.67
		Auxiliary Engine (Maneuvering)	25	100%	4,588	1.00	0.01	0.20	0.03	0.02	0.00	0.00	0.00	0.0000	51.62	0.00	0.00	0.01	0.74	52.36
US Towing Tug 1	US Towing Tug	Main Engine (Transit)	25	27%	45,633	7.54	0.14	1.81	0.26	0.25	0.03	0.00	0.02	0.0012	509.80	0.00	0.02	0.08	7.32	517.20
		Main Engine (Maneuvering)	25	100%	107,759	17.81	0.34	4.28	0.62	0.60	0.06	0.00	0.04	0.0028	1,203.87	0.01	0.06	0.19	17.28	1,221.34
		Auxiliary Engine (Transit)	25	27%	1,105	0.19	0.00	0.05	0.01	0.01	0.00	0.00	0.00	0.0000	12.43	0.00	0.00	0.00	0.18	12.61
		Auxiliary Engine (Maneuvering)	25	100%	21,655	3.80	0.05	0.93	0.12	0.12	0.00	0.00	0.01	0.0001	243.63	0.00	0.01	0.04	3.47	247.14
US Towing Tug 2	US Towing Tug	Main Engine (Transit)	25	27%	45,633	7.54	0.14	1.81	0.26	0.25	0.03	0.00	0.02	0.0012	509.80	0.00	0.02	0.08	7.32	517.20
		Main Engine (Maneuvering)	25	100%	107,759	17.81	0.34	4.28	0.62	0.60	0.06	0.00	0.04	0.0028	1,203.87	0.01	0.06	0.19	17.28	1,221.34
		Auxiliary Engine (Transit)	25	27%	1,105	0.19	0.00	0.05	0.01	0.01	0.00	0.00	0.00	0.0000	12.43	0.00	0.00	0.00	0.18	12.61
		Auxiliary Engine (Maneuvering)	25	100%	21,655	3.80	0.05	0.93	0.12	0.12	0.00	0.00	0.01	0.0001	243.63	0.00	0.01	0.04	3.47	247.14
Crew Transfer / PSO / Noise Monitoring Vessel	Crew Transfer Vessel	Main Engine (Transit)	17	100%	10,873	1.73	0.03	0.43	0.06	0.06	0.00	0.00	0.00	0.0001	122.32	0.00	0.01	0.02	1.74	124.08
		Main Engine (Maneuvering)	17	100%	44,555	7.08	0.11	1.78	0.24	0.23	0.00	0.00	0.01	0.0002	501.24	0.00	0.02	0.08	7.14	508.46
		Auxiliary Engine (Transit)	17	100%	146	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.0000	1.64	0.00	0.00	0.00	0.02	1.66
		Auxiliary Engine (Maneuvering)	17	100%	4,955	0.89	0.01	0.21	0.03	0.03	0.00	0.00	0.00	0.0000	55.75	0.00	0.00	0.01	0.79	56.55
Bubble Curtain Power	Air Compressor	Air Compressor	N/A	100%	638,400	39.41	4.93	34.48	1.97	1.97	0.07	0.00	0.17	0.0031	7,286.51	0.30	0.06	7.39	17.62	7,311.52
Hydraulic Hammer Power	Hydraulic Hammer Engine	Hammer Engine	N/A	100%	143,280	14.15	1.75	7.74	0.44	0.44	0.02	0.00	0.02	0.0007	1,635.36	0.07	0.01	1.66	3.95	1,640.97

BOEM Emissions Tool Default Vessel Emissions Factors

EF Ref	Vessel Type	Engine type	Emission Factors (g/kWh)										
			NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	CO2	CH4	N2O
1M	Anchor Handling Tugs	Main	9.26	0.24	2.16	0.34	0.33	0.079	4.0E-05	0.026	636.09	0.004	0.031
1A		Auxiliary	9.88	0.14	2.48	0.32	0.31	0.006	4.8E-05	0.018	648.20	0.004	0.031
2M	Barge	Main	13.61	0.63	1.40	0.45	0.42	0.362	1.2E-05	0.060	588.90	0.004	0.031
2A		Auxiliary	12.57	0.14	2.48	0.32	0.31	0.006	4.8E-05	0.018	648.20	0.004	0.031
3M	Cable Laying	Main	9.49	0.25	2.20	0.34	0.33	0.085	3.9E-05	0.027	635.02	0.004	0.031
3A		Auxiliary	9.89	0.14	2.48	0.32	0.31	0.006	4.8E-05	0.018	648.20	0.004	0.031
4M	Crew	Main	9.15	0.14	2.30	0.31	0.30	0.006	4.6E-05	0.018	648.16	0.004	0.031
4A		Auxiliary	10.39	0.14	2.48	0.32	0.31	0.006	4.8E-05	0.018	648.20	0.004	0.031
5M	Dredging	Main	9.60	0.28	2.13	0.36	0.34	0.112	3.7E-05	0.030	630.62	0.004	0.031
5A		Auxiliary	9.85	0.14	2.48	0.32	0.31	0.006	4.8E-05	0.018	648.20	0.004	0.031
6M	Ice Breaker	Main	9.92	0.45	1.78	0.40	0.38	0.230	2.5E-05	0.044	610.83	0.004	0.031
6A		Auxiliary	10.09	0.14	2.48	0.32	0.31	0.006	4.8E-05	0.018	648.20	0.004	0.031
7M	Jackup	Main	10.03	0.14	2.30	0.31	0.30	0.013	4.5E-05	0.018	647.08	0.004	0.031
7A		Auxiliary	11.55	0.14	2.48	0.32	0.31	0.006	4.8E-05	0.018	648.20	0.004	0.031
8M	Research / Survey	Main	9.86	0.22	2.25	0.34	0.33	0.066	4.2E-05	0.025	638.26	0.004	0.031
8A		Auxiliary	10.21	0.14	2.48	0.32	0.31	0.006	4.8E-05	0.018	648.20	0.004	0.031
9M	Shuttle Tanker	Main	9.05	0.63	1.40	0.45	0.42	0.362	1.2E-05	0.060	588.90	0.004	0.031
9A		Auxiliary	9.80	0.14	2.48	0.32	0.31	0.006	4.8E-05	0.018	648.20	0.004	0.031
10M	Supply Ship	Main	9.44	0.17	2.29	0.32	0.31	0.028	4.5E-05	0.020	644.58	0.004	0.031
10A		Auxiliary	10.43	0.14	2.48	0.32	0.31	0.006	4.8E-05	0.018	648.20	0.004	0.031
11M	Tug	Main	9.52	0.18	2.29	0.33	0.32	0.033	4.5E-05	0.021	643.66	0.004	0.031
11A		Auxiliary	10.10	0.14	2.48	0.32	0.31	0.006	4.8E-05	0.018	648.20	0.004	0.031

BOEM Emissions Tool Default Helicopter Emissions Factors

EF Ref	Engine	Size (kW)	Emission Factors (lb/hr)										
			NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	CO2	CH4	N2O
12	Helicopter	Single	2.32	1.63	1.89	0.07	0.07	0.300	0.0E+00	N/A	956.92	0.030	0.030
13	Helicopter	Twin Light	3.14	3.66	4.28	0.10	0.09	0.500	0.0E+00	N/A	1589.69	0.040	0.050
14	Helicopter	Twin Medium	7.22	3.02	3.48	0.20	0.20	0.780	0.0E+00	N/A	2459.92	0.070	0.080
15	Helicopter	Twin heavy	34.66	2.40	2.67	0.82	0.80	2.110	0.0E+00	N/A	6640.46	0.190	0.220

Load Factors for Main Engines

Vessel/Engine	Activity	Load Factor
Cat. 3 Main (Propulsion) Engine	Transit/cruise	0.83
Cat. 3 Main (Propulsion) Engine	Maneuvering	0.2
Cat. 3 Main (Propulsion) Engine	Hoteling	0
Cat. 1/2 Main (Propulsion) Engine	Transit/cruise	0.83
Cat. 1/2 Main (Propulsion) Engine	Maneuvering	0.2
Cat. 1/2 Main (Propulsion) Engine	Hoteling	0

Load Factors for Auxiliary Engines on Vessels w/ Cat. 3 Main Engines

Vessel Type	Maneuver	Hotel
Bulk Carrier	0.45	0.1
Bulk Carrier, Laker	0.45	0.22
Buoy Tender	0.45	0.19
Container	0.48	0.26
Crude Oil Tanker	0.33	0.22
Drilling	0.45	0.22
Fishing	0.45	0.22
Floating Production and Storage Offloading	0.45	0.22
General Cargo	0.45	0.22
Icebreaker	0.45	0.22
Jackup	0.45	0.22
LNG Tanker	0.33	0.26
LPG Tanker	0.33	0.26
Misc.	0.45	0.22
Passenger	0.8	0.64
Pipelaying	0.45	0.22
Reefer	0.67	0.32
Research	0.45	0.22
RORO	0.45	0.26
Supply	0.45	0.22
Support	0.45	0.22
Tanker	0.33	0.26
Tug	0.45	0.22
Vehicle Carrier	0.45	0.22
Well stimulation	0.45	0.22

Table 4-120 of https://www.epa.gov/sites/production/files/2018-07/documents/nei2014v2_tsd_05jul2018.pdf

Emissions Factors for Engines													
EF Ref	Engine	Size (kW)	Emission Factors (g/kWh)										
			NOx[1]	VOC[2]	CO	PM10	PM2.5	SO2[3]	Pb	HAPs[5]	CO2[4]	CH4[4]	N2O[4]
16	Air Compressor Engines	~399	4	0.5	3.5	0.2	0.2	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
17	Motion Compensation Engines	500	4	0.495	3.5	0.2	0.2	0.0068	0.00E+00	7.14E-03	739.60	0.030	0.0060
18	Cat C18 Acert	597	6.4	0.8	3.5	0.2	0.2	0.0068	0.00E+00	7.14E-03	739.60	0.030	0.0060
19	Tier 2 Engines 0-8 kW	0-8	7.5	0.929	8	0.8	0.8	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
20	Tier 2 Engines 8-19 kW	8-19	7.5	0.929	6.6	0.8	0.8	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
21	Tier 2 Engines 19-37 kW	19-37	7.5	0.929	5.5	0.6	0.6	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
22	Tier 3 Engines 37-75 kW	37-75	4.7	0.582	5	0.4	0.4	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
23	Tier 3 Engines 75-130 kW	75-130	4	0.495	5	0.3	0.3	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
24	Tier 3 Engines 130-225 kW	130-225	4	0.495	3.5	0.2	0.2	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
25	Tier 3 Engines 225-450 kW	225-450	4	0.495	3.5	0.2	0.2	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
26	Tier 3 Engines 450-560 kW	450-560	4	0.495	3.5	0.2	0.2	0.0068	0.00E+00	7.14E-03	739.60	0.030	0.0060
27	Tier 2 Engines >560 kW	>560	6.4	0.792	3.5	0.2	0.2	0.0068	0.00E+00	7.14E-03	739.60	0.030	0.0060
30	Tier 4 Engine 130-560 kW	130-560	0.67	0.19	3.5	0.02	0.02	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
31	OSS Commissioning Generator	500 kW	5.80	0.70	5.00	0.10	0.10	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
32	WTG Commissioning Generator	240 kW	5.40	0.65	5.00	0.12	0.12	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060

1 NOx emission values are assumed to be 100% of the relevant tier standard for NOx+NMHC if no separate NOx standard

2 VOC emission values are assumed to be 12% of the relevant tier standard for NOx+NMHC if no separate VOC/NMHC standard

3 Based on ULSD Fuel Sulfur of 0.0015%, fuel density of ~7lb/gal, fuel heat content of ~0.14 MMBtu/gal, and SO2:Sulfur ratio of 2.0

4 Based on GHG emissions and heat content of ULSD from 40 CFR 98 Tables C-1 and C-2 and an assumed engine efficiency of 10,000 Btu/kW

5 HAP Emission Factors are in lb/MMBtu in AP-42 and converted to g/kwH based on an assumed 10,000 btu/kW

Commuting Emissions													
EF Ref	Engine	Fuel	Emission Factors (g/VMT)										
			NOx[1]	VOC[1]	CO[1]	PM10[1]	PM2.5[1]	SO2[2]	Pb	HAPs	CO2[3]	CH4[3]	N2O[3]
28	Light-duty vehicles	Gasoline	0.289	0.35	3.94	0.012	0.012	0.0025	0.00E+00	N/A	393.61	0.017	0.0034
29	Light-duty trucks	Gasoline	0.478	0.421	5.66	0.014	0.014	0.0025	0.00E+00	N/A	393.61	0.017	0.0034

1 2018 values from Table 4-43 "Estimated U.S. Average Vehicle emissions Rates per Vehicle by Vehicle Type Using Gasoline and Diesel" at https://www.bts.gov/content/estimated-national-average-vehicle-emissions-rates-vehicle-vehicle-type-using-gasoline-and

2 Based on 10 ppm sulfur in gasoline, 6.07 lb/gal density, fleet average of 22.3 mpg, and SO2 to Sulfur weight ratio of 2.

3 Based on GHG emissions and heat content of motor gasoline from 40 CFR 98 Tables C-1 and C-2 and fleet average of 22.3 mpg

4 Fleet average MPG is from Table 4-23M from Bureau of Transportation Statistics found here: https://www.bts.gov/content/average-fuel-efficiency-us-passenger-cars-and-light-trucks

Load Factors for Auxiliary Engines on Vessels w/ Cat. 1 & 2 Main	
Vessel Group	Auxiliary Operating Load Factor
Bulk Carrier	0.1
Commercial Fishing	0.43
Container Ship	0.19
Ferry Excursion	0.43
General Cargo	0.22
Government	0.43
Miscellaneous	0.43
Offshore support	0.56
Reefer	0.32
RORO	0.26
Tanker	0.26
Tug	0.43
Work Boat	0.43

Eastern Research Group. 2019. Category 1 and 2 Commercial Marine Vessel 2017 Emissions Inventory (2019). Table 4. Auxiliary and Boiler Power Surrogates.

Load Factors for Auxiliary Engines on Vessels w/ Cat. 3 Main Engines			
EPA Vessel Type (NEI Vessel Types)	Cruise	RSZ	Maneuver
Auto Carrier	0.15	0.3	0.45
Bulk Carrier	0.17	0.27	0.45
Container Ship	0.13	0.25	0.48
Cruise Ship (Passenger)	0.8	0.8	0.8
General Cargo (Supply, Vehicle Carrier)	0.17	0.27	0.45
Miscellaneous (Buoy Tender, Drilling, Fishing, FPSO, Icebreaker, Jackup, Miscellaneous, Pipelaying, Research, Support, Well Stimulation)	0.17	0.27	0.45
OG Tug (Tug)	0.17	0.27	0.45
Reefer	0.2	0.34	0.67
RORO	0.15	0.3	0.45
Tanker (LNG Tanker, LPG Tanker, Crude Oil Tanker)	0.24	0.28	0.33

Sources:

EPA. 2009. Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories: Final

EPA. 2015. Commercial Marine Vessels – 2014 NEI Commercial Marine Vessels Final. Table 4-17: Auxiliary

Fuel Use Factors		
Engine Type	**Fuel Use (g/kWh)**	**Fuel Use (gal/kWh)**
Slow-speed Diesel, Marine Diesel Oil[1]	185	0.057
Medium-speed Diesel, Marine Diesel Oil[1]	203	0.063
Medium-speed Diesel, Marine Diesel Oil Auxiliary[1]	217	0.067
Cat. 1 & 2 (main and auxiliary)[2]	N/A	0.064

1 From "Current Methodologies and Best Practices in Preparing Port Emission Inventories" April 2009, Table 2-9: Emission Factors for OGV Main Engines, Table 2-16: Auxiliary Engine Emission Factors
2 Calculated from BOEM CO2 emission rate for Cat. 1 & 2 Marine Engines below

Fuel Use Calculations	
Diesel Fuel Density (lb/gal)[1]	7.10
Distillate Fuel No. 2 Higher Heating Value (MMBtu/gal)[2]	0.138
Distillate Fuel No. 2 CO2 Emission Factor (kg CO2/MMBtu)[2]	73.96
Cat. 1 & 2 Main Engine CO2 Emission Factor (g/kW*hr)[3]	648.20
Cat. 1 & 2 (main and auxiliary)) fuel use (gal/kWh)	0.064

1 From Table 3.4-1 AP 42
2 From 40 CFR Part 98 Table C-1: Default CO2 Emission Factors and High Heat Values for Various Types of Fuel
3 From BOEM Offshore Wind Energy Facilities Emission Estimating Tool Technical Documentation Table 3: Weighted Marine Vessel Emission Factors

Global Warming Potentials[1]	
Compound	**GWP**
CH4	25
N2O	298

1 Table A-1 of 40 CFR 98

Overall COP South Port Distance			
Port Name	**Lookup**	**Port Distance (Mi)**	**Port Distance (NM)**
Atlantic City	Atlantic City	20	17
New Jersey Wind Port	NJWP	105	91
Europe	Europe	288	250
Paulsboro	Paulsboro	145	126

Overall COP South Port Distance in OCS Applicability Zone			
Port Name	**Lookup**	**Port Distance (Mi)**	**Port Distance (NM)**
Atlantic City	Atlantic City	20	17
New Jersey Wind Port	NJWP	29	25
Europe	Europe	29	25
Paulsboro	Paulsboro	29	25

Max Export Cable Included in OCS Area	51%	
measured export cable length max in OCS area	37.74	miles
measured export cable length max	73.86	miles
North Export Cable OCS	29.19	miles
North Export Cable Total	61.86	miles
South Export Cable OCS	8.55	miles
South Export Cable Total	12	miles

2017 NEI HAPs for Marine Vessels		
Pollutant	**Basis**	**Fraction**
1,3-Butadiene	VOC	1.01E-03
2,2,4-Trimethylpentane	VOC	7.12E-03
Acenaphthene	VOC	5.09E-05
Acenaphthylene	VOC	1.18E-04
Acetaldehyde	VOC	9.78E-03
Acrolein	VOC	1.85E-03
Ammonia	PM2.5	1.92E-02
Anthracene	VOC	3.44E-04
Antimony	PM2.5	6.15E-04
Arsenic	PM2.5	2.59E-05
Benz[a]Anthracene	PM2.5	8.82E-06
Benzene	VOC	4.74E-03
Benzo[a]Pyrene	PM2.5	4.18E-06
Benzo[b]Fluoranthene	PM2.5	8.35E-06
Benzo[k]Fluoranthene	PM2.5	4.18E-06
Benzo(g,h,i)Fluoranthene	PM2.5	1.32E-04
Cadmium	PM2.5	2.36E-04
Chrysene	PM2.5	1.63E-05
Chromium (VI)	PM2.5	7.24E-09
Dibenzo[a,h]anthracene	PM2.5	8.65E-06
Ethyl Benzene	VOC	4.39E-04
Fluoranthene	PM2.5	8.97E-05
Fluorene	VOC	1.64E-04
Formaldehyde	VOC	4.27E-02
Indeno[1,2,3-c,d]Pyrene	PM2.5	8.35E-06
Lead	PM2.5	1.25E-04
Manganese	PM2.5	3.22E-06
Mercury	PM2.5	4.18E-08
Naphthalene	VOC	2.73E-03
Hexane	VOC	2.79E-03
Nickel	PM2.5	6.87E-04
Polychlorinated Biphenyls	PM2.5	4.18E-07
Phenanthrene	VOC	1.36E-03
Propionaldehyde	VOC	1.52E-03
Pyrene	PM2.5	3.37E-05
Selenium	PM2.5	4.38E-08
Toluene	VOC	2.04E-03
Xylenes (Mixed Isomers)	VOC	1.42E-03
o-Xylene	VOC	5.13E-04
Total Fraction of VOC		**0.0807**
Total Fraction of PM2.5		**0.0213**

*Source: EPA 2017 NEI Development Documentation - Methodology Documentation for EPA's Commercial Marine Emissions Estimates

Stationary Internal Combustion Engine (<600 HP) HAPs from AP-42 Chapter 3.3	
Pollutant	**Emission Factor (lb/mmBtu)**
Benzene	9.33E-04
Toluene	4.09E-04
Xylenes	2.85E-04
1,3-Butadiene	3.91E-05
Formaldehyde	1.18E-03
Acetaldehyde	7.67E-04
Acrolein	9.25E-05
Total PAH	1.68E-04
Total HAP	**3.87E-03**

Total HAP Emission Factor	
lb/MMBtu	3.87E-03
g/MMBtu	1.76
Btu/kW	10,000
MMBtu/kW	0.010
g/kW	**1.76E-02**

Stationary Internal Combustion Engine (>600 HP) HAPs from AP-42 Chapter 3.4	
Pollutant	**Emission Factor (lb/mmBtu)**
Benzene	7.76E-04
Toluene	2.81E-04
Xylenes	1.93E-04
Formaldehyde	7.89E-05
Acetaldehyde	2.52E-05
Acrolein	7.88E-06
Total PAH	2.12E-04
Total HAP	**1.57E-03**

Total HAP Emission Factor	
lb/MMBtu	1.57E-03
g/MMBtu	0.71
Btu/kW	10,000
MMBtu/kW	0.010
g/kW	**7.14E-03**

Mode		Yearly Operating Time	Avg. Engine Load Factor	Average Fuel Consumption per Year (L)	% of In Field (maneuvering)	Weighted Maneuvering Load Factor
1	Dynamic Positioning / gangway operations	40%	10%	640,000	42.6%	4.3%
2	Standby in field / hotel	33%	8%	465,000	35.1%	2.8%
3	In field transit	21%	15%	486,000	22.3%	3.4%
4	Transit to/from harbor	2%	**16%**	46,000	0.0%	0.0%
5	Harbor	4%	4%	28,000	0.0%	0.0%
Maneuvering					100.0%	**10.4%**

*Preliminary results for assessment of logistics options

~94% of activities in windfarm each year

85 m “standard” European SOV with 60 PAX and diesel electric propulsion system

Total engine capacity of 6,600 kW made up of 4x 1,650 kW generators

CTV Scenario Total Emissions																
Scenario	Fuel Consumption (gal/yr)	Emissions (tons per year)														
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Project 1 with Overlap	1,672,285.59	289.41	4.39	69.07	9.32	9.03	0.39	0.0014	0.54	0.02	19,270.51	0.12	0.92	3.00	274.80	21,805.24
Project 2 with Overlap	1,200,127.40	208.11	3.17	49.64	6.70	6.48	0.29	0.0010	0.39	0.01	13,840.33	0.09	0.66	2.16	197.29	15,729.96
Sum P1 and P2	2,872,413.00	497.52	7.56	118.71	16.02	15.51	0.69	0.0023	0.94	0.03	33,110.85	0.21	1.58	5.17	472.09	37,535.20
PDE	2,716,112.89	480.79	7.20	113.27	15.26	14.78	0.68	0.0022	0.89	0.03	31,524.48	0.20	1.51	4.92	449.50	35,497.48

SOV Scenario Total Emissions																
Scenario	Fuel Consumption (gal/yr)	Emissions (tons per year)														
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Project 1 with Overlap	1,967,419.75	344.3	6.1	81.3	11.2	10.9	1.1	0.0	0.7	0.1	22,476.3	0.1	1.1	3.5	322.1	25,058.9
Project 2 with Overlap	1,631,934.55	284.9	5.2	67.3	9.4	9.1	1.0	0.0	0.6	0.0	18,583.7	0.1	0.9	2.9	266.5	20,543.3
Sum P1 and P2	3,599,354.30	629.2	11.3	148.6	20.6	20.0	2.1	0.0	1.3	0.1	41,060.0	0.3	2.0	6.4	588.7	45,602.2
PDE	2,913,549.79	520.1	8.6	121.6	16.7	16.1	1.4	0.0	1.0	0.1	33,631.2	0.2	1.6	5.3	481.2	37,636.2

CTV Scenario OCS Emissions																
Scenario	Fuel Consumption (gal/yr)	Emissions (tons per year)														
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Project 1 with Overlap	1,371,852.04	232.6	3.6	56.1	7.6	7.3	0.3	0.0	0.4	0.0	15,643.4	0.1	0.7	2.4	222.9	18,125.7
Project 2 with Overlap	973,361.04	165.2	2.5	39.9	5.4	5.2	0.2	0.0	0.3	0.0	11,104.0	0.1	0.5	1.7	158.2	12,954.1
PDE	2,124,940.69	368.8	5.5	87.7	11.8	11.4	0.5	0.0	0.7	0.0	24,378.0	0.2	1.2	3.8	347.3	28,247.7

SOV Scenario OCS Emissions																
Scenario	Fuel Consumption (gal/yr)	Emissions (tons per year)														
		NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Project 1 with Overlap	1,666,986.20	287.5	5.2	68.3	9.5	9.2	1.0	0.0	0.6	0.0	18,849.1	0.1	0.9	3.0	270.3	21,379.3
Project 2 with Overlap	1,405,168.18	242.0	4.5	57.5	8.0	7.8	0.9	0.0	0.5	0.0	15,847.4	0.1	0.8	2.5	227.4	17,767.4
PDE	2,322,377.59	408.1	7.0	96.0	13.2	12.8	1.2	0.0	0.8	0.1	26,484.7	0.2	1.3	4.2	379.0	30,386.4

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Round Trips (per year)	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Emissions During Operations (CTV Scenario)																	
WTG and BoP Crew logistics																	
CTV all-year 1	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	250	17	8,690	20	434	0	0	0	434	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	250	12	3,000	3,000	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		250	17	8,690	20	434	0	0	0	434	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	250	12	3,000	3,000	4A
CTV all-year 2	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	250	17	8,690	20	434	0	0	0	434	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	250	12	3,000	3,000	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		250	17	8,690	20	434	0	0	0	434	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	250	12	3,000	3,000	4A
CTV all-year 3	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	250	17	8,690	20	434	0	0	0	434	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	250	12	3,000	3,000	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		250	17	8,690	20	434	0	0	0	434	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	250	12	3,000	3,000	4A
CTV all-year 4	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	250	17	8,690	20	434	0	0	0	434	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	250	12	3,000	3,000	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		250	17	8,690	20	434	0	0	0	434	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	250	12	3,000	3,000	4A
CTV all-year 5	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	250	17	8,690	20	434	0	0	0	434	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	250	12	3,000	3,000	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		250	17	8,690	20	434	0	0	0	434	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	250	12	3,000	3,000	4A
CTV Summer Campaign 1	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	124	17	4,310	20	216	0	0	0	216	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	124	12	1,488	1,488	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		124	17	4,310	20	216	0	0	0	216	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	124	12	1,488	1,488	4A
CTV Summer Campaign 2	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	124	17	4,310	20	216	0	0	0	216	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	124	12	1,488	1,488	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		124	17	4,310	20	216	0	0	0	216	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	124	12	1,488	1,488	4A
CTV Summer Campaign 3	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	124	17	4,310	20	216	0	0	0	216	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	124	12	1,488	1,488	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		124	17	4,310	20	216	0	0	0	216	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	124	12	1,488	1,488	4A
CTV Summer Campaign 4	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	124	17	4,310	20	216	0	0	0	216	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	124	12	1,488	1,488	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		124	17	4,310	20	216	0	0	0	216	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	124	12	1,488	1,488	4A
CTV Summer Campaign 5	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	124	17	4,310	20	216	0	0	0	216	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	124	12	1,488	1,488	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		124	17	4,310	20	216	0	0	0	216	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	124	12	1,488	1,488	4A
CTV Summer Campaign 6	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	124	17	4,310	20	216	0	0	0	216	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	124	12	1,488	1,488	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		124	17	4,310	20	216	0	0	0	216	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	124	12	1,488	1,488	4A
WTG heavy logistics / jack-up																	
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	NJWP	8	91	1,460	10	146	0	0	0	146	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	91	0	0	0	40	24	960	960	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		8	91	1,460	10	146	0	0	0	146	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	91	0	0	0	40	24	960	960	7A
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	2	2350	4,700	3 main	NJWP	8	91	1,460	10	146	0	0	0	146	7M
		Main Engine (Maneuvering)	2	2350	4,700	3 main		0	91	0	0	0	40	24	960	960	7M
		Auxiliary Engine (Transit)	2	1000	2,000	3 auxiliary		8	91	1,460	10	146	0	0	0	146	7A
		Auxiliary Engine (Maneuvering)	2	1000	2,000	3 auxiliary		0	91	0	0	0	40	24	960	960	7A
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	Europe	8	250	4,000	10	400	0	0	0	400	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	250	0	0	0	40	24	960	960	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		8	250	4,000	10	400	0	0	0	400	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	250	0	0	0	40	24	960	960	7A
Cable repair vessel - export cable																	
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0	0	7,280	1 & 2 main	NJWP	0.7	91	128	10	13	0	0	0	13	3M
		Main Engine (Maneuvering)	0	0	7,280	1 & 2 main		0	91	0	0	0	25	24	600	600	3M
		Auxiliary Engine (Transit)	0	0	220	1 & 2 auxiliary		0.7	91	128	10	13	0	0	0	13	3A
		Auxiliary Engine (Maneuvering)	0	0	220	1 & 2 auxiliary		0	91	0	0	0	25	24	600	600	3A

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Round Trips (per year)	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Cable repair vessel - arrray cable																	
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0	0	7,280	1 & 2 main	NJWP	0.9	91	164	10	16	0	0	0	16	3M
		Main Engine (Maneuvering)	0	0	7,280	1 & 2 main		0	91	0	0	0	11	24	264	264	3M
		Auxiliary Engine (Transit)	0	0	220	1 & 2 auxiliary		0.9	91	164	10	16	0	0	0	16	3A
		Auxiliary Engine (Maneuvering)	0	0	220	1 & 2 auxiliary		0	91	0	0	0	11	24	264	264	3A
Cable survey vessel - export cable																	
Cable survey vessel	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	91	0	0	0	30	24	720	720	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	91	0	0	0	30	24	720	720	8A
Cable survey vessel - arrray cable																	
Cable survey vessel	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	91	0	0	0	13	24	312	312	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	91	0	0	0	13	24	312	312	8A
Foundation below water inspection																	
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	Atlantic City	5	17	174	10	17	0	0	0	17	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	17	0	0	0	40	24	960	960	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		5	17	174	10	17	0	0	0	17	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	17	0	0	0	40	24	960	960	8A
Other vessels																	
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	12	17	417	20	21	0	0	0	21	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	12	8	96	96	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		12	17	417	20	21	0	0	0	21	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	12	8	96	96	4A
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	4	2,306	9,224	1 & 2 main	NJWP	0.03	91	6	10	1	0	0	0	1	3M
		Main Engine (Maneuvering)	4	2,306	9,224	1 & 2 main		0	91	0	0	0	3	24	72	72	3M
		Auxiliary Engine (Transit)	4	2,000	8,000	1 & 2 auxiliary		0.03	91	6	10	1	0	0	0	1	3A
		Auxiliary Engine (Maneuvering)	4	2,000	8,000	1 & 2 auxiliary		0	91	0	0	0	3	24	72	72	3A
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	NJWP	0.03	91	6	10	1	0	0	0	1	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	91	0	0	0	3	24	72	72	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		0.03	91	6	10	1	0	0	0	1	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	91	0	0	0	3	24	72	72	7A
Miscellaneous																	
SF6 Loss	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OSS Generators	Generator	Marine Tier 3 Generator	8	500	4,000	Marine Tier 3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24	24	31

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Operations (CTV Scenario)																			
WTG and BoP Crew logistics																			
CTV all-year 1	Crew Transfer Vessel	Main Engine (Transit)	0.83	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0	8	546
		Main Engine (Maneuvering)	0.20	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0	13	908
		Auxiliary Engine (Transit)	0.43	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0	0	7
		Auxiliary Engine (Maneuvering)	0.43	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0	1	50
CTV all-year 2	Crew Transfer Vessel	Main Engine (Transit)	0.83	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0	8	546
		Main Engine (Maneuvering)	0.20	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0	13	908
		Auxiliary Engine (Transit)	0.43	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0	0	7
		Auxiliary Engine (Maneuvering)	0.43	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0	1	50
CTV all-year 3	Crew Transfer Vessel	Main Engine (Transit)	0.83	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0	8	546
		Main Engine (Maneuvering)	0.20	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0	13	908
		Auxiliary Engine (Transit)	0.43	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0	0	7
		Auxiliary Engine (Maneuvering)	0.43	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0	1	50
CTV all-year 4	Crew Transfer Vessel	Main Engine (Transit)	0.83	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0	8	546
		Main Engine (Maneuvering)	0.20	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0	13	908
		Auxiliary Engine (Transit)	0.43	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0	0	7
		Auxiliary Engine (Maneuvering)	0.43	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0	1	50
CTV all-year 5	Crew Transfer Vessel	Main Engine (Transit)	0.83	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0	8	546
		Main Engine (Maneuvering)	0.20	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0	13	908
		Auxiliary Engine (Transit)	0.43	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0	0	7
		Auxiliary Engine (Maneuvering)	0.43	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0	1	50
CTV Summer Campaign 1	Crew Transfer Vessel	Main Engine (Transit)	0.83	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0	4	271
		Main Engine (Maneuvering)	0.20	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0	6	450
		Auxiliary Engine (Transit)	0.43	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0	0	4
		Auxiliary Engine (Maneuvering)	0.43	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0	0	25
CTV Summer Campaign 2	Crew Transfer Vessel	Main Engine (Transit)	0.83	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0	4	271
		Main Engine (Maneuvering)	0.20	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0	6	450
		Auxiliary Engine (Transit)	0.43	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0	0	4
		Auxiliary Engine (Maneuvering)	0.43	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0	0	25
CTV Summer Campaign 3	Crew Transfer Vessel	Main Engine (Transit)	0.83	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0	4	271
		Main Engine (Maneuvering)	0.20	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0	6	450
		Auxiliary Engine (Transit)	0.43	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0	0	4
		Auxiliary Engine (Maneuvering)	0.43	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0	0	25
CTV Summer Campaign 4	Crew Transfer Vessel	Main Engine (Transit)	0.83	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0	4	271
		Main Engine (Maneuvering)	0.20	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0	6	450
		Auxiliary Engine (Transit)	0.43	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0	0	4
		Auxiliary Engine (Maneuvering)	0.43	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0	0	25
CTV Summer Campaign 5	Crew Transfer Vessel	Main Engine (Transit)	0.83	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0	4	271
		Main Engine (Maneuvering)	0.20	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0	6	450
		Auxiliary Engine (Transit)	0.43	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0	0	4
		Auxiliary Engine (Maneuvering)	0.43	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0	0	25
CTV Summer Campaign 6	Crew Transfer Vessel	Main Engine (Transit)	0.83	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0	4	271
		Main Engine (Maneuvering)	0.20	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0	6	450
		Auxiliary Engine (Transit)	0.43	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0	0	4
		Auxiliary Engine (Maneuvering)	0.43	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0	0	25
WTG heavy logistics / jack-up																			
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	0.83	139,211	26.79	0.37	6.14	0.83	0.80	0.03	0.00	0.05	0.00	1728.57	0.01	0.08	0	25	1,754
		Main Engine (Maneuvering)	0.20	220,586	42.46	0.59	9.74	1.31	1.27	0.06	0.00	0.07	0.00	2739.01	0.02	0.13	0	39	2,779
		Auxiliary Engine (Transit)	0.43	16,919	3.20	0.04	0.69	0.09	0.09	0.00	0.00	0.00	0.00	179.42	0.00	0.01	0	3	182
		Auxiliary Engine (Maneuvering)	0.43	111,259	21.02	0.25	4.51	0.58	0.56	0.01	0.00	0.03	0.00	1179.81	0.01	0.06	0	17	1,197
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	0.83	32,715	6.30	0.09	1.44	0.19	0.19	0.01	0.00	0.01	0.00	406.21	0.00	0.02	0	6	412
		Main Engine (Maneuvering)	0.20	51,838	9.98	0.14	2.29	0.31	0.30	0.01	0.00	0.02	0.00	643.67	0.00	0.03	0	9	653
		Auxiliary Engine (Transit)	0.45	8,853	1.67	0.02	0.36	0.05	0.04	0.00	0.00	0.00	0.00	93.88	0.00	0.00	0	1	95
		Auxiliary Engine (Maneuvering)	0.45	58,217	11.00	0.13	2.36	0.30	0.30	0.01	0.00	0.02	0.00	617.34	0.00	0.03	0	9	626
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	0.83	381,431	73.41	1.02	16.83	2.27	2.20	0.10	0.00	0.13	0.00	4736.20	0.03	0.23	1	68	4,805
		Main Engine (Maneuvering)	0.20	220,586	42.46	0.59	9.74	1.31	1.27	0.06	0.00	0.07	0.00	2739.01	0.02	0.13	0	39	2,779
		Auxiliary Engine (Transit)	0.43	46,358	8.76	0.11	1.88	0.24	0.24	0.00	0.00	0.01	0.00	491.59	0.00	0.02	0	7	499
		Auxiliary Engine (Maneuvering)	0.43	111,259	21.02	0.25	4.51	0.58	0.56	0.01	0.00	0.03	0.00	1179.81	0.01	0.06	0	17	1,197
Cable repair vessel - export cable																			
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0.83	4,902	0.81	0.02	0.19	0.03	0.03	0.01	0.00	0.00	0.00	54.03	0.00	0.00	0	1	55
		Main Engine (Maneuvering)	0.20	55,481	9.14	0.24	2.12	0.33	0.32	0.08	0.00	0.03	0.00	611.51	0.00	0.03	0	9	621
		Auxiliary Engine (Transit)	0.56	100	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.12	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.56	4,695	0.81	0.01	0.20	0.03	0.03	0.00	0.00	0.00	0.00	52.82	0.00	0.00	0	1	54

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Cable repair vessel - arrray cable																			
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0.83	6,302	1.04	0.03	0.24	0.04	0.04	0.01	0.00	0.00	0.00	69.47	0.00	0.00	0	1	70
		Main Engine (Maneuvering)	0.20	24,412	4.02	0.11	0.93	0.14	0.14	0.04	0.00	0.01	0.00	269.06	0.00	0.01	0	4	273
		Auxiliary Engine (Transit)	0.56	129	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.45	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.56	2,066	0.35	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	23.24	0.00	0.00	0	0	24
Cable survey vessel - export cable																			
Cable survey vessel	Survey Vessel	Main Engine (Transit)	0.83	3,655	0.63	0.01	0.14	0.02	0.02	0.00	0.00	0.00	0.00	40.49	0.00	0.00	0	1	41
		Main Engine (Maneuvering)	0.20	34,752	5.95	0.13	1.36	0.21	0.20	0.04	0.00	0.01	0.00	384.99	0.00	0.02	0	6	391
		Auxiliary Engine (Transit)	0.43	99	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.43	3,893	0.69	0.01	0.17	0.02	0.02	0.00	0.00	0.00	0.00	43.80	0.00	0.00	0	1	44
Cable survey vessel - arrray cable																			
Cable survey vessel	Survey Vessel	Main Engine (Transit)	0.83	3,655	0.63	0.01	0.14	0.02	0.02	0.00	0.00	0.00	0.00	40.49	0.00	0.00	0	1	41
		Main Engine (Maneuvering)	0.20	15,059	2.58	0.06	0.59	0.09	0.09	0.02	0.00	0.01	0.00	166.83	0.00	0.01	0	2	169
		Auxiliary Engine (Transit)	0.43	99	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.43	1,687	0.30	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	18.98	0.00	0.00	0	0	19
Foundation below water inspection																			
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	0.83	3,481	0.60	0.01	0.14	0.02	0.02	0.00	0.00	0.00	0.00	38.57	0.00	0.00	0	1	39
		Main Engine (Maneuvering)	0.20	46,336	7.93	0.18	1.81	0.27	0.27	0.05	0.00	0.02	0.00	513.32	0.00	0.02	0	7	521
		Auxiliary Engine (Transit)	0.43	94	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.06	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.43	5,191	0.92	0.01	0.22	0.03	0.03	0.00	0.00	0.00	0.00	58.40	0.00	0.00	0	1	59
Other vessels																			
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	0.83	2,295	0.36	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	25.82	0.00	0.00	0	0	26
		Main Engine (Maneuvering)	0.20	2,546	0.40	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.00	28.64	0.00	0.00	0	0	29
		Auxiliary Engine (Transit)	0.43	31	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0	0	0
		Auxiliary Engine (Maneuvering)	0.43	142	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0	0	2
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	0.16	57	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0	0	1
		Main Engine (Maneuvering)	0.10	4,393	0.72	0.02	0.17	0.03	0.03	0.01	0.00	0.00	0.00	48.42	0.00	0.00	0	1	49
		Auxiliary Engine (Transit)	0.16	49	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.10	3,810	0.65	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	42.86	0.00	0.00	0	1	43
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	0.83	580	0.11	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.20	0.00	0.00	0	0	7
		Main Engine (Maneuvering)	0.20	16,544	3.18	0.04	0.73	0.10	0.10	0.00	0.00	0.01	0.00	205.43	0.00	0.01	0	3	208
		Auxiliary Engine (Transit)	0.45	74	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.45	8,733	1.65	0.02	0.35	0.05	0.04	0.00	0.00	0.00	0.00	92.60	0.00	0.00	0	1	94
Miscellaneous																			
SF6 Loss	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,519
OSS Generators	Generator	Marine Tier 3 Generator	0.75	5,143	0.46	0.06	0.40	0.01	0.01	0.00	0.00	0.00	0.00	58.70	0.00	0.00	0	0	59

Total/yr	2,716,113	480.79	7.20	113.27	15.26	14.78	0.68	0.00	0.89	0.03	31,524.48	0.20	1.51	4.92	449.50	35,497.48
Total over Project Life	81,483,387	14,423.63	215.88	3,398.24	457.87	443.27	20.33	0.07	26.74	0.93	945,734.40	5.91	45.25	147.71	13,484.86	1,064,924.31

Vessels	2,710,970	480.33	7.14	112.88	15.25	14.77	0.68	0.00	0.89	0.03	31,465.78	0.19	1.51	4.86	449.35	31,920.00
	81,329,101	14,409.82	214.22	3,386.34	457.63	443.04	20.31	0.07	26.70	0.93	943,973.43	5.84	45.24	145.93	13,480.61	957,599.96

Non-vessel	5,143	0.46	0.06	0.40	0.01	0.01	0.00	0.00	0.00	0.00	58.70	0.00	0.00	0.06	0.14	3,577.48
	154,286	13.81	1.66	11.90	0.24	0.23	0.02	0.00	0.04	0.00	1,760.97	0.07	0.01	1.79	4.26	107,324.35

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Operations (CTV Scenario)																				
WTG and BoP Crew logistics																				
CTV all-year 1	Crew Transfer Vessel	Main Engine (Transit)	17	100%	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.0002	537.98	0.00	0.03	0.08	7.67	545.73
		Main Engine (Maneuvering)	17	100%	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0.14	12.76	907.97
		Auxiliary Engine (Transit)	17	100%	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0.00	0.10	7.31
		Auxiliary Engine (Maneuvering)	17	100%	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0.01	0.71	50.49
CTV all-year 2	Crew Transfer Vessel	Main Engine (Transit)	17	100%	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0.08	7.67	545.73
		Main Engine (Maneuvering)	17	100%	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0.14	12.76	907.97
		Auxiliary Engine (Transit)	17	100%	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0.00	0.10	7.31
		Auxiliary Engine (Maneuvering)	17	100%	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0.01	0.71	50.49
CTV all-year 3	Crew Transfer Vessel	Main Engine (Transit)	17	100%	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0.08	7.67	545.73
		Main Engine (Maneuvering)	17	100%	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0.14	12.76	907.97
		Auxiliary Engine (Transit)	17	100%	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0.00	0.10	7.31
		Auxiliary Engine (Maneuvering)	17	100%	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0.01	0.71	50.49
CTV all-year 4	Crew Transfer Vessel	Main Engine (Transit)	17	100%	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0.08	7.67	545.73
		Main Engine (Maneuvering)	17	100%	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0.14	12.76	907.97
		Auxiliary Engine (Transit)	17	100%	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0.00	0.10	7.31
		Auxiliary Engine (Maneuvering)	17	100%	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0.01	0.71	50.49
CTV all-year 5	Crew Transfer Vessel	Main Engine (Transit)	17	100%	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0.08	7.67	545.73
		Main Engine (Maneuvering)	17	100%	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0.14	12.76	907.97
		Auxiliary Engine (Transit)	17	100%	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0.00	0.10	7.31
		Auxiliary Engine (Maneuvering)	17	100%	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0.01	0.71	50.49
CTV Summer Campaign 1	Crew Transfer Vessel	Main Engine (Transit)	17	100%	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0.04	3.80	270.68
		Main Engine (Maneuvering)	17	100%	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0.07	6.33	450.35
		Auxiliary Engine (Transit)	17	100%	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0.00	0.05	3.63
		Auxiliary Engine (Maneuvering)	17	100%	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0.00	0.35	25.04
CTV Summer Campaign 2	Crew Transfer Vessel	Main Engine (Transit)	17	100%	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0.04	3.80	270.68
		Main Engine (Maneuvering)	17	100%	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0.07	6.33	450.35
		Auxiliary Engine (Transit)	17	100%	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0.00	0.05	3.63
		Auxiliary Engine (Maneuvering)	17	100%	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0.00	0.35	25.04
CTV Summer Campaign 3	Crew Transfer Vessel	Main Engine (Transit)	17	100%	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0.04	3.80	270.68
		Main Engine (Maneuvering)	17	100%	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0.07	6.33	450.35
		Auxiliary Engine (Transit)	17	100%	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0.00	0.05	3.63
		Auxiliary Engine (Maneuvering)	17	100%	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0.00	0.35	25.04
CTV Summer Campaign 4	Crew Transfer Vessel	Main Engine (Transit)	17	100%	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0.04	3.80	270.68
		Main Engine (Maneuvering)	17	100%	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0.07	6.33	450.35
		Auxiliary Engine (Transit)	17	100%	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0.00	0.05	3.63
		Auxiliary Engine (Maneuvering)	17	100%	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0.00	0.35	25.04
CTV Summer Campaign 5	Crew Transfer Vessel	Main Engine (Transit)	17	100%	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0.04	3.80	270.68
		Main Engine (Maneuvering)	17	100%	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0.07	6.33	450.35
		Auxiliary Engine (Transit)	17	100%	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0.00	0.05	3.63
		Auxiliary Engine (Maneuvering)	17	100%	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0.00	0.35	25.04
CTV Summer Campaign 6	Crew Transfer Vessel	Main Engine (Transit)	17	100%	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0.04	3.80	270.68
		Main Engine (Maneuvering)	17	100%	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0.07	6.33	450.35
		Auxiliary Engine (Transit)	17	100%	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0.00	0.05	3.63
		Auxiliary Engine (Maneuvering)	17	100%	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0.00	0.35	25.04
WTG heavy logistics / jack-up																				
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	25	27%	38,143	7.34	0.10	1.68	0.23	0.22	0.01	0.00	0.01	0.00	473.62	0.00	0.02	0.07	6.76	480.46
		Main Engine (Maneuvering)	25	100%	220,586	42.46	0.59	9.74	1.31	1.27	0.06	0.00	0.07	0.00	2,739.01	0.02	0.13	0.42	39.10	2,778.54
		Auxiliary Engine (Transit)	25	27%	4,636	0.88	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.16	0.00	0.00	0.01	0.70	49.87
		Auxiliary Engine (Maneuvering)	25	100%	111,259	21.02	0.25	4.51	0.58	0.56	0.01	0.00	0.03	0.00	1,179.81	0.01	0.06	0.18	16.81	1,196.81
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	25	27%	8,964	1.73	0.02	0.40	0.05	0.05	0.00	0.00	0.00	0.00	111.30	0.00	0.01	0.02	1.59	112.91
		Main Engine (Maneuvering)	25	100%	51,838	9.98	0.14	2.29	0.31	0.30	0.01	0.00	0.02	0.00	643.67	0.00	0.03	0.10	9.19	652.96
		Auxiliary Engine (Transit)	25	27%	2,426	0.46	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.00	25.72	0.00	0.00	0.00	0.37	26.09
		Auxiliary Engine (Maneuvering)	25	100%	58,217	11.00	0.13	2.36	0.30	0.30	0.01	0.00	0.02	0.00	617.34	0.00	0.03	0.10	8.80	626.24
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	25	10%	38,143	7.34	0.10	1.68	0.23	0.22	0.01	0.00	0.01	0.00	473.62	0.00	0.02	0.07	6.76	480.46
		Main Engine (Maneuvering)	25	100%	220,586	42.46	0.59	9.74	1.31	1.27	0.06	0.00	0.07	0.00	2,739.01	0.02	0.13	0.42	39.10	2,778.54
		Auxiliary Engine (Transit)	25	10%	4,636	0.88	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.16	0.00	0.00	0.01	0.70	49.87
		Auxiliary Engine (Maneuvering)	25	100%	111,259	21.02	0.25	4.51	0.58	0.56	0.01	0.00	0.03	0.00	1,179.81	0.01	0.06	0.18	16.81	1,196.81
Cable repair vessel - export cable																				
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	25	27%	1,343	0.22	0.01	0.05	0.01	0.01	0.00	0.00	0.00	0.00	14.80	0.00	0.00	0.00	0.22	15.02
		Main Engine (Maneuvering)	25	51%	28,347	4.67	0.12	1.08	0.17	0.16	0.04	0.00	0.01	0.00	312.44	0.00	0.02	0.05	4.55	317.04
		Auxiliary Engine (Transit)	25	27%	27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.31
		Auxiliary Engine (Maneuvering)	25	51%	2,399	0.41	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.00	26.99	0.00	0.00	0.00	0.38	27.37

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Cable repair vessel - arrray cable																				
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	25	27%	1,727	0.28	0.01	0.07	0.01	0.01	0.00	0.00	0.00	0.00	19.03	0.00	0.00	0.00	0.28	19.31
		Main Engine (Maneuvering)	25	100%	24,412	4.02	0.11	0.93	0.14	0.14	0.04	0.00	0.01	0.00	269.06	0.00	0.01	0.04	3.91	273.02
		Auxiliary Engine (Transit)	25	27%	35	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.01	0.40
		Auxiliary Engine (Maneuvering)	25	100%	2,066	0.35	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	23.24	0.00	0.00	0.00	0.33	23.57
Cable survey vessel - export cable																				
Cable survey vessel	Survey Vessel	Main Engine (Transit)	25	27%	1,002	0.17	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	11.10	0.00	0.00	0.00	0.16	11.26
		Main Engine (Maneuvering)	25	51%	17,756	3.04	0.07	0.69	0.10	0.10	0.02	0.00	0.01	0.00	196.70	0.00	0.01	0.03	2.85	199.58
		Auxiliary Engine (Transit)	25	27%	27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.31
		Auxiliary Engine (Maneuvering)	25	51%	1,989	0.35	0.00	0.09	0.01	0.01	0.00	0.00	0.00	0.00	22.38	0.00	0.00	0.00	0.32	22.70
Cable survey vessel - arrray cable																				
Cable survey vessel	Survey Vessel	Main Engine (Transit)	25	27%	1,002	0.17	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	11.10	0.00	0.00	0.00	0.16	11.26
		Main Engine (Maneuvering)	25	100%	15,059	2.58	0.06	0.59	0.09	0.09	0.02	0.00	0.01	0.00	166.83	0.00	0.01	0.03	2.41	169.27
		Auxiliary Engine (Transit)	25	27%	27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.31
		Auxiliary Engine (Maneuvering)	25	100%	1,687	0.30	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	18.98	0.00	0.00	0.00	0.27	19.25
Foundation below water inspection																				
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	17	100%	3,481	0.60	0.01	0.14	0.02	0.02	0.00	0.00	0.00	0.00	38.57	0.00	0.00	0.01	0.56	39.13
		Main Engine (Maneuvering)	17	100%	46,336	7.93	0.18	1.81	0.27	0.27	0.05	0.00	0.02	0.00	513.32	0.00	0.02	0.08	7.43	520.83
		Auxiliary Engine (Transit)	17	100%	94	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.06	0.00	0.00	0.00	0.02	1.07
		Auxiliary Engine (Maneuvering)	17	100%	5,191	0.92	0.01	0.22	0.03	0.03	0.00	0.00	0.00	0.00	58.40	0.00	0.00	0.01	0.83	59.24
Other vessels																				
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	17	100%	2,295	0.36	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	25.82	0.00	0.00	0.00	0.37	26.19
		Main Engine (Maneuvering)	17	100%	2,546	0.40	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.00	28.64	0.00	0.00	0.00	0.41	29.06
		Auxiliary Engine (Transit)	17	100%	31	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.35
		Auxiliary Engine (Maneuvering)	17	100%	142	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0.00	0.02	1.62
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	25	27%	16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.17
		Main Engine (Maneuvering)	25	100%	4,393	0.72	0.02	0.17	0.03	0.03	0.01	0.00	0.00	0.00	48.42	0.00	0.00	0.01	0.70	49.13
		Auxiliary Engine (Transit)	25	27%	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.15
		Auxiliary Engine (Maneuvering)	25	100%	3,810	0.65	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	42.86	0.00	0.00	0.01	0.61	43.48
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	25	27%	159	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.97	0.00	0.00	0.00	0.03	2.00
		Main Engine (Maneuvering)	25	100%	16,544	3.18	0.04	0.73	0.10	0.10	0.00	0.00	0.01	0.00	205.43	0.00	0.01	0.03	2.93	208.39
		Auxiliary Engine (Transit)	25	27%	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.22
		Auxiliary Engine (Maneuvering)	25	100%	8,733	1.65	0.02	0.35	0.05	0.04	0.00	0.00	0.00	0.00	92.60	0.00	0.00	0.01	1.32	93.94
Miscellaneous																				
SF6 Loss	N/A	N/A	N/A	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,518.6
OSS Generators	Generator	Marine Tier 3 Generator	N/A	100%	5,143	0.46	0.06	0.40	0.008	0.008	0.0005	0.000	0.0014	0.00	58.70	0.00	0.00	0.06	0.14	58.90

OCS Total Ton/yr	**2,124,941**	**368.8**	**5.5**	**87.7**	**11.8**	**11.4**	**0.5**	**0.002**	**0.7**	**0.02**	**24,378.0**	**0.2**	**1.2**	**3.8**	**347.3**	**28,247.7**
OCS Total Tons over life	**63,748,221**	**11,062.73**	**166.48**	**2,631.82**	**353.80**	**342.52**	**14.30**	**0.05**	**20.61**	**0.66**	**731,339.78**	**4.58**	**34.97**	**114.53**	**10,419.95**	**847,431.60**
Vessels	2,119,798	368.3	5.5	87.3	11.8	11.4	0.5	0.002	0.69	0.02	24,319.3	0.2	1.2	3.8	347.2	24,670.2
	63,593,935	11,048.92	164.82	2,619.91	353.56	342.29	14.28	0.05	20.57	0.66	729,578.81	4.51	34.95	112.75	10,415.70	740,107.25
Non-vessel	5,143	0.46	0.06	0.40	0.01	0.01	0.00	0.00	0.00	0.00	58.70	0.00	0.00	0.06	0.14	3,577.48
	154,286	13.81	1.66	11.90	0.24	0.23	0.02	0.00	0.04	0.00	1,760.97	0.07	0.01	1.79	4.26	107,324.35

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Round Trips (per year)	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Emissions During Operations (CTV Scenario)																	
WTG and BoP Crew logistics																	
CTV all-year 1	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	250	17	8,690	20	434	0	0	0	434	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	250	12	3,000	3,000	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		250	17	8,690	20	434	0	0	0	434	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	250	12	3,000	3,000	4A
CTV all-year 2	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	250	17	8,690	20	434	0	0	0	434	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	250	12	3,000	3,000	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		250	17	8,690	20	434	0	0	0	434	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	250	12	3,000	3,000	4A
CTV all-year 3	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	250	17	8,690	20	434	0	0	0	434	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	250	12	3,000	3,000	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		250	17	8,690	20	434	0	0	0	434	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	250	12	3,000	3,000	4A
CTV all-year 4	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	250	17	8,690	20	434	0	0	0	434	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	250	12	3,000	3,000	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		250	17	8,690	20	434	0	0	0	434	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	250	12	3,000	3,000	4A
CTV Summer Campaign 1	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	124	17	4,310	20	216	0	0	0	216	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	124	12	1,488	1,488	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		124	17	4,310	20	216	0	0	0	216	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	124	12	1,488	1,488	4A
CTV Summer Campaign 2	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	124	17	4,310	20	216	0	0	0	216	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	124	12	1,488	1,488	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		124	17	4,310	20	216	0	0	0	216	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	124	12	1,488	1,488	4A
CTV Summer Campaign 3	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	124	17	4,310	20	216	0	0	0	216	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	124	12	1,488	1,488	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		124	17	4,310	20	216	0	0	0	216	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	124	12	1,488	1,488	4A
CTV Summer Campaign 4	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	124	17	4,310	20	216	0	0	0	216	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	124	12	1,488	1,488	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		124	17	4,310	20	216	0	0	0	216	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	124	12	1,488	1,488	4A
CTV Summer Campaign 5	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	124	17	4,310	20	216	0	0	0	216	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	124	12	1,488	1,488	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		124	17	4,310	20	216	0	0	0	216	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	124	12	1,488	1,488	4A
WTG heavy logistics / jack-up																	
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	NJWP	4	91	730	10	73	0	0	0	73	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	91	0	0	0	17	24	408	408	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		4	91	730	10	73	0	0	0	73	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	91	0	0	0	17	24	408	408	7A
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	2	2350	4,700	3 main	NJWP	4	91	730	10	73	0	0	0	73	7M
		Main Engine (Maneuvering)	2	2350	4,700	3 main		0	91	0	0	0	17	24	408	408	7M
		Auxiliary Engine (Transit)	2	1000	2,000	3 auxiliary		4	91	730	10	73	0	0	0	73	7A
		Auxiliary Engine (Maneuvering)	2	1000	2,000	3 auxiliary		0	91	0	0	0	17	24	408	408	7A
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	Europe	4	250	2,000	10	200	0	0	0	200	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	250	0	0	0	17	24	408	408	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		4	250	2,000	10	200	0	0	0	200	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	250	0	0	0	17	24	408	408	7A
Cable repair vessel - export cable																	
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0	0	7,280	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	3M
		Main Engine (Maneuvering)	0	0	7,280	1 & 2 main		0	91	0	0	0	7	24	168	168	3M
		Auxiliary Engine (Transit)	0	0	220	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	3A
		Auxiliary Engine (Maneuvering)	0	0	220	1 & 2 auxiliary		0	91	0	0	0	7	24	168	168	3A

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Round Trips (per year)	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Cable repair vessel - arrray cable																	
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0	0	7,280	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	3M
		Main Engine (Maneuvering)	0	0	7,280	1 & 2 main		0	91	0	0	0	9	24	216	216	3M
		Auxiliary Engine (Transit)	0	0	220	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	3A
		Auxiliary Engine (Maneuvering)	0	0	220	1 & 2 auxiliary		0	91	0	0	0	9	24	216	216	3A
Cable survey vessel - export cable																	
Cable survey vessel	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	91	0	0	0	14	24	336	336	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	91	0	0	0	14	24	336	336	8A
Cable survey vessel - arrray cable																	
Cable survey vessel	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	NJWP	2	91	365	10	36	0	0	0	36	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	91	0	0	0	17	24	408	408	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		2	91	365	10	36	0	0	0	36	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	91	0	0	0	17	24	408	408	8A
Foundation below water inspection																	
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	Atlantic City	3	17	104	10	10	0	0	0	10	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	17	0	0	0	19	24	456	456	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		3	17	104	10	10	0	0	0	10	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	17	0	0	0	19	24	456	456	8A
Other vessels																	
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	12	17	417	20	21	0	0	0	21	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	12	8	96	96	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		12	17	417	20	21	0	0	0	21	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	12	8	96	96	4A
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	4	2,306	9,224	1 & 2 main	NJWP	0.03	91	6	10	1	0	0	0	1	3M
		Main Engine (Maneuvering)	4	2,306	9,224	1 & 2 main		0	91	0	0	0	3	24	72	72	3M
		Auxiliary Engine (Transit)	4	2,000	8,000	1 & 2 auxiliary		0.03	91	6	10	1	0	0	0	1	3A
		Auxiliary Engine (Maneuvering)	4	2,000	8,000	1 & 2 auxiliary		0	91	0	0	0	3	24	72	72	3A
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	NJWP	0.03	91	6	10	1	0	0	0	1	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	91	0	0	0	3	24	72	72	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		0.03	91	6	10	1	0	0	0	1	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	91	0	0	0	3	24	72	72	7A
Miscellaneous																	
SF6 Loss	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OSS Generators	Generator	Marine Tier 3 Generator	4	500	2,000	Marine Tier 3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24	24	31

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Operations (CTV Scenario)																			
WTG and BoP Crew logistics																			
CTV all-year 1	Crew Transfer Vessel	Main Engine (Transit)	0.83	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0	8	546
		Main Engine (Maneuvering)	0.20	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0	13	908
		Auxiliary Engine (Transit)	0.43	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0	0	7
		Auxiliary Engine (Maneuvering)	0.43	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0	1	50
CTV all-year 2	Crew Transfer Vessel	Main Engine (Transit)	0.83	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0	8	546
		Main Engine (Maneuvering)	0.20	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0	13	908
		Auxiliary Engine (Transit)	0.43	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0	0	7
		Auxiliary Engine (Maneuvering)	0.43	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0	1	50
CTV all-year 3	Crew Transfer Vessel	Main Engine (Transit)	0.83	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0	8	546
		Main Engine (Maneuvering)	0.20	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0	13	908
		Auxiliary Engine (Transit)	0.43	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0	0	7
		Auxiliary Engine (Maneuvering)	0.43	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0	1	50
CTV all-year 4	Crew Transfer Vessel	Main Engine (Transit)	0.83	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0	8	546
		Main Engine (Maneuvering)	0.20	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0	13	908
		Auxiliary Engine (Transit)	0.43	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0	0	7
		Auxiliary Engine (Maneuvering)	0.43	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0	1	50
CTV Summer Campaign 1	Crew Transfer Vessel	Main Engine (Transit)	0.83	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0	4	271
		Main Engine (Maneuvering)	0.20	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0	6	450
		Auxiliary Engine (Transit)	0.43	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0	0	4
		Auxiliary Engine (Maneuvering)	0.43	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0	0	25
CTV Summer Campaign 2	Crew Transfer Vessel	Main Engine (Transit)	0.83	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0	4	271
		Main Engine (Maneuvering)	0.20	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0	6	450
		Auxiliary Engine (Transit)	0.43	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0	0	4
		Auxiliary Engine (Maneuvering)	0.43	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0	0	25
CTV Summer Campaign 3	Crew Transfer Vessel	Main Engine (Transit)	0.83	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0	4	271
		Main Engine (Maneuvering)	0.20	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0	6	450
		Auxiliary Engine (Transit)	0.43	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0	0	4
		Auxiliary Engine (Maneuvering)	0.43	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0	0	25
CTV Summer Campaign 4	Crew Transfer Vessel	Main Engine (Transit)	0.83	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0	4	271
		Main Engine (Maneuvering)	0.20	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0	6	450
		Auxiliary Engine (Transit)	0.43	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0	0	4
		Auxiliary Engine (Maneuvering)	0.43	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0	0	25
CTV Summer Campaign 5	Crew Transfer Vessel	Main Engine (Transit)	0.83	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0	4	271
		Main Engine (Maneuvering)	0.20	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0	6	450
		Auxiliary Engine (Transit)	0.43	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0	0	4
		Auxiliary Engine (Maneuvering)	0.43	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0	0	25
WTG heavy logistics / jack-up																			
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	0.83	69,605	13.40	0.19	3.07	0.41	0.40	0.02	0.00	0.02	0.00	864.29	0.01	0.04	0	12	877
		Main Engine (Maneuvering)	0.20	93,749	18.04	0.25	4.14	0.56	0.54	0.02	0.00	0.03	0.00	1164.08	0.01	0.06	0	17	1,181
		Auxiliary Engine (Transit)	0.43	8,460	1.60	0.02	0.34	0.04	0.04	0.00	0.00	0.00	0.00	89.71	0.00	0.00	0	1	91
		Auxiliary Engine (Maneuvering)	0.43	47,285	8.93	0.11	1.92	0.25	0.24	0.00	0.00	0.01	0.00	501.42	0.00	0.02	0	7	509
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	0.83	16,357	3.15	0.04	0.72	0.10	0.09	0.00	0.00	0.01	0.00	203.11	0.00	0.01	0	3	206
		Main Engine (Maneuvering)	0.20	22,031	4.24	0.06	0.97	0.13	0.13	0.01	0.00	0.01	0.00	273.56	0.00	0.01	0	4	278
		Auxiliary Engine (Transit)	0.45	4,427	0.84	0.01	0.18	0.02	0.02	0.00	0.00	0.00	0.00	46.94	0.00	0.00	0	1	48
		Auxiliary Engine (Maneuvering)	0.45	24,742	4.68	0.06	1.00	0.13	0.13	0.00	0.00	0.01	0.00	262.37	0.00	0.01	0	4	266
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	0.83	190,715	36.71	0.51	8.42	1.13	1.10	0.05	0.00	0.06	0.00	2368.10	0.01	0.11	0	34	2,402
		Main Engine (Maneuvering)	0.20	93,749	18.04	0.25	4.14	0.56	0.54	0.02	0.00	0.03	0.00	1164.08	0.01	0.06	0	17	1,181
		Auxiliary Engine (Transit)	0.43	23,179	4.38	0.05	0.94	0.12	0.12	0.00	0.00	0.01	0.00	245.79	0.00	0.01	0	4	249
		Auxiliary Engine (Maneuvering)	0.43	47,285	8.93	0.11	1.92	0.25	0.24	0.00	0.00	0.01	0.00	501.42	0.00	0.02	0	7	509
Cable repair vessel - export cable																			
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0.83	7,003	1.15	0.03	0.27	0.04	0.04	0.01	0.00	0.00	0.00	77.18	0.00	0.00	0	1	78
		Main Engine (Maneuvering)	0.20	15,535	2.56	0.07	0.59	0.09	0.09	0.02	0.00	0.01	0.00	171.22	0.00	0.01	0	2	174
		Auxiliary Engine (Transit)	0.56	143	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.61	0.00	0.00	0	0	2
		Auxiliary Engine (Maneuvering)	0.56	1,314	0.23	0.00	0.06	0.01	0.01	0.00	0.00	0.00	0.00	14.79	0.00	0.00	0	0	15

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Cable repair vessel - arrray cable																			
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0.83	7,003	1.15	0.03	0.27	0.04	0.04	0.01	0.00	0.00	0.00	77.18	0.00	0.00	0	1	78
		Main Engine (Maneuvering)	0.20	19,973	3.29	0.09	0.76	0.12	0.11	0.03	0.00	0.01	0.00	220.14	0.00	0.01	0	3	223
		Auxiliary Engine (Transit)	0.56	143	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.61	0.00	0.00	0	0	2
		Auxiliary Engine (Maneuvering)	0.56	1,690	0.29	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	19.01	0.00	0.00	0	0	19
Cable survey vessel - export cable																			
Cable survey vessel	Survey Vessel	Main Engine (Transit)	0.83	3,655	0.63	0.01	0.14	0.02	0.02	0.00	0.00	0.00	0.00	40.49	0.00	0.00	0	1	41
		Main Engine (Maneuvering)	0.20	16,218	2.78	0.06	0.63	0.10	0.09	0.02	0.00	0.01	0.00	179.66	0.00	0.01	0	3	182
		Auxiliary Engine (Transit)	0.43	99	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.43	1,817	0.32	0.00	0.08	0.01	0.01	0.00	0.00	0.00	0.00	20.44	0.00	0.00	0	0	21
Cable survey vessel - arrray cable																			
Cable survey vessel	Survey Vessel	Main Engine (Transit)	0.83	7,311	1.25	0.03	0.29	0.04	0.04	0.01	0.00	0.00	0.00	80.99	0.00	0.00	0	1	82
		Main Engine (Maneuvering)	0.20	19,693	3.37	0.08	0.77	0.12	0.11	0.02	0.00	0.01	0.00	218.16	0.00	0.01	0	3	221
		Auxiliary Engine (Transit)	0.43	197	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	2.22	0.00	0.00	0	0	2
		Auxiliary Engine (Maneuvering)	0.43	2,206	0.39	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.82	0.00	0.00	0	0	25
Foundation below water inspection																			
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	0.83	2,089	0.36	0.01	0.08	0.01	0.01	0.00	0.00	0.00	0.00	23.14	0.00	0.00	0	0	23
		Main Engine (Maneuvering)	0.20	22,010	3.77	0.08	0.86	0.13	0.13	0.03	0.00	0.01	0.00	243.83	0.00	0.01	0	4	247
		Auxiliary Engine (Transit)	0.43	56	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.43	2,466	0.44	0.01	0.11	0.01	0.01	0.00	0.00	0.00	0.00	27.74	0.00	0.00	0	0	28
Other vessels																			
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	0.83	2,295	0.36	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	25.82	0.00	0.00	0	0	26
		Main Engine (Maneuvering)	0.20	2,546	0.40	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.00	28.64	0.00	0.00	0	0	29
		Auxiliary Engine (Transit)	0.43	31	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0	0	0
		Auxiliary Engine (Maneuvering)	0.43	142	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0	0	2
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	0.16	57	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0	0	1
		Main Engine (Maneuvering)	0.10	4,393	0.72	0.02	0.17	0.03	0.03	0.01	0.00	0.00	0.00	48.42	0.00	0.00	0	1	49
		Auxiliary Engine (Transit)	0.16	49	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.10	3,810	0.65	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	42.86	0.00	0.00	0	1	43
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	0.83	580	0.11	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.20	0.00	0.00	0	0	7
		Main Engine (Maneuvering)	0.20	16,544	3.18	0.04	0.73	0.10	0.10	0.00	0.00	0.01	0.00	205.43	0.00	0.01	0	3	208
		Auxiliary Engine (Transit)	0.45	74	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.45	8,733	1.65	0.02	0.35	0.05	0.04	0.00	0.00	0.00	0.00	92.60	0.00	0.00	0	1	94
Miscellaneous																			
SF6 Loss	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,257
OSS Generators	Generator	Marine Tier 3 Generator	0.75	2,571	0.23	0.03	0.20	0.00	0.00	0.00	0.00	0.00	0.00	29.35	0.00	0.00	0	0	29

Total/yr	1,672,286	289.41	4.39	69.07	9.32	9.03	0.39	0.00	0.54	0.02	19,270.51	0.12	0.92	3.00	274.80	21,805.24
Total over Project Life	50,168,568	8,682.35	131.78	2,072.23	279.70	270.77	11.83	0.04	16.34	0.54	578,115.44	3.60	27.66	90.11	8,244.14	654,157.17

Vessels	1,669,714	289.18	4.37	68.88	9.32	9.02	0.39	0.00	0.54	0.02	19,241.17	0.12	0.92	2.97	274.73	19,518.87
	50,091,425	8,675.44	130.95	2,066.28	279.58	270.66	11.82	0.04	16.32	0.54	577,234.95	3.57	27.66	89.22	8,242.01	585,566.18

Non-vessel	2,571	0.23	0.03	0.20	0.00	0.00	0.00	0.00	0.00	0.00	29.35	0.00	0.00	0.03	0.07	2,286.37
	77,143	6.90	0.83	5.95	0.12	0.12	0.01	0.00	0.02	0.00	880.49	0.04	0.01	0.89	2.13	68,591.00

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Operations (CTV Scenario)																				
WTG and BoP Crew logistics																				
CTV all-year 1	Crew Transfer Vessel	Main Engine (Transit)	17	100%	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0.08	7.67	545.73
		Main Engine (Maneuvering)	17	100%	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0.14	12.76	907.97
		Auxiliary Engine (Transit)	17	100%	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0.00	0.10	7.31
		Auxiliary Engine (Maneuvering)	17	100%	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0.01	0.71	50.49
CTV all-year 2	Crew Transfer Vessel	Main Engine (Transit)	17	100%	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0.08	7.67	545.73
		Main Engine (Maneuvering)	17	100%	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0.14	12.76	907.97
		Auxiliary Engine (Transit)	17	100%	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0.00	0.10	7.31
		Auxiliary Engine (Maneuvering)	17	100%	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0.01	0.71	50.49
CTV all-year 3	Crew Transfer Vessel	Main Engine (Transit)	17	100%	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0.08	7.67	545.73
		Main Engine (Maneuvering)	17	100%	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0.14	12.76	907.97
		Auxiliary Engine (Transit)	17	100%	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0.00	0.10	7.31
		Auxiliary Engine (Maneuvering)	17	100%	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0.01	0.71	50.49
CTV all-year 4	Crew Transfer Vessel	Main Engine (Transit)	17	100%	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0.08	7.67	545.73
		Main Engine (Maneuvering)	17	100%	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0.14	12.76	907.97
		Auxiliary Engine (Transit)	17	100%	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0.00	0.10	7.31
		Auxiliary Engine (Maneuvering)	17	100%	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0.01	0.71	50.49
CTV Summer Campaign 1	Crew Transfer Vessel	Main Engine (Transit)	17	100%	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0.04	3.80	270.68
		Main Engine (Maneuvering)	17	100%	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0.07	6.33	450.35
		Auxiliary Engine (Transit)	17	100%	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0.00	0.05	3.63
		Auxiliary Engine (Maneuvering)	17	100%	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0.00	0.35	25.04
CTV Summer Campaign 2	Crew Transfer Vessel	Main Engine (Transit)	17	100%	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0.04	3.80	270.68
		Main Engine (Maneuvering)	17	100%	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0.07	6.33	450.35
		Auxiliary Engine (Transit)	17	100%	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0.00	0.05	3.63
		Auxiliary Engine (Maneuvering)	17	100%	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0.00	0.35	25.04
CTV Summer Campaign 3	Crew Transfer Vessel	Main Engine (Transit)	17	100%	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0.04	3.80	270.68
		Main Engine (Maneuvering)	17	100%	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0.07	6.33	450.35
		Auxiliary Engine (Transit)	17	100%	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0.00	0.05	3.63
		Auxiliary Engine (Maneuvering)	17	100%	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0.00	0.35	25.04
CTV Summer Campaign 4	Crew Transfer Vessel	Main Engine (Transit)	17	100%	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0.04	3.80	270.68
		Main Engine (Maneuvering)	17	100%	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0.07	6.33	450.35
		Auxiliary Engine (Transit)	17	100%	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0.00	0.05	3.63
		Auxiliary Engine (Maneuvering)	17	100%	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0.00	0.35	25.04
CTV Summer Campaign 5	Crew Transfer Vessel	Main Engine (Transit)	17	100%	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0.04	3.80	270.68
		Main Engine (Maneuvering)	17	100%	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0.07	6.33	450.35
		Auxiliary Engine (Transit)	17	100%	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0.00	0.05	3.63
		Auxiliary Engine (Maneuvering)	17	100%	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0.00	0.35	25.04
WTG heavy logistics / jack-up																				
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	25	27%	19,072	3.67	0.05	0.84	0.11	0.11	0.00	0.00	0.01	0.00	236.81	0.00	0.01	0.04	3.38	240.23
		Main Engine (Maneuvering)	25	100%	93,749	18.04	0.25	4.14	0.56	0.54	0.02	0.00	0.03	0.00	1,164.08	0.01	0.06	0.18	16.62	1,180.88
		Auxiliary Engine (Transit)	25	27%	2,318	0.44	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.58	0.00	0.00	0.00	0.35	24.93
		Auxiliary Engine (Maneuvering)	25	100%	47,285	8.93	0.11	1.92	0.25	0.24	0.00	0.00	0.01	0.00	501.42	0.00	0.02	0.08	7.15	508.64
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	25	27%	4,482	0.86	0.01	0.20	0.03	0.03	0.00	0.00	0.00	0.00	55.65	0.00	0.00	0.01	0.79	56.45
		Main Engine (Maneuvering)	25	100%	22,031	4.24	0.06	0.97	0.13	0.13	0.01	0.00	0.01	0.00	273.56	0.00	0.01	0.04	3.91	277.51
		Auxiliary Engine (Transit)	25	27%	1,213	0.23	0.00	0.05	0.01	0.01	0.00	0.00	0.00	0.00	12.86	0.00	0.00	0.00	0.18	13.05
		Auxiliary Engine (Maneuvering)	25	100%	24,742	4.68	0.06	1.00	0.13	0.13	0.00	0.00	0.01	0.00	262.37	0.00	0.01	0.04	3.74	266.15
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	25	10%	19,072	3.67	0.05	0.84	0.11	0.11	0.00	0.00	0.01	0.00	236.81	0.00	0.01	0.04	3.38	240.23
		Main Engine (Maneuvering)	25	100%	93,749	18.04	0.25	4.14	0.56	0.54	0.02	0.00	0.03	0.00	1,164.08	0.01	0.06	0.18	16.62	1,180.88
		Auxiliary Engine (Transit)	25	10%	2,318	0.44	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.58	0.00	0.00	0.00	0.35	24.93
		Auxiliary Engine (Maneuvering)	25	100%	47,285	8.93	0.11	1.92	0.25	0.24	0.00	0.00	0.01	0.00	501.42	0.00	0.02	0.08	7.15	508.64
Cable repair vessel - export cable																				
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	25	27%	1,919	0.32	0.01	0.07	0.01	0.01	0.00	0.00	0.00	0.00	21.15	0.00	0.00	0.00	0.31	21.46
		Main Engine (Maneuvering)	25	51%	7,937	1.31	0.03	0.30	0.05	0.05	0.01	0.00	0.00	0.00	87.48	0.00	0.00	0.01	1.27	88.77
		Auxiliary Engine (Transit)	25	27%	39	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.01	0.45
		Auxiliary Engine (Maneuvering)	25	51%	672	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.56	0.00	0.00	0.00	0.11	7.66

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)													
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Cable repair vessel - arrray cable																				
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	25	27%	1,919	0.32	0.01	0.07	0.01	0.01	0.00	0.00	0.00	0.00	21.15	0.00	0.00	0.00	0.31	21.46
		Main Engine (Maneuvering)	25	100%	19,973	3.29	0.09	0.76	0.12	0.11	0.03	0.00	0.01	0.00	220.14	0.00	0.01	0.03	3.20	223.38
		Auxiliary Engine (Transit)	25	27%	39	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.01	0.45
		Auxiliary Engine (Maneuvering)	25	100%	1,690	0.29	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	19.01	0.00	0.00	0.00	0.27	19.29
Cable survey vessel - export cable																				
Cable survey vessel	Survey Vessel	Main Engine (Transit)	25	27%	1,002	0.17	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	11.10	0.00	0.00	0.00	0.16	11.26
		Main Engine (Maneuvering)	25	51%	8,286	1.42	0.03	0.32	0.05	0.05	0.01	0.00	0.00	0.00	91.80	0.00	0.00	0.01	1.33	93.14
		Auxiliary Engine (Transit)	25	27%	27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.31
		Auxiliary Engine (Maneuvering)	25	51%	928	0.16	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.00	10.44	0.00	0.00	0.00	0.15	10.59
Cable survey vessel - arrray cable																				
Cable survey vessel	Survey Vessel	Main Engine (Transit)	25	27%	2,003	0.34	0.01	0.08	0.01	0.01	0.00	0.00	0.00	0.00	22.19	0.00	0.00	0.00	0.32	22.51
		Main Engine (Maneuvering)	25	100%	19,693	3.37	0.08	0.77	0.12	0.11	0.02	0.00	0.01	0.00	218.16	0.00	0.01	0.03	3.16	221.35
		Auxiliary Engine (Transit)	25	27%	54	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.00	0.01	0.62
		Auxiliary Engine (Maneuvering)	25	100%	2,206	0.39	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.82	0.00	0.00	0.00	0.35	25.18
Foundation below water inspection																				
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	17	100%	2,089	0.36	0.01	0.08	0.01	0.01	0.00	0.00	0.00	0.00	23.14	0.00	0.00	0.00	0.33	23.48
		Main Engine (Maneuvering)	17	100%	22,010	3.77	0.08	0.86	0.13	0.13	0.03	0.00	0.01	0.00	243.83	0.00	0.01	0.04	3.53	247.39
		Auxiliary Engine (Transit)	17	100%	56	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0.00	0.01	0.64
		Auxiliary Engine (Maneuvering)	17	100%	2,466	0.44	0.01	0.11	0.01	0.01	0.00	0.00	0.00	0.00	27.74	0.00	0.00	0.00	0.40	28.14
Other vessels																				
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	17	100%	2,295	0.36	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	25.82	0.00	0.00	0.00	0.37	26.19
		Main Engine (Maneuvering)	17	100%	2,546	0.40	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.00	28.64	0.00	0.00	0.00	0.41	29.06
		Auxiliary Engine (Transit)	17	100%	31	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.35
		Auxiliary Engine (Maneuvering)	17	100%	142	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0.00	0.02	1.62
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	25	27%	16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.17
		Main Engine (Maneuvering)	25	100%	4,393	0.72	0.02	0.17	0.03	0.03	0.01	0.00	0.00	0.00	48.42	0.00	0.00	0.01	0.70	49.13
		Auxiliary Engine (Transit)	25	27%	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.15
		Auxiliary Engine (Maneuvering)	25	100%	3,810	0.65	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	42.86	0.00	0.00	0.01	0.61	43.48
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	25	27%	159	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.97	0.00	0.00	0.00	0.03	2.00
		Main Engine (Maneuvering)	25	100%	16,544	3.18	0.04	0.73	0.10	0.10	0.00	0.00	0.01	0.00	205.43	0.00	0.01	0.03	2.93	208.39
		Auxiliary Engine (Transit)	25	27%	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.22
		Auxiliary Engine (Maneuvering)	25	100%	8,733	1.65	0.02	0.35	0.05	0.04	0.00	0.00	0.00	0.00	92.60	0.00	0.00	0.01	1.32	93.94
Miscellaneous																				
SF6 Loss	N/A	N/A	N/A	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,256.92
OSS Generators	Generator	Marine Tier 3 Generator	N/A	100%	2,571	0.23	0.03	0.20	0.00	0.00	0.00	0.00	0.00	0.00	29.35	0.00	0.00	0.03	0.07	29.45

OCS Total Ton/yr	**1,371,852**	**232.56**	**3.55**	**56.11**	**7.56**	**7.32**	**0.29**	**0.00**	**0.44**	**0.01**	**15,643.36**	**0.10**	**0.75**	**2.44**	**222.94**	**18,125.66**
OCS Total Tons over life	**41,155,561**	**6,976.88**	**106.52**	**1,683.34**	**226.80**	**219.56**	**8.64**	**0.03**	**13.21**	**0.40**	**469,300.74**	**2.93**	**22.44**	**73.27**	**6,688.26**	**543,769.76**
Vessels	1,369,281	232.33	3.52	55.91	7.56	7.31	0.29	0.00	0.44	0.01	15,614.01	0.10	0.75	2.41	222.87	15,839.29
	41,078,418	6,969.98	105.69	1,677.39	226.68	219.45	8.63	0.03	13.19	0.40	468,420.26	2.90	22.44	72.38	6,686.14	475,178.77
Non-vessel	2,571	0.23	0.03	0.20	0.00	0.00	0.00	0.00	0.00	0.00	29.35	0.00	0.00	0.03	0.07	2,286.37
	77,143	6.90	0.83	5.95	0.12	0.12	0.01	0.00	0.02	0.00	880.49	0.04	0.01	0.89	2.13	68,591.00

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Round Trips (per year)	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Emissions During Operations (CTV Scenario)																	
WTG and BoP Crew logistics																	
CTV all-year 1	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	250	17	8,690	20	434	0	0	0	434	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	250	12	3,000	3,000	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		250	17	8,690	20	434	0	0	0	434	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	250	12	3,000	3,000	4A
CTV all-year 2	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	250	17	8,690	20	434	0	0	0	434	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	250	12	3,000	3,000	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		250	17	8,690	20	434	0	0	0	434	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	250	12	3,000	3,000	4A
CTV all-year 3	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	250	17	8,690	20	434	0	0	0	434	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	250	12	3,000	3,000	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		250	17	8,690	20	434	0	0	0	434	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	250	12	3,000	3,000	4A
CTV Summer Campaign 1	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	124	17	4,310	20	216	0	0	0	216	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	124	12	1,488	1,488	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		124	17	4,310	20	216	0	0	0	216	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	124	12	1,488	1,488	4A
CTV Summer Campaign 2	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	124	17	4,310	20	216	0	0	0	216	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	124	12	1,488	1,488	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		124	17	4,310	20	216	0	0	0	216	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	124	12	1,488	1,488	4A
CTV Summer Campaign 3	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	124	17	4,310	20	216	0	0	0	216	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	124	12	1,488	1,488	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		124	17	4,310	20	216	0	0	0	216	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	124	12	1,488	1,488	4A
WTG heavy logistics / jack-up																	
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	NJWP	3	91	547	10	55	0	0	0	55	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	91	0	0	0	12	24	288	288	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		3	91	547	10	55	0	0	0	55	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	91	0	0	0	12	24	288	288	7A
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	2	2350	4,700	3 main	NJWP	3	91	547	10	55	0	0	0	55	7M
		Main Engine (Maneuvering)	2	2350	4,700	3 main		0	91	0	0	0	12	24	288	288	7M
		Auxiliary Engine (Transit)	2	1000	2,000	3 auxiliary		3	91	547	10	55	0	0	0	55	7A
		Auxiliary Engine (Maneuvering)	2	1000	2,000	3 auxiliary		0	91	0	0	0	12	24	288	288	7A
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	Europe	3	250	1,500	10	150	0	0	0	150	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	250	0	0	0	12	24	288	288	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		3	250	1,500	10	150	0	0	0	150	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	250	0	0	0	12	24	288	288	7A
Cable repair vessel - export cable																	
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0	0	7,280	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	3M
		Main Engine (Maneuvering)	0	0	7,280	1 & 2 main		0	91	0	0	0	5	24	120	120	3M
		Auxiliary Engine (Transit)	0	0	220	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	3A
		Auxiliary Engine (Maneuvering)	0	0	220	1 & 2 auxiliary		0	91	0	0	0	5	24	120	120	3A

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Round Trips (per year)	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Cable repair vessel - arrray cable																	
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0	0	7,280	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	3M
		Main Engine (Maneuvering)	0	0	7,280	1 & 2 main		0	91	0	0	0	7	24	168	168	3M
		Auxiliary Engine (Transit)	0	0	220	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	3A
		Auxiliary Engine (Maneuvering)	0	0	220	1 & 2 auxiliary		0	91	0	0	0	7	24	168	168	3A
Cable survey vessel - export cable																	
Cable survey vessel	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	91	0	0	0	10	24	240	240	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	91	0	0	0	10	24	240	240	8A
Cable survey vessel - arrray cable																	
Cable survey vessel	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	91	0	0	0	12	24	288	288	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	91	0	0	0	12	24	288	288	8A
Foundation below water inspection																	
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	Atlantic City	2	17	70	10	7	0	0	0	7	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	17	0	0	0	13	24	312	312	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		2	17	70	10	7	0	0	0	7	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	17	0	0	0	13	24	312	312	8A
Other vessels																	
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	12	17	417	20	21	0	0	0	21	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	12	8	96	96	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		12	17	417	20	21	0	0	0	21	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	12	8	96	96	4A
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	4	2,306	9,224	1 & 2 main	NJWP	0.03	91	6	10	1	0	0	0	1	3M
		Main Engine (Maneuvering)	4	2,306	9,224	1 & 2 main		0	91	0	0	0	3	24	72	72	3M
		Auxiliary Engine (Transit)	4	2,000	8,000	1 & 2 auxiliary		0.03	91	6	10	1	0	0	0	1	3A
		Auxiliary Engine (Maneuvering)	4	2,000	8,000	1 & 2 auxiliary		0	91	0	0	0	3	24	72	72	3A
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	NJWP	0.03	91	6	10	1	0	0	0	1	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	91	0	0	0	3	24	72	72	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		0.03	91	6	10	1	0	0	0	1	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	91	0	0	0	3	24	72	72	7A
Miscellaneous																	
SF6 Loss	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OSS Generators	Generator	Marine Tier 3 Generator	4	500	2,000	Marine Tier 3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24	24	31

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Operations (CTV Scenario)																			
WTG and BoP Crew logistics																			
CTV all-year 1	Crew Transfer Vessel	Main Engine (Transit)	0.83	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0	8	546
		Main Engine (Maneuvering)	0.20	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0	13	908
		Auxiliary Engine (Transit)	0.43	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0	0	7
		Auxiliary Engine (Maneuvering)	0.43	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0	1	50
CTV all-year 2	Crew Transfer Vessel	Main Engine (Transit)	0.83	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0	8	546
		Main Engine (Maneuvering)	0.20	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0	13	908
		Auxiliary Engine (Transit)	0.43	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0	0	7
		Auxiliary Engine (Maneuvering)	0.43	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0	1	50
CTV all-year 3	Crew Transfer Vessel	Main Engine (Transit)	0.83	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0	8	546
		Main Engine (Maneuvering)	0.20	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0	13	908
		Auxiliary Engine (Transit)	0.43	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0	0	7
		Auxiliary Engine (Maneuvering)	0.43	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0	1	50
CTV Summer Campaign 1	Crew Transfer Vessel	Main Engine (Transit)	0.83	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0	4	271
		Main Engine (Maneuvering)	0.20	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0	6	450
		Auxiliary Engine (Transit)	0.43	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0	0	4
		Auxiliary Engine (Maneuvering)	0.43	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0	0	25
CTV Summer Campaign 2	Crew Transfer Vessel	Main Engine (Transit)	0.83	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0	4	271
		Main Engine (Maneuvering)	0.20	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0	6	450
		Auxiliary Engine (Transit)	0.43	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0	0	4
		Auxiliary Engine (Maneuvering)	0.43	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0	0	25
CTV Summer Campaign 3	Crew Transfer Vessel	Main Engine (Transit)	0.83	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0	4	271
		Main Engine (Maneuvering)	0.20	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0	6	450
		Auxiliary Engine (Transit)	0.43	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0	0	4
		Auxiliary Engine (Maneuvering)	0.43	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0	0	25
WTG heavy logistics / jack-up																			
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	0.83	52,204	10.05	0.14	2.30	0.31	0.30	0.01	0.00	0.02	0.00	648.21	0.00	0.03	0	9	658
		Main Engine (Maneuvering)	0.20	66,176	12.74	0.18	2.92	0.39	0.38	0.02	0.00	0.02	0.00	821.70	0.01	0.04	0	12	834
		Auxiliary Engine (Transit)	0.43	6,345	1.20	0.01	0.26	0.03	0.03	0.00	0.00	0.00	0.00	67.28	0.00	0.00	0	1	68
		Auxiliary Engine (Maneuvering)	0.43	33,378	6.31	0.08	1.35	0.17	0.17	0.00	0.00	0.01	0.00	353.94	0.00	0.02	0	5	359
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	0.83	12,268	2.36	0.03	0.54	0.07	0.07	0.00	0.00	0.00	0.00	152.33	0.00	0.01	0	2	155
		Main Engine (Maneuvering)	0.20	15,551	2.99	0.04	0.69	0.09	0.09	0.00	0.00	0.01	0.00	193.10	0.00	0.01	0	3	196
		Auxiliary Engine (Transit)	0.45	3,320	0.63	0.01	0.13	0.02	0.02	0.00	0.00	0.00	0.00	35.20	0.00	0.00	0	1	36
		Auxiliary Engine (Maneuvering)	0.45	17,465	3.30	0.04	0.71	0.09	0.09	0.00	0.00	0.01	0.00	185.20	0.00	0.01	0	3	188
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	0.83	143,037	27.53	0.38	6.31	0.85	0.82	0.04	0.00	0.05	0.00	1776.08	0.01	0.09	0	25	1,802
		Main Engine (Maneuvering)	0.20	66,176	12.74	0.18	2.92	0.39	0.38	0.02	0.00	0.02	0.00	821.70	0.01	0.04	0	12	834
		Auxiliary Engine (Transit)	0.43	17,384	3.28	0.04	0.71	0.09	0.09	0.00	0.00	0.01	0.00	184.35	0.00	0.01	0	3	187
		Auxiliary Engine (Maneuvering)	0.43	33,378	6.31	0.08	1.35	0.17	0.17	0.00	0.00	0.01	0.00	353.94	0.00	0.02	0	5	359
Cable repair vessel - export cable																			
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0.83	7,003	1.15	0.03	0.27	0.04	0.04	0.01	0.00	0.00	0.00	77.18	0.00	0.00	0	1	78
		Main Engine (Maneuvering)	0.20	11,096	1.83	0.05	0.42	0.07	0.06	0.02	0.00	0.01	0.00	122.30	0.00	0.01	0	2	124
		Auxiliary Engine (Transit)	0.56	143	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.61	0.00	0.00	0	0	2
		Auxiliary Engine (Maneuvering)	0.56	939	0.16	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	10.56	0.00	0.00	0	0	11

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Cable repair vessel - arrray cable																			
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0.83	7,003	1.15	0.03	0.27	0.04	0.04	0.01	0.00	0.00	0.00	77.18	0.00	0.00	0	1	78
		Main Engine (Maneuvering)	0.20	15,535	2.56	0.07	0.59	0.09	0.09	0.02	0.00	0.01	0.00	171.22	0.00	0.01	0	2	174
		Auxiliary Engine (Transit)	0.56	143	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.61	0.00	0.00	0	0	2
		Auxiliary Engine (Maneuvering)	0.56	1,314	0.23	0.00	0.06	0.01	0.01	0.00	0.00	0.00	0.00	14.79	0.00	0.00	0	0	15
Cable survey vessel - export cable																			
Cable survey vessel	Survey Vessel	Main Engine (Transit)	0.83	3,655	0.63	0.01	0.14	0.02	0.02	0.00	0.00	0.00	0.00	40.49	0.00	0.00	0	1	41
		Main Engine (Maneuvering)	0.20	11,584	1.98	0.04	0.45	0.07	0.07	0.01	0.00	0.00	0.00	128.33	0.00	0.01	0	2	130
		Auxiliary Engine (Transit)	0.43	99	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.43	1,298	0.23	0.00	0.06	0.01	0.01	0.00	0.00	0.00	0.00	14.60	0.00	0.00	0	0	15
Cable survey vessel - arrray cable																			
Cable survey vessel	Survey Vessel	Main Engine (Transit)	0.83	3,655	0.63	0.01	0.14	0.02	0.02	0.00	0.00	0.00	0.00	40.49	0.00	0.00	0	1	41
		Main Engine (Maneuvering)	0.20	13,901	2.38	0.05	0.54	0.08	0.08	0.02	0.00	0.01	0.00	154.00	0.00	0.01	0	2	156
		Auxiliary Engine (Transit)	0.43	99	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.43	1,557	0.28	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	17.52	0.00	0.00	0	0	18
Foundation below water inspection																			
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	0.83	1,392	0.24	0.01	0.05	0.01	0.01	0.00	0.00	0.00	0.00	15.43	0.00	0.00	0	0	16
		Main Engine (Maneuvering)	0.20	15,059	2.58	0.06	0.59	0.09	0.09	0.02	0.00	0.01	0.00	166.83	0.00	0.01	0	2	169
		Auxiliary Engine (Transit)	0.43	38	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.00	0.00	0	0	0
		Auxiliary Engine (Maneuvering)	0.43	1,687	0.30	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	18.98	0.00	0.00	0	0	19
Other vessels																			
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	0.83	2,295	0.36	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	25.82	0.00	0.00	0	0	26
		Main Engine (Maneuvering)	0.20	2,546	0.40	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.00	28.64	0.00	0.00	0	0	29
		Auxiliary Engine (Transit)	0.43	31	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0	0	0
		Auxiliary Engine (Maneuvering)	0.43	142	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0	0	2
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	0.16	57	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0	0	1
		Main Engine (Maneuvering)	0.10	4,393	0.72	0.02	0.17	0.03	0.03	0.01	0.00	0.00	0.00	48.42	0.00	0.00	0	1	49
		Auxiliary Engine (Transit)	0.16	49	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.10	3,810	0.65	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	42.86	0.00	0.00	0	1	43
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	0.83	580	0.11	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.20	0.00	0.00	0	0	7
		Main Engine (Maneuvering)	0.20	16,544	3.18	0.04	0.73	0.10	0.10	0.00	0.00	0.01	0.00	205.43	0.00	0.01	0	3	208
		Auxiliary Engine (Transit)	0.45	74	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.45	8,733	1.65	0.02	0.35	0.05	0.04	0.00	0.00	0.00	0.00	92.60	0.00	0.00	0	1	94
Miscellaneous																			
SF6 Loss	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,690
OSS Generators	Generator	Marine Tier 3 Generator	0.75	2,571	0.23	0.03	0.20	0.00	0.00	0.00	0.00	0.00	0.00	29.35	0.00	0.00	0	0	29
				Total/yr	1,200,127	208.11	3.17	49.64	6.70	6.48	0.29	0.00	0.39	0.01	13,840.33	0.09	0.66	2.16	197.29	15,729.96
				Total over Project Life	36,003,822	6,243.31	95.13	1,489.18	200.90	194.49	8.75	0.03	11.76	0.40	415,209.94	2.60	19.86	64.94	5,918.70	471,898.79
				Vessels	1,197,556	207.88	3.14	49.44	6.69	6.48	0.29	0.00	0.39	0.01	13,810.98	0.09	0.66	2.13	197.22	14,010.34
					35,926,679	6,236.41	94.30	1,483.23	200.78	194.38	8.74	0.03	11.74	0.40	414,329.45	2.56	19.85	64.05	5,916.57	420,310.07
				Non-vessel	2,571	0.23	0.03	0.20	0.00	0.00	0.00	0.00	0.00	0.00	29.35	0.00	0.00	0.03	0.07	1,719.62
					77,143	6.90	0.83	5.95	0.12	0.12	0.01	0.00	0.02	0.00	880.49	0.04	0.01	0.89	2.13	51,588.73

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Operations (CTV Scenario)																				
WTG and BoP Crew logistics																				
CTV all-year 1	Crew Transfer Vessel	Main Engine (Transit)	17	100%	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0.08	7.67	545.73
		Main Engine (Maneuvering)	17	100%	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0.14	12.76	907.97
		Auxiliary Engine (Transit)	17	100%	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0.00	0.10	7.31
		Auxiliary Engine (Maneuvering)	17	100%	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0.01	0.71	50.49
CTV all-year 2	Crew Transfer Vessel	Main Engine (Transit)	17	100%	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0.08	7.67	545.73
		Main Engine (Maneuvering)	17	100%	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0.14	12.76	907.97
		Auxiliary Engine (Transit)	17	100%	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0.00	0.10	7.31
		Auxiliary Engine (Maneuvering)	17	100%	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0.01	0.71	50.49
CTV all-year 3	Crew Transfer Vessel	Main Engine (Transit)	17	100%	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0.08	7.67	545.73
		Main Engine (Maneuvering)	17	100%	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0.14	12.76	907.97
		Auxiliary Engine (Transit)	17	100%	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0.00	0.10	7.31
		Auxiliary Engine (Maneuvering)	17	100%	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0.01	0.71	50.49
CTV Summer Campaign 1	Crew Transfer Vessel	Main Engine (Transit)	17	100%	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0.04	3.80	270.68
		Main Engine (Maneuvering)	17	100%	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0.07	6.33	450.35
		Auxiliary Engine (Transit)	17	100%	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0.00	0.05	3.63
		Auxiliary Engine (Maneuvering)	17	100%	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0.00	0.35	25.04
CTV Summer Campaign 2	Crew Transfer Vessel	Main Engine (Transit)	17	100%	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0.04	3.80	270.68
		Main Engine (Maneuvering)	17	100%	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0.07	6.33	450.35
		Auxiliary Engine (Transit)	17	100%	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0.00	0.05	3.63
		Auxiliary Engine (Maneuvering)	17	100%	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0.00	0.35	25.04
CTV Summer Campaign 3	Crew Transfer Vessel	Main Engine (Transit)	17	100%	23,719	3.77	0.06	0.95	0.13	0.12	0.00	0.00	0.01	0.00	266.84	0.00	0.01	0.04	3.80	270.68
		Main Engine (Maneuvering)	17	100%	39,463	6.27	0.10	1.58	0.21	0.21	0.00	0.00	0.01	0.00	443.96	0.00	0.02	0.07	6.33	450.35
		Auxiliary Engine (Transit)	17	100%	318	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	0.00	0.00	0.05	3.63
		Auxiliary Engine (Maneuvering)	17	100%	2,194	0.40	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.69	0.00	0.00	0.00	0.35	25.04
WTG heavy logistics / jack-up																				
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	25	27%	14,304	2.75	0.04	0.63	0.09	0.08	0.00	0.00	0.00	0.00	177.61	0.00	0.01	0.03	2.54	180.17
		Main Engine (Maneuvering)	25	100%	66,176	12.74	0.18	2.92	0.39	0.38	0.02	0.00	0.02	0.00	821.70	0.01	0.04	0.13	11.73	833.56
		Auxiliary Engine (Transit)	25	27%	1,738	0.33	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	18.43	0.00	0.00	0.00	0.26	18.70
		Auxiliary Engine (Maneuvering)	25	100%	33,378	6.31	0.08	1.35	0.17	0.17	0.00	0.00	0.01	0.00	353.94	0.00	0.02	0.05	5.04	359.04
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	25	27%	3,361	0.65	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.00	41.74	0.00	0.00	0.01	0.60	42.34
		Main Engine (Maneuvering)	25	100%	15,551	2.99	0.04	0.69	0.09	0.09	0.00	0.00	0.01	0.00	193.10	0.00	0.01	0.03	2.76	195.89
		Auxiliary Engine (Transit)	25	27%	910	0.17	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	9.65	0.00	0.00	0.00	0.14	9.78
		Auxiliary Engine (Maneuvering)	25	100%	17,465	3.30	0.04	0.71	0.09	0.09	0.00	0.00	0.01	0.00	185.20	0.00	0.01	0.03	2.64	187.87
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	25	10%	14,304	2.75	0.04	0.63	0.09	0.08	0.00	0.00	0.00	0.00	177.61	0.00	0.01	0.03	2.54	180.17
		Main Engine (Maneuvering)	25	100%	66,176	12.74	0.18	2.92	0.39	0.38	0.02	0.00	0.02	0.00	821.70	0.01	0.04	0.13	11.73	833.56
		Auxiliary Engine (Transit)	25	10%	1,738	0.33	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	18.43	0.00	0.00	0.00	0.26	18.70
		Auxiliary Engine (Maneuvering)	25	100%	33,378	6.31	0.08	1.35	0.17	0.17	0.00	0.00	0.01	0.00	353.94	0.00	0.02	0.05	5.04	359.04
Cable repair vessel - export cable																				
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	25	27%	1,919	0.32	0.01	0.07	0.01	0.01	0.00	0.00	0.00	0.00	21.15	0.00	0.00	0.00	0.31	21.46
		Main Engine (Maneuvering)	25	51%	5,669	0.93	0.02	0.22	0.03	0.03	0.01	0.00	0.00	0.00	62.49	0.00	0.00	0.01	0.91	63.41
		Auxiliary Engine (Transit)	25	27%	39	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.01	0.45
		Auxiliary Engine (Maneuvering)	25	51%	480	0.08	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	5.40	0.00	0.00	0.00	0.08	5.47

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Cable repair vessel - arrray cable																				
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	25	27%	1,919	0.32	0.01	0.07	0.01	0.01	0.00	0.00	0.00	0.00	21.15	0.00	0.00	0.00	0.31	21.46
		Main Engine (Maneuvering)	25	100%	15,535	2.56	0.07	0.59	0.09	0.09	0.02	0.00	0.01	0.00	171.22	0.00	0.01	0.03	2.49	173.74
		Auxiliary Engine (Transit)	25	27%	39	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.01	0.45
		Auxiliary Engine (Maneuvering)	25	100%	1,314	0.23	0.00	0.06	0.01	0.01	0.00	0.00	0.00	0.00	14.79	0.00	0.00	0.00	0.21	15.00
Cable survey vessel - export cable																				
Cable survey vessel	Survey Vessel	Main Engine (Transit)	25	27%	1,002	0.17	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	11.10	0.00	0.00	0.00	0.16	11.26
		Main Engine (Maneuvering)	25	51%	5,919	1.01	0.02	0.23	0.03	0.03	0.01	0.00	0.00	0.00	65.57	0.00	0.00	0.01	0.95	66.53
		Auxiliary Engine (Transit)	25	27%	27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.31
		Auxiliary Engine (Maneuvering)	25	51%	663	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.46	0.00	0.00	0.00	0.11	7.57
Cable survey vessel - arrray cable																				
Cable survey vessel	Survey Vessel	Main Engine (Transit)	25	27%	1,002	0.17	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	11.10	0.00	0.00	0.00	0.16	11.26
		Main Engine (Maneuvering)	25	100%	13,901	2.38	0.05	0.54	0.08	0.08	0.02	0.00	0.01	0.00	154.00	0.00	0.01	0.02	2.23	156.25
		Auxiliary Engine (Transit)	25	27%	27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.31
		Auxiliary Engine (Maneuvering)	25	100%	1,557	0.28	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	17.52	0.00	0.00	0.00	0.25	17.77
Foundation below water inspection																				
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	17	100%	1,392	0.24	0.01	0.05	0.01	0.01	0.00	0.00	0.00	0.00	15.43	0.00	0.00	0.00	0.22	15.65
		Main Engine (Maneuvering)	17	100%	15,059	2.58	0.06	0.59	0.09	0.09	0.02	0.00	0.01	0.00	166.83	0.00	0.01	0.03	2.41	169.27
		Auxiliary Engine (Transit)	17	100%	38	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.01	0.43
		Auxiliary Engine (Maneuvering)	17	100%	1,687	0.30	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	18.98	0.00	0.00	0.00	0.27	19.25
Other vessels																				
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	17	100%	2,295	0.36	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	25.82	0.00	0.00	0.00	0.37	26.19
		Main Engine (Maneuvering)	17	100%	2,546	0.40	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.00	28.64	0.00	0.00	0.00	0.41	29.06
		Auxiliary Engine (Transit)	17	100%	31	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.35
		Auxiliary Engine (Maneuvering)	17	100%	142	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0.00	0.02	1.62
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	25	27%	16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.17
		Main Engine (Maneuvering)	25	100%	4,393	0.72	0.02	0.17	0.03	0.03	0.01	0.00	0.00	0.00	48.42	0.00	0.00	0.01	0.70	49.13
		Auxiliary Engine (Transit)	25	27%	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.15
		Auxiliary Engine (Maneuvering)	25	100%	3,810	0.65	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	42.86	0.00	0.00	0.01	0.61	43.48
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	25	27%	159	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.97	0.00	0.00	0.00	0.03	2.00
		Main Engine (Maneuvering)	25	100%	16,544	3.18	0.04	0.73	0.10	0.10	0.00	0.00	0.01	0.00	205.43	0.00	0.01	0.03	2.93	208.39
		Auxiliary Engine (Transit)	25	27%	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.22
		Auxiliary Engine (Maneuvering)	25	100%	8,733	1.65	0.02	0.35	0.05	0.04	0.00	0.00	0.00	0.00	92.60	0.00	0.00	0.01	1.32	93.94
Miscellaneous																				
SF6 Loss	N/A	N/A	N/A	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,690.17
OSS Generators	Generator	Marine Tier 3 Generator	N/A	100%	2,571	0.23	0.03	0.20	0.00	0.00	0.00	0.00	0.00	0.00	29.35	0.00	0.00	0.03	0.07	29.45

OCS Total Ton/yr	**973,361**	**165.24**	**2.53**	**39.86**	**5.37**	**5.19**	**0.21**	**0.00**	**0.31**	**0.01**	**11,103.99**	**0.07**	**0.53**	**1.74**	**158.16**	**12,954.07**
OCS Total Tons over life	**29,200,831**	**4,957.19**	**75.98**	**1,195.87**	**160.97**	**155.84**	**6.29**	**0.02**	**9.39**	**0.29**	**333,119.81**	**2.09**	**15.92**	**52.23**	**4,744.81**	**388,622.07**
Vessels	970,790	165.01	2.51	39.66	5.36	5.19	0.21	0.00	0.31	0.01	11,074.64	0.07	0.53	1.71	158.09	11,234.44
	29,123,688	4,950.28	75.16	1,189.92	160.86	155.72	6.28	0.02	9.37	0.29	332,239.33	2.05	15.92	51.34	4,742.68	337,033.35
Non-vessel	2,571	0.23	0.03	0.20	0.00	0.00	0.00	0.00	0.00	0.00	29.35	0.00	0.00	0.03	0.07	1,719.62
	77,143	6.90	0.83	5.95	0.12	0.12	0.01	0.00	0.02	0.00	880.49	0.04	0.01	0.89	2.13	51,588.73

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Round Trips (per year)	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Emissions During Operations (SOV Scenario)																	
WTG and BoP Crew logistics																	
CTV All-Year 1	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	250	17	8,690	20	434	0	0	0	434	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	250	12	3,000	3,000	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		250	17	8,690	20	434	0	0	0	434	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	250	12	3,000	3,000	4A
CTV All-Year 2	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	250	17	8,690	20	434	0	0	0	434	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	250	12	3,000	3,000	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		250	17	8,690	20	434	0	0	0	434	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	250	12	3,000	3,000	4A
SOV All-Year 1	Service Operation Vessel	Main Engine (Transit)	4	2,306	9,224	1 & 2 main	Atlantic City	24	17	834	20	42	0	0	0	42	3M
		Main Engine (Maneuvering)	4	2,306	9,224	1 & 2 main		0	17	0	0	0	341	24	8,184	8,184	3M
		Auxiliary Engine (Transit)	4	2,000	8,000	1 & 2 auxiliary		24	17	834	20	42	0	0	0	42	3A
		Auxiliary Engine (Maneuvering)	4	2,000	8,000	1 & 2 auxiliary		0	17	0	0	0	341	24	8,184	8,184	3A
SOV Daughter Craft 1	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	N/A	0	0	0	20	0	0	0	0	0	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	0	0	0	0	220	8	1,760	1,760	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		0	0	0	20	0	0	0	0	0	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	0	0	0	0	220	8	1,760	1,760	4A
WTG heavy logistics / jack-up																	
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	NJWP	8	91	1,460	10	146	0	0	0	146	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	91	0	0	0	40	24	960	960	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		8	91	1,460	10	146	0	0	0	146	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	91	0	0	0	40	24	960	960	7A
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	2	2350	4,700	3 main	NJWP	8	91	1,460	10	146	0	0	0	146	7M
		Main Engine (Maneuvering)	2	2350	4,700	3 main		0	91	0	0	0	40	24	960	960	7M
		Auxiliary Engine (Transit)	2	1000	2,000	3 auxiliary		8	91	1,460	10	146	0	0	0	146	7A
		Auxiliary Engine (Maneuvering)	2	1000	2,000	3 auxiliary		0	91	0	0	0	40	24	960	960	7A
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	Europe	8	250	4,000	10	400	0	0	0	400	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	250	0	0	0	40	24	960	960	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		8	250	4,000	10	400	0	0	0	400	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	250	0	0	0	40	24	960	960	7A
Cable repair vessel - export cable																	
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0	0	7,280	1 & 2 main	NJWP	0.7	91	128	10	13	0	0	0	13	3M
		Main Engine (Maneuvering)	0	0	7,280	1 & 2 main		0	91	0	0	0	25	24	600	600	3M
		Auxiliary Engine (Transit)	0	0	220	1 & 2 auxiliary		0.7	91	128	10	13	0	0	0	13	3A
		Auxiliary Engine (Maneuvering)	0	0	220	1 & 2 auxiliary		0	91	0	0	0	25	24	600	600	3A

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Round Trips (per year)	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Cable repair vessel - array cable																	
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0	0	7,280	1 & 2 main	NJWP	0.9	91	164	10	16	0	0	0	16	3M
		Main Engine (Maneuvering)	0	0	7,280	1 & 2 main		0	91	0	0	0	11	24	264	264	3M
		Auxiliary Engine (Transit)	0	0	220	1 & 2 auxiliary		0.9	91	164	10	16	0	0	0	16	3A
		Auxiliary Engine (Maneuvering)	0	0	220	1 & 2 auxiliary		0	91	0	0	0	11	24	264	264	3A
Cable survey vessel - export cable																	
Cable survey vessel	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	91	0	0	0	30	24	720	720	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	91	0	0	0	30	24	720	720	8A
Cable survey vessel - array cable																	
Cable survey vessel	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	91	0	0	0	13	24	312	312	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	91	0	0	0	13	24	312	312	8A
Foundation below water inspection																	
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	Atlantic City	5	17	174	10	17	0	0	0	17	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	17	0	0	0	40	24	960	960	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		5	17	174	10	17	0	0	0	17	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	17	0	0	0	40	24	960	960	8A
Other vessels																	
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	12	17	417	20	21	0	0	0	21	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	12	8	96	96	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		12	17	417	20	21	0	0	0	21	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	12	8	96	96	4A
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	4	2,306	9,224	1 & 2 main	NJWP	0.03	91	6	10	1	0	0	0	1	3M
		Main Engine (Maneuvering)	4	2,306	9,224	1 & 2 main		0	91	0	0	0	3	24	72	72	3M
		Auxiliary Engine (Transit)	4	2,000	8,000	1 & 2 auxiliary		0.03	91	6	10	1	0	0	0	1	3A
		Auxiliary Engine (Maneuvering)	4	2,000	8,000	1 & 2 auxiliary		0	91	0	0	0	3	24	72	72	3A
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	NJWP	0.03	91	6	10	1	0	0	0	1	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	91	0	0	0	3	24	72	72	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		0.03	91	6	10	1	0	0	0	1	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	91	0	0	0	3	24	72	72	7A
Miscellaneous																	
SF6 Loss	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OSS Generators	Generator	Marine Tier 3 Generator	8	500	4,000	Marine Tier 3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24	24	31

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Operations (SOV Scenario)																			
WTG and BoP Crew logistics																			
CTV All-Year 1	Crew Transfer Vessel	Main Engine (Transit)	0.83	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0.08	7.67	545.73
		Main Engine (Maneuvering)	0.20	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0.14	12.76	907.97
		Auxiliary Engine (Transit)	0.43	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0.00	0.10	7.31
		Auxiliary Engine (Maneuvering)	0.43	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0.01	0.71	50.49
CTV All-Year 2	Crew Transfer Vessel	Main Engine (Transit)	0.83	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0.08	7.67	545.73
		Main Engine (Maneuvering)	0.20	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0.14	12.76	907.97
		Auxiliary Engine (Transit)	0.43	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0.00	0.10	7.31
		Auxiliary Engine (Maneuvering)	0.43	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0.01	0.71	50.49
SOV All-Year 1	Service Operation Vessel	Main Engine (Transit)	0.16	3,910	0.64	0.02	0.15	0.02	0.02	0.01	0.00	0.00	0.00	43.09	0.00	0.00	0.01	0.63	43.72
		Main Engine (Maneuvering)	0.10	499,313	82.25	2.17	19.07	2.95	2.86	0.74	0.00	0.24	0.03	5,503.40	0.03	0.27	0.87	80.06	5,584.33
		Auxiliary Engine (Transit)	0.16	3,391	0.58	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.00	38.15	0.00	0.00	0.01	0.54	38.70
		Auxiliary Engine (Maneuvering)	0.10	433,055	74.34	1.05	18.64	2.41	2.33	0.05	0.00	0.13	0.00	4,872.18	0.03	0.23	0.75	69.44	4,942.37
SOV Daughter Craft 1	Crew Transfer Vessel	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.20	46,676	7.41	0.11	1.86	0.25	0.24	0.00	0.00	0.01	0.00	525.11	0.00	0.03	0.08	7.48	532.68
		Auxiliary Engine (Transit)	0.43	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Maneuvering)	0.43	2,595	0.47	0.01	0.11	0.01	0.01	0.00	0.00	0.00	0.00	29.20	0.00	0.00	0.00	0.42	29.62
WTG heavy logistics / jack-up																			
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	0.83	139,211	26.79	0.37	6.14	0.83	0.80	0.03	0.00	0.05	0.00	1,728.57	0.01	0.08	0.27	24.68	1,753.52
		Main Engine (Maneuvering)	0.20	220,586	42.46	0.59	9.74	1.31	1.27	0.06	0.00	0.07	0.00	2,739.01	0.02	0.13	0.42	39.10	2,778.54
		Auxiliary Engine (Transit)	0.43	16,919	3.20	0.04	0.69	0.09	0.09	0.00	0.00	0.00	0.00	179.42	0.00	0.01	0.03	2.56	182.00
		Auxiliary Engine (Maneuvering)	0.43	111,259	21.02	0.25	4.51	0.58	0.56	0.01	0.00	0.03	0.00	1,179.81	0.01	0.06	0.18	16.81	1,196.81
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	0.83	32,715	6.30	0.09	1.44	0.19	0.19	0.01	0.00	0.01	0.00	406.21	0.00	0.02	0.06	5.80	412.08
		Main Engine (Maneuvering)	0.20	51,838	9.98	0.14	2.29	0.31	0.30	0.01	0.00	0.02	0.00	643.67	0.00	0.03	0.10	9.19	652.96
		Auxiliary Engine (Transit)	0.45	8,853	1.67	0.02	0.36	0.05	0.04	0.00	0.00	0.00	0.00	93.88	0.00	0.00	0.01	1.34	95.23
		Auxiliary Engine (Maneuvering)	0.45	58,217	11.00	0.13	2.36	0.30	0.30	0.01	0.00	0.02	0.00	617.34	0.00	0.03	0.10	8.80	626.24
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	0.83	381,431	73.41	1.02	16.83	2.27	2.20	0.10	0.00	0.13	0.00	4,736.20	0.03	0.23	0.73	67.62	4,804.55
		Main Engine (Maneuvering)	0.20	220,586	42.46	0.59	9.74	1.31	1.27	0.06	0.00	0.07	0.00	2,739.01	0.02	0.13	0.42	39.10	2,778.54
		Auxiliary Engine (Transit)	0.43	46,358	8.76	0.11	1.88	0.24	0.24	0.00	0.00	0.01	0.00	491.59	0.00	0.02	0.08	7.01	498.67
		Auxiliary Engine (Maneuvering)	0.43	111,259	21.02	0.25	4.51	0.58	0.56	0.01	0.00	0.03	0.00	1,179.81	0.01	0.06	0.18	16.81	1,196.81
Cable repair vessel - export cable																			
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0.83	4,902	0.81	0.02	0.19	0.03	0.03	0.01	0.00	0.00	0.00	54.03	0.00	0.00	0.01	0.79	54.82
		Main Engine (Maneuvering)	0.20	55,481	9.14	0.24	2.12	0.33	0.32	0.08	0.00	0.03	0.00	611.51	0.00	0.03	0.10	8.90	620.50
		Auxiliary Engine (Transit)	0.56	100	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.12	0.00	0.00	0.00	0.02	1.14
		Auxiliary Engine (Maneuvering)	0.56	4,695	0.81	0.01	0.20	0.03	0.03	0.00	0.00	0.00	0.00	52.82	0.00	0.00	0.01	0.75	53.58

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Cable repair vessel - array cable																			
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0.83	6,302	1.04	0.03	0.24	0.04	0.04	0.01	0.00	0.00	0.00	69.47	0.00	0.00	0.01	1.01	70.49
		Main Engine (Maneuvering)	0.20	24,412	4.02	0.11	0.93	0.14	0.14	0.04	0.00	0.01	0.00	269.06	0.00	0.01	0.04	3.91	273.02
		Auxiliary Engine (Transit)	0.56	129	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.45	0.00	0.00	0.00	0.02	1.47
		Auxiliary Engine (Maneuvering)	0.56	2,066	0.35	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	23.24	0.00	0.00	0.00	0.33	23.57
Cable survey vessel - export cable																			
Cable survey vessel	Survey Vessel	Main Engine (Transit)	0.83	3,655	0.63	0.01	0.14	0.02	0.02	0.00	0.00	0.00	0.00	40.49	0.00	0.00	0.01	0.59	41.09
		Main Engine (Maneuvering)	0.20	34,752	5.95	0.13	1.36	0.21	0.20	0.04	0.00	0.01	0.00	384.99	0.00	0.02	0.06	5.57	390.62
		Auxiliary Engine (Transit)	0.43	99	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0.00	0.02	1.13
		Auxiliary Engine (Maneuvering)	0.43	3,893	0.69	0.01	0.17	0.02	0.02	0.00	0.00	0.00	0.00	43.80	0.00	0.00	0.01	0.62	44.43
Cable survey vessel - array cable																			
Cable survey vessel	Survey Vessel	Main Engine (Transit)	0.83	3,655	0.63	0.01	0.14	0.02	0.02	0.00	0.00	0.00	0.00	40.49	0.00	0.00	0.01	0.59	41.09
		Main Engine (Maneuvering)	0.20	15,059	2.58	0.06	0.59	0.09	0.09	0.02	0.00	0.01	0.00	166.83	0.00	0.01	0.03	2.41	169.27
		Auxiliary Engine (Transit)	0.43	99	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0.00	0.02	1.13
		Auxiliary Engine (Maneuvering)	0.43	1,687	0.30	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	18.98	0.00	0.00	0.00	0.27	19.25
Foundation below water inspection																			
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	0.83	3,481	0.60	0.01	0.14	0.02	0.02	0.00	0.00	0.00	0.00	38.57	0.00	0.00	0.01	0.56	39.13
		Main Engine (Maneuvering)	0.20	46,336	7.93	0.18	1.81	0.27	0.27	0.05	0.00	0.02	0.00	513.32	0.00	0.02	0.08	7.43	520.83
		Auxiliary Engine (Transit)	0.43	94	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.06	0.00	0.00	0.00	0.02	1.07
		Auxiliary Engine (Maneuvering)	0.43	5,191	0.92	0.01	0.22	0.03	0.03	0.00	0.00	0.00	0.00	58.40	0.00	0.00	0.01	0.83	59.24
Other vessels																			
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	0.83	2,295	0.36	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	25.82	0.00	0.00	0	0	26
		Main Engine (Maneuvering)	0.20	2,546	0.40	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.00	28.64	0.00	0.00	0	0	29
		Auxiliary Engine (Transit)	0.43	31	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0	0	0
		Auxiliary Engine (Maneuvering)	0.43	142	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0	0	2
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	0.16	57	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0	0	1
		Main Engine (Maneuvering)	0.10	4,393	0.72	0.02	0.17	0.03	0.03	0.01	0.00	0.00	0.00	48.42	0.00	0.00	0	1	49
		Auxiliary Engine (Transit)	0.16	49	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.10	3,810	0.65	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	42.86	0.00	0.00	0	1	43
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	0.83	580	0.11	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.20	0.00	0.00	0	0	7
		Main Engine (Maneuvering)	0.20	16,544	3.18	0.04	0.73	0.10	0.10	0.00	0.00	0.01	0.00	205.43	0.00	0.01	0	3	208
		Auxiliary Engine (Transit)	0.45	74	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.45	8,733	1.65	0.02	0.35	0.05	0.04	0.00	0.00	0.00	0.00	92.60	0.00	0.00	0	1	94
Miscellaneous																			
SF6 Loss	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,519
OSS Generators	Generator	Marine Tier 3 Generator	0.75	5,143	0.46	0.06	0.40	0.01	0.01	0.00	0.00	0.00	0.00	58.70	0.00	0.00	0	0	58.9

Total/yr	2,913,550	520.1	8.6	121.6	16.7	16.1	1.4	0.0	1.0	0.1	33,631.2	0.2	1.6	5.3	481.2	37,636.2
Total over Project Life	87,406,494	15,603.8	259.1	3,646.8	499.7	484.1	41.6	0.1	31.1	1.9	1,008,934.9	6.3	48.4	158.0	14,434.6	1,129,084.8

Vessels	2,908,407	519.7	8.6	121.2	16.6	16.1	1.4	0.0	1.0	0.1	33,572.5	0.2	1.6	5.2	481.0	34,058.7
	87,252,208	15,589.9	257.4	3,634.9	499.5	483.9	41.6	0.1	31.1	1.9	1,007,174.0	6.2	48.4	156.2	14,430.3	1,021,760.5

Non-vessel	5,143	0.46	0.06	0.40	0.01	0.01	0.00	0.00	0.00	0.00	58.70	0.00	0.00	0.06	0.14	3,577.48
	154,286	13.8	1.7	11.9	0.2	0.2	0.0	0.0	0.0	0.0	1,761.0	0.1	0.0	1.8	4.3	107,324.3

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Operations (SOV Scenario)																				
WTG and BoP Crew logistics																				
CTV All-Year 1	Crew Transfer Vessel	Main Engine (Transit)	17	100%	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0.08	7.67	545.73
		Main Engine (Maneuvering)	17	100%	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0.14	12.76	907.97
		Auxiliary Engine (Transit)	17	100%	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0.00	0.10	7.31
		Auxiliary Engine (Maneuvering)	17	100%	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0.01	0.71	50.49
CTV All-Year 2	Crew Transfer Vessel	Main Engine (Transit)	17	100%	47,820	7.59	0.12	1.91	0.26	0.25	0.00	0.00	0.01	0.00	537.98	0.00	0.03	0.08	7.67	545.73
		Main Engine (Maneuvering)	17	100%	79,562	12.64	0.19	3.18	0.43	0.41	0.01	0.00	0.02	0.00	895.08	0.01	0.04	0.14	12.76	907.97
		Auxiliary Engine (Transit)	17	100%	641	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.21	0.00	0.00	0.00	0.10	7.31
		Auxiliary Engine (Maneuvering)	17	100%	4,424	0.80	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.77	0.00	0.00	0.01	0.71	50.49
SOV All-Year 1	Service Operation Vessel	Main Engine (Transit)	17	100%	3,910	0.64	0.02	0.15	0.02	0.02	0.01	0.00	0.00	0.00	43.09	0.00	0.00	0.01	0.63	43.72
		Main Engine (Maneuvering)	17	100%	499,313	82.25	2.17	19.07	2.95	2.86	0.74	0.00	0.24	0.03	5,503.40	0.03	0.27	0.87	80.06	5,584.33
		Auxiliary Engine (Transit)	17	100%	3,391	0.58	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.00	38.15	0.00	0.00	0.01	0.54	38.70
		Auxiliary Engine (Maneuvering)	17	100%	433,055	74.34	1.05	18.64	2.41	2.33	0.05	0.00	0.13	0.00	4,872.18	0.03	0.23	0.75	69.44	4,942.37
SOV Daughter Craft 1	Crew Transfer Vessel	Main Engine (Transit)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		Main Engine (Maneuvering)	N/A	100%	46,676	7.41	0.11	1.86	0.25	0.24	0.00	0.00	0.01	0.00	525.11	0.00	0.03	0.08	7.48	532.68
		Auxiliary Engine (Transit)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		Auxiliary Engine (Maneuvering)	N/A	100%	2,595	0.47	0.01	0.11	0.01	0.01	0.00	0.00	0.00	0.00	29.20	0.00	0.00	0.00	0.42	29.62
WTG heavy logistics / jack-up																				
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	25	27%	38,143	7.34	0.10	1.68	0.23	0.22	0.01	0.00	0.01	0.00	473.62	0.00	0.02	0.07	6.76	480.46
		Main Engine (Maneuvering)	25	100%	220,586	42.46	0.59	9.74	1.31	1.27	0.06	0.00	0.07	0.00	2,739.01	0.02	0.13	0.42	39.10	2,778.54
		Auxiliary Engine (Transit)	25	27%	4,636	0.88	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.16	0.00	0.00	0.01	0.70	49.87
		Auxiliary Engine (Maneuvering)	25	100%	111,259	21.02	0.25	4.51	0.58	0.56	0.01	0.00	0.03	0.00	1,179.81	0.01	0.06	0.18	16.81	1,196.81
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	25	27%	8,964	1.73	0.02	0.40	0.05	0.05	0.00	0.00	0.00	0.00	111.30	0.00	0.01	0.02	1.59	112.91
		Main Engine (Maneuvering)	25	100%	51,838	9.98	0.14	2.29	0.31	0.30	0.01	0.00	0.02	0.00	643.67	0.00	0.03	0.10	9.19	652.96
		Auxiliary Engine (Transit)	25	27%	2,426	0.46	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.00	25.72	0.00	0.00	0.00	0.37	26.09
		Auxiliary Engine (Maneuvering)	25	100%	58,217	11.00	0.13	2.36	0.30	0.30	0.01	0.00	0.02	0.00	617.34	0.00	0.03	0.10	8.80	626.24
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	25	10%	38,143	7.34	0.10	1.68	0.23	0.22	0.01	0.00	0.01	0.00	473.62	0.00	0.02	0.07	6.76	480.46
		Main Engine (Maneuvering)	25	100%	220,586	42.46	0.59	9.74	1.31	1.27	0.06	0.00	0.07	0.00	2,739.01	0.02	0.13	0.42	39.10	2,778.54
		Auxiliary Engine (Transit)	25	10%	4,636	0.88	0.01	0.19	0.02	0.02	0.00	0.00	0.00	0.00	49.16	0.00	0.00	0.01	0.70	49.87
		Auxiliary Engine (Maneuvering)	25	100%	111,259	21.02	0.25	4.51	0.58	0.56	0.01	0.00	0.03	0.00	1,179.81	0.01	0.06	0.18	16.81	1,196.81
Cable repair vessel - export cable																				
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	25	27%	1,343	0.22	0.01	0.05	0.01	0.01	0.00	0.00	0.00	0.00	14.80	0.00	0.00	0.00	0.22	15.02
		Main Engine (Maneuvering)	25	51%	28,347	4.67	0.12	1.08	0.17	0.16	0.04	0.00	0.01	0.00	312.44	0.00	0.02	0.05	4.55	317.04
		Auxiliary Engine (Transit)	25	27%	27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.31
		Auxiliary Engine (Maneuvering)	25	51%	2,399	0.41	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.00	26.99	0.00	0.00	0.00	0.38	27.37

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Cable repair vessel - array cable																				
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	25	27%	1,727	0.28	0.01	0.07	0.01	0.01	0.00	0.00	0.00	0.00	19.03	0.00	0.00	0.00	0.28	19.31
		Main Engine (Maneuvering)	25	100%	24,412	4.02	0.11	0.93	0.14	0.14	0.04	0.00	0.01	0.00	269.06	0.00	0.01	0.04	3.91	273.02
		Auxiliary Engine (Transit)	25	27%	35	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.01	0.40
		Auxiliary Engine (Maneuvering)	25	100%	2,066	0.35	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	23.24	0.00	0.00	0.00	0.33	23.57
Cable survey vessel - export cable																				
Cable survey vessel	Survey Vessel	Main Engine (Transit)	25	27%	1,002	0.17	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	11.10	0.00	0.00	0.00	0.16	11.26
		Main Engine (Maneuvering)	25	51%	17,756	3.04	0.07	0.69	0.10	0.10	0.02	0.00	0.01	0.00	196.70	0.00	0.01	0.03	2.85	199.58
		Auxiliary Engine (Transit)	25	27%	27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.31
		Auxiliary Engine (Maneuvering)	25	51%	1,989	0.35	0.00	0.09	0.01	0.01	0.00	0.00	0.00	0.00	22.38	0.00	0.00	0.00	0.32	22.70
Cable survey vessel - array cable																				
Cable survey vessel	Survey Vessel	Main Engine (Transit)	25	27%	1,002	0.17	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	11.10	0.00	0.00	0.00	0.16	11.26
		Main Engine (Maneuvering)	25	100%	15,059	2.58	0.06	0.59	0.09	0.09	0.02	0.00	0.01	0.00	166.83	0.00	0.01	0.03	2.41	169.27
		Auxiliary Engine (Transit)	25	27%	27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.31
		Auxiliary Engine (Maneuvering)	25	100%	1,687	0.30	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	18.98	0.00	0.00	0.00	0.27	19.25
Foundation below water inspection																				
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	17	100%	3,481	0.60	0.01	0.14	0.02	0.02	0.00	0.00	0.00	0.00	38.57	0.00	0.00	0.01	0.56	39.13
		Main Engine (Maneuvering)	17	100%	46,336	7.93	0.18	1.81	0.27	0.27	0.05	0.00	0.02	0.00	513.32	0.00	0.02	0.08	7.43	520.83
		Auxiliary Engine (Transit)	17	100%	94	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.06	0.00	0.00	0.00	0.02	1.07
		Auxiliary Engine (Maneuvering)	17	100%	5,191	0.92	0.01	0.22	0.03	0.03	0.00	0.00	0.00	0.00	58.40	0.00	0.00	0.01	0.83	59.24
Other vessels																				
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	17	100%	2,295	0.36	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	25.82	0.00	0.00	0.00	0.37	26.19
		Main Engine (Maneuvering)	17	100%	2,546	0.40	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.00	28.64	0.00	0.00	0.00	0.41	29.06
		Auxiliary Engine (Transit)	17	100%	31	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.35
		Auxiliary Engine (Maneuvering)	17	100%	142	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0.00	0.02	1.62
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	25	27%	16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.17
		Main Engine (Maneuvering)	25	100%	4,393	0.72	0.02	0.17	0.03	0.03	0.01	0.00	0.00	0.00	48.42	0.00	0.00	0.01	0.70	49.13
		Auxiliary Engine (Transit)	25	27%	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.15
		Auxiliary Engine (Maneuvering)	25	100%	3,810	0.65	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	42.86	0.00	0.00	0.01	0.61	43.48
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	25	27%	159	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.97	0.00	0.00	0.00	0.03	2.00
		Main Engine (Maneuvering)	25	100%	16,544	3.18	0.04	0.73	0.10	0.10	0.00	0.00	0.01	0.00	205.43	0.00	0.01	0.03	2.93	208.39
		Auxiliary Engine (Transit)	25	27%	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.22
		Auxiliary Engine (Maneuvering)	25	100%	8,733	1.65	0.02	0.35	0.05	0.04	0.00	0.00	0.00	0.00	92.60	0.00	0.00	0.01	1.32	93.94
Miscellaneous																				
SF6 Loss	N/A	N/A	N/A	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,518.58
OSS Generators	Generator	Marine Tier 3 Generator	N/A	100%	5,143	0.46	0.06	0.40	0.008	0.008	0.001	0.000	0.001	0.000	58.70	0.00	0.00	0.06	0.14	58.90

OCS Total Ton/yr	**2,322,378**	**408.1**	**7.0**	**96.0**	**13.2**	**12.8**	**1.2**	**0.002**	**0.83**	**0.05**	**26,484.7**	**0.17**	**1.3**	**4.2**	**379.0**	**30,386.4**
OCS Total Tons over life	**69,671,328**	**12,242.9**	**209.7**	**2,880.4**	**395.7**	**383.4**	**35.6**	**0.1**	**25.0**	**1.6**	**794,540.3**	**5.0**	**38.2**	**124.8**	**11,369.7**	**911,592.1**

Vessels	**2,317,235**	**407.6**	**6.9**	**95.6**	**13.2**	**12.8**	**1.2**	**0.002**	**0.83**	**0.05**	**26,426.0**	**0.16**	**1.3**	**4.1**	**378.8**	**26,808.9**
	69,517,042	**12,229.0**	**208.0**	**2,868.5**	**395.4**	**383.1**	**35.6**	**0.1**	**24.9**	**1.6**	**792,779.3**	**4.9**	**38.1**	**123.0**	**11,365.4**	**804,267.8**

Non-vessel	**5,143**	**0.5**	**0.1**	**0.4**	**0.0**	**0.0**	**0.0**	**0.000**	**0.00**	**0.00**	**58.7**	**0.00**	**0.0**	**0.1**	**0.1**	**3,577.5**
	154,286	**13.8**	**1.7**	**11.9**	**0.2**	**0.2**	**0.0**	**0.0**	**0.0**	**0.0**	**1,761.0**	**0.1**	**0.0**	**1.8**	**4.3**	**107,324.3**

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Round Trips (per year)	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Emissions During Operations (SOV Scenario)																	
WTG and BoP Crew logistics																	
CTV All-Year 1	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	170	17	5,909	20	295	0	0	0	295	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	170	12	2,040	2,040	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		170	17	5,909	20	295	0	0	0	295	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	170	12	2,040	2,040	4A
CTV All-Year 2	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	170	17	5,909	20	295	0	0	0	295	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	170	12	2,040	2,040	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		170	17	5,909	20	295	0	0	0	295	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	170	12	2,040	2,040	4A
SOV All-Year 1	Service Operation Vessel	Main Engine (Transit)	4	2,306	9,224	1 & 2 main	Atlantic City	24	17	834	20	42	0	0	0	42	3M
		Main Engine (Maneuvering)	4	2,306	9,224	1 & 2 main		0	17	0	0	0	341	24	8,184	8,184	3M
		Auxiliary Engine (Transit)	4	2,000	8,000	1 & 2 auxiliary		24	17	834	20	42	0	0	0	42	3A
		Auxiliary Engine (Maneuvering)	4	2,000	8,000	1 & 2 auxiliary		0	17	0	0	0	341	24	8,184	8,184	3A
SOV Daughter Craft 1	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	N/A	0	0	0	20	0	0	0	0	0	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	0	0	0	0	150	8	1,200	1,200	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		0	0	0	20	0	0	0	0	0	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	0	0	0	0	150	8	1,200	1,200	4A
WTG heavy logistics / jack-up																	
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	NJWP	4	91	730	10	73	0	0	0	73	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	91	0	0	0	17	24	408	408	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		4	91	730	10	73	0	0	0	73	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	91	0	0	0	17	24	408	408	7A
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	2	2350	4,700	3 main	NJWP	4	91	730	10	73	0	0	0	73	7M
		Main Engine (Maneuvering)	2	2350	4,700	3 main		0	91	0	0	0	17	24	408	408	7M
		Auxiliary Engine (Transit)	2	1000	2,000	3 auxiliary		4	91	730	10	73	0	0	0	73	7A
		Auxiliary Engine (Maneuvering)	2	1000	2,000	3 auxiliary		0	91	0	0	0	17	24	408	408	7A
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	Europe	4	250	2,000	10	200	0	0	0	200	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	250	0	0	0	17	24	408	408	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		4	250	2,000	10	200	0	0	0	200	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	250	0	0	0	17	24	408	408	7A
Cable repair vessel - export cable																	
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0	0	7,280	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	3M
		Main Engine (Maneuvering)	0	0	7,280	1 & 2 main		0	91	0	0	0	7	24	168	168	3M
		Auxiliary Engine (Transit)	0	0	220	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	3A
		Auxiliary Engine (Maneuvering)	0	0	220	1 & 2 auxiliary		0	91	0	0	0	7	24	168	168	3A
Cable repair vessel - arrray cable																	
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0	0	7,280	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	3M
		Main Engine (Maneuvering)	0	0	7,280	1 & 2 main		0	91	0	0	0	9	24	216	216	3M
		Auxiliary Engine (Transit)	0	0	220	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	3A
		Auxiliary Engine (Maneuvering)	0	0	220	1 & 2 auxiliary		0	91	0	0	0	9	24	216	216	3A
Cable survey vessel - export cable																	
Cable survey vessel	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	91	0	0	0	14	24	336	336	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	91	0	0	0	14	24	336	336	8A
Cable survey vessel - arrray cable																	
Cable survey vessel	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	NJWP	2	91	365	10	36	0	0	0	36	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	91	0	0	0	17	24	408	408	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		2	91	365	10	36	0	0	0	36	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	91	0	0	0	17	24	408	408	8A

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Round Trips (per year)	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Foundation below water inspection																	
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	Atlantic City	3	17	104	10	10	0	0	0	10	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	17	0	0	0	19	24	456	456	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		3	17	104	10	10	0	0	0	10	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	17	0	0	0	19	24	456	456	8A
Other vessels																	
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	12	17	417	20	21	0	0	0	21	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	12	8	96	96	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		12	17	417	20	21	0	0	0	21	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	12	8	96	96	4A
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	4	2,306	9,224	1 & 2 main	NJWP	0.03	91	6	10	1	0	0	0	1	3M
		Main Engine (Maneuvering)	4	2,306	9,224	1 & 2 main		0	91	0	0	0	3	24	72	72	3M
		Auxiliary Engine (Transit)	4	2,000	8,000	1 & 2 auxiliary		0.03	91	6	10	1	0	0	0	1	3A
		Auxiliary Engine (Maneuvering)	4	2,000	8,000	1 & 2 auxiliary		0	91	0	0	0	3	24	72	72	3A
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	NJWP	0.03	91	6	10	1	0	0	0	1	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	91	0	0	0	3	24	72	72	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		0.03	91	6	10	1	0	0	0	1	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	91	0	0	0	3	24	72	72	7A
Miscellaneous																	
SF6 Loss	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OSS Generators	Generator	Marine Tier 3 Generator	4	500	2,000	Marine Tier 3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24	24	31

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Operations (SOV Scenario)																			
WTG and BoP Crew logistics																			
CTV All-Year 1	Crew Transfer Vessel	Main Engine (Transit)	0.83	32,518	5.16	0.08	1.30	0.17	0.17	0.00	0.00	0.01	0.00	365.83	0.00	0.02	0.06	5.21	371.10
		Main Engine (Maneuvering)	0.20	54,102	8.59	0.13	2.16	0.29	0.28	0.01	0.00	0.02	0.00	608.65	0.00	0.03	0.09	8.67	617.42
		Auxiliary Engine (Transit)	0.43	436	0.08	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	4.90	0.00	0.00	0.00	0.07	4.97
		Auxiliary Engine (Maneuvering)	0.43	3,008	0.54	0.01	0.13	0.02	0.02	0.00	0.00	0.00	0.00	33.85	0.00	0.00	0.01	0.48	34.33
CTV All-Year 2	Crew Transfer Vessel	Main Engine (Transit)	0.83	32,518	5.16	0.08	1.30	0.17	0.17	0.00	0.00	0.01	0.00	365.83	0.00	0.02	0.06	5.21	371.10
		Main Engine (Maneuvering)	0.20	54,102	8.59	0.13	2.16	0.29	0.28	0.01	0.00	0.02	0.00	608.65	0.00	0.03	0.09	8.67	617.42
		Auxiliary Engine (Transit)	0.43	436	0.08	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	4.90	0.00	0.00	0.00	0.07	4.97
		Auxiliary Engine (Maneuvering)	0.43	3,008	0.54	0.01	0.13	0.02	0.02	0.00	0.00	0.00	0.00	33.85	0.00	0.00	0.01	0.48	34.33
SOV All-Year 1	Service Operation Vessel	Main Engine (Transit)	0.16	3,910	0.64	0.02	0.15	0.02	0.02	0.01	0.00	0.00	0.00	43.09	0.00	0.00	0.01	0.63	43.72
		Main Engine (Maneuvering)	0.10	499,313	82.25	2.17	19.07	2.95	2.86	0.74	0.00	0.24	0.03	5,503.40	0.03	0.27	0.87	80.06	5,584.33
		Auxiliary Engine (Transit)	0.16	3,391	0.58	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.00	38.15	0.00	0.00	0.01	0.54	38.70
		Auxiliary Engine (Maneuvering)	0.10	433,055	74.34	1.05	18.64	2.41	2.33	0.05	0.00	0.13	0.00	4,872.18	0.03	0.23	0.75	69.44	4,942.37
SOV Daughter Craft 1	Crew Transfer Vessel	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.20	31,825	5.05	0.08	1.27	0.17	0.17	0.00	0.00	0.01	0.00	358.03	0.00	0.02	0.06	5.10	363.19
		Auxiliary Engine (Transit)	0.43	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Maneuvering)	0.43	1,770	0.32	0.00	0.08	0.01	0.01	0.00	0.00	0.00	0.00	19.91	0.00	0.00	0.00	0.28	20.20
WTG heavy logistics / jack-up																			
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	0.83	69,605	13.40	0.19	3.07	0.41	0.40	0.02	0.00	0.02	0.00	864.29	0.01	0.04	0.13	12.34	876.76
		Main Engine (Maneuvering)	0.20	93,749	18.04	0.25	4.14	0.56	0.54	0.02	0.00	0.03	0.00	1,164.08	0.01	0.06	0.18	16.62	1,180.88
		Auxiliary Engine (Transit)	0.43	8,460	1.60	0.02	0.34	0.04	0.04	0.00	0.00	0.00	0.00	89.71	0.00	0.00	0.01	1.28	91.00
		Auxiliary Engine (Maneuvering)	0.43	47,285	8.93	0.11	1.92	0.25	0.24	0.00	0.00	0.01	0.00	501.42	0.00	0.02	0.08	7.15	508.64
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	0.83	16,357	3.15	0.04	0.72	0.10	0.09	0.00	0.00	0.01	0.00	203.11	0.00	0.01	0.03	2.90	206.04
		Main Engine (Maneuvering)	0.20	22,031	4.24	0.06	0.97	0.13	0.13	0.01	0.00	0.01	0.00	273.56	0.00	0.01	0.04	3.91	277.51
		Auxiliary Engine (Transit)	0.45	4,427	0.84	0.01	0.18	0.02	0.02	0.00	0.00	0.00	0.00	46.94	0.00	0.00	0.01	0.67	47.62
		Auxiliary Engine (Maneuvering)	0.45	24,742	4.68	0.06	1.00	0.13	0.13	0.00	0.00	0.01	0.00	262.37	0.00	0.01	0.04	3.74	266.15
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	0.83	190,715	36.71	0.51	8.42	1.13	1.10	0.05	0.00	0.06	0.00	2,368.10	0.01	0.11	0.37	33.81	2,402.28
		Main Engine (Maneuvering)	0.20	93,749	18.04	0.25	4.14	0.56	0.54	0.02	0.00	0.03	0.00	1,164.08	0.01	0.06	0.18	16.62	1,180.88
		Auxiliary Engine (Transit)	0.43	23,179	4.38	0.05	0.94	0.12	0.12	0.00	0.00	0.01	0.00	245.79	0.00	0.01	0.04	3.50	249.34
		Auxiliary Engine (Maneuvering)	0.43	47,285	8.93	0.11	1.92	0.25	0.24	0.00	0.00	0.01	0.00	501.42	0.00	0.02	0.08	7.15	508.64
Cable repair vessel - export cable																			
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0.83	7,003	1.15	0.03	0.27	0.04	0.04	0.01	0.00	0.00	0.00	77.18	0.00	0.00	0.01	1.12	78.32
		Main Engine (Maneuvering)	0.20	15,535	2.56	0.07	0.59	0.09	0.09	0.02	0.00	0.01	0.00	171.22	0.00	0.01	0.03	2.49	173.74
		Auxiliary Engine (Transit)	0.56	143	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.61	0.00	0.00	0.00	0.02	1.63
		Auxiliary Engine (Maneuvering)	0.56	1,314	0.23	0.00	0.06	0.01	0.01	0.00	0.00	0.00	0.00	14.79	0.00	0.00	0.00	0.21	15.00
Cable repair vessel - arrray cable																			
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0.83	7,003	1.15	0.03	0.27	0.04	0.04	0.01	0.00	0.00	0.00	77.18	0.00	0.00	0.01	1.12	78.32
		Main Engine (Maneuvering)	0.20	19,973	3.29	0.09	0.76	0.12	0.11	0.03	0.00	0.01	0.00	220.14	0.00	0.01	0.03	3.20	223.38
		Auxiliary Engine (Transit)	0.56	143	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.61	0.00	0.00	0.00	0.02	1.63
		Auxiliary Engine (Maneuvering)	0.56	1,690	0.29	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	19.01	0.00	0.00	0.00	0.27	19.29
Cable survey vessel - export cable																			
Cable survey vessel	Survey Vessel	Main Engine (Transit)	0.83	3,655	0.63	0.01	0.14	0.02	0.02	0.00	0.00	0.00	0.00	40.49	0.00	0.00	0.01	0.59	41.09
		Main Engine (Maneuvering)	0.20	16,218	2.78	0.06	0.63	0.10	0.09	0.02	0.00	0.01	0.00	179.66	0.00	0.01	0.03	2.60	182.29
		Auxiliary Engine (Transit)	0.43	99	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0.00	0.02	1.13
		Auxiliary Engine (Maneuvering)	0.43	1,817	0.32	0.00	0.08	0.01	0.01	0.00	0.00	0.00	0.00	20.44	0.00	0.00	0.00	0.29	20.73
Cable survey vessel - arrray cable																			
Cable survey vessel	Survey Vessel	Main Engine (Transit)	0.83	7,311	1.25	0.03	0.29	0.04	0.04	0.01	0.00	0.00	0.00	80.99	0.00	0.00	0.01	1.17	82.17
		Main Engine (Maneuvering)	0.20	19,693	3.37	0.08	0.77	0.12	0.11	0.02	0.00	0.01	0.00	218.16	0.00	0.01	0.03	3.16	221.35
		Auxiliary Engine (Transit)	0.43	197	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	2.22	0.00	0.00	0.00	0.03	2.25
		Auxiliary Engine (Maneuvering)	0.43	2,206	0.39	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.82	0.00	0.00	0.00	0.35	25.18

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation below water inspection																			
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	0.83	2,089	0.36	0.01	0.08	0.01	0.01	0.00	0.00	0.00	0.00	23.14	0.00	0.00	0.00	0.33	23.48
		Main Engine (Maneuvering)	0.20	22,010	3.77	0.08	0.86	0.13	0.13	0.03	0.00	0.01	0.00	243.83	0.00	0.01	0.04	3.53	247.39
		Auxiliary Engine (Transit)	0.43	56	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0.00	0.01	0.64
		Auxiliary Engine (Maneuvering)	0.43	2,466	0.44	0.01	0.11	0.01	0.01	0.00	0.00	0.00	0.00	27.74	0.00	0.00	0.00	0.40	28.14
Other vessels																			
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	0.83	2,295	0.36	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	25.82	0.00	0.00	0	0	26
		Main Engine (Maneuvering)	0.20	2,546	0.40	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.00	28.64	0.00	0.00	0	0	29
		Auxiliary Engine (Transit)	0.43	31	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0	0	0
		Auxiliary Engine (Maneuvering)	0.43	142	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0	0	2
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	0.16	57	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0	0	1
		Main Engine (Maneuvering)	0.10	4,393	0.72	0.02	0.17	0.03	0.03	0.01	0.00	0.00	0.00	48.42	0.00	0.00	0	1	49
		Auxiliary Engine (Transit)	0.16	49	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.10	3,810	0.65	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	42.86	0.00	0.00	0	1	43
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	0.83	580	0.11	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.20	0.00	0.00	0	0	7
		Main Engine (Maneuvering)	0.20	16,544	3.18	0.04	0.73	0.10	0.10	0.00	0.00	0.01	0.00	205.43	0.00	0.01	0	3	208
		Auxiliary Engine (Transit)	0.45	74	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.45	8,733	1.65	0.02	0.35	0.05	0.04	0.00	0.00	0.00	0.00	92.60	0.00	0.00	0	1	94
Miscellaneous																			
SF6 Loss	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,257
OSS Generators	Generator	Marine Tier 3 Generator	0.75	2,571	0.23	0.03	0.20	0.00	0.00	0.00	0.00	0.00	0.00	29.35	0.00	0.00	0	0	29.5

Total/yr	1,967,420	344.3	6.1	81.3	11.2	10.9	1.1	0.0	0.7	0.1	22,476.3	0.1	1.1	3.5	322.1	25,058.9
Total over Project Life	59,022,593	10,330.2	182.1	2,438.1	337.3	326.9	33.4	0.0	21.6	1.5	674,288.9	4.2	32.4	105.5	9,663.8	751,765.7

Vessels	1,964,848	344.1	6.0	81.1	11.2	10.9	1.1	0.0	0.7	0.1	22,446.9	0.1	1.1	3.5	322.1	22,772.5
	58,945,450	10,323.3	181.3	2,432.2	337.2	326.8	33.4	0.0	21.6	1.5	673,408.4	4.2	32.4	104.6	9,661.7	683,174.7
Non-vessel	2,571	0.23	0.03	0.20	0.00	0.00	0.00	0.00	0.00	0.00	29.35	0.00	0.00	0.03	0.07	2,286.37
	77,143	6.9	0.8	6.0	0.1	0.1	0.0	0.0	0.0	0.0	880.5	0.0	0.0	0.9	2.1	68,591.0

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Operations (SOV Scenario)																				
WTG and BoP Crew logistics																				
CTV All-Year 1	Crew Transfer Vessel	Main Engine (Transit)	17	100%	32,518	5.16	0.08	1.30	0.17	0.17	0.00	0.00	0.01	0.00	365.83	0.00	0.02	0.06	5.21	371.10
		Main Engine (Maneuvering)	17	100%	54,102	8.59	0.13	2.16	0.29	0.28	0.01	0.00	0.02	0.00	608.65	0.00	0.03	0.09	8.67	617.42
		Auxiliary Engine (Transit)	17	100%	436	0.08	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	4.90	0.00	0.00	0.00	0.07	4.97
		Auxiliary Engine (Maneuvering)	17	100%	3,008	0.54	0.01	0.13	0.02	0.02	0.00	0.00	0.00	0.00	33.85	0.00	0.00	0.01	0.48	34.33
CTV All-Year 2	Crew Transfer Vessel	Main Engine (Transit)	17	100%	32,518	5.16	0.08	1.30	0.17	0.17	0.00	0.00	0.01	0.00	365.83	0.00	0.02	0.06	5.21	371.10
		Main Engine (Maneuvering)	17	100%	54,102	8.59	0.13	2.16	0.29	0.28	0.01	0.00	0.02	0.00	608.65	0.00	0.03	0.09	8.67	617.42
		Auxiliary Engine (Transit)	17	100%	436	0.08	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	4.90	0.00	0.00	0.00	0.07	4.97
		Auxiliary Engine (Maneuvering)	17	100%	3,008	0.54	0.01	0.13	0.02	0.02	0.00	0.00	0.00	0.00	33.85	0.00	0.00	0.01	0.48	34.33
SOV All-Year 1	Service Operation Vessel	Main Engine (Transit)	17	100%	3,910	0.64	0.02	0.15	0.02	0.02	0.01	0.00	0.00	0.00	43.09	0.00	0.00	0.01	0.63	43.72
		Main Engine (Maneuvering)	17	100%	499,313	82.25	2.17	19.07	2.95	2.86	0.74	0.00	0.24	0.03	5,503.40	0.03	0.27	0.87	80.06	5,584.33
		Auxiliary Engine (Transit)	17	100%	3,391	0.58	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.00	38.15	0.00	0.00	0.01	0.54	38.70
		Auxiliary Engine (Maneuvering)	17	100%	433,055	74.34	1.05	18.64	2.41	2.33	0.05	0.00	0.13	0.00	4,872.18	0.03	0.23	0.75	69.44	4,942.37
SOV Daughter Craft 1	Crew Transfer Vessel	Main Engine (Transit)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		Main Engine (Maneuvering)	N/A	100%	31,825	5.05	0.08	1.27	0.17	0.17	0.00	0.00	0.01	0.00	358.03	0.00	0.02	0.06	5.10	363.19
		Auxiliary Engine (Transit)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		Auxiliary Engine (Maneuvering)	N/A	100%	1,770	0.32	0.00	0.08	0.01	0.01	0.00	0.00	0.00	0.00	19.91	0.00	0.00	0.00	0.28	20.20
WTG heavy logistics / jack-up																				
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	25	27%	19,072	3.67	0.05	0.84	0.11	0.11	0.00	0.00	0.01	0.00	236.81	0.00	0.01	0.04	3.38	240.23
		Main Engine (Maneuvering)	25	100%	93,749	18.04	0.25	4.14	0.56	0.54	0.02	0.00	0.03	0.00	1,164.08	0.01	0.06	0.18	16.62	1,180.88
		Auxiliary Engine (Transit)	25	27%	2,318	0.44	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.58	0.00	0.00	0.00	0.35	24.93
		Auxiliary Engine (Maneuvering)	25	100%	47,285	8.93	0.11	1.92	0.25	0.24	0.00	0.00	0.01	0.00	501.42	0.00	0.02	0.08	7.15	508.64
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	25	27%	4,482	0.86	0.01	0.20	0.03	0.03	0.00	0.00	0.00	0.00	55.65	0.00	0.00	0.01	0.79	56.45
		Main Engine (Maneuvering)	25	100%	22,031	4.24	0.06	0.97	0.13	0.13	0.01	0.00	0.01	0.00	273.56	0.00	0.01	0.04	3.91	277.51
		Auxiliary Engine (Transit)	25	27%	1,213	0.23	0.00	0.05	0.01	0.01	0.00	0.00	0.00	0.00	12.86	0.00	0.00	0.00	0.18	13.05
		Auxiliary Engine (Maneuvering)	25	100%	24,742	4.68	0.06	1.00	0.13	0.13	0.00	0.00	0.01	0.00	262.37	0.00	0.01	0.04	3.74	266.15
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	25	10%	19,072	3.67	0.05	0.84	0.11	0.11	0.00	0.00	0.01	0.00	236.81	0.00	0.01	0.04	3.38	240.23
		Main Engine (Maneuvering)	25	100%	93,749	18.04	0.25	4.14	0.56	0.54	0.02	0.00	0.03	0.00	1,164.08	0.01	0.06	0.18	16.62	1,180.88
		Auxiliary Engine (Transit)	25	10%	2,318	0.44	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.58	0.00	0.00	0.00	0.35	24.93
		Auxiliary Engine (Maneuvering)	25	100%	47,285	8.93	0.11	1.92	0.25	0.24	0.00	0.00	0.01	0.00	501.42	0.00	0.02	0.08	7.15	508.64
Cable repair vessel - export cable																				
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	25	27%	1,919	0.32	0.01	0.07	0.01	0.01	0.00	0.00	0.00	0.00	21.15	0.00	0.00	0.00	0.31	21.46
		Main Engine (Maneuvering)	25	51%	7,937	1.31	0.03	0.30	0.05	0.05	0.01	0.00	0.00	0.00	87.48	0.00	0.00	0.01	1.27	88.77
		Auxiliary Engine (Transit)	25	27%	39	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.01	0.45
		Auxiliary Engine (Maneuvering)	25	51%	672	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.56	0.00	0.00	0.00	0.11	7.66
Cable repair vessel - arrray cable																				
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	25	27%	1,919	0.32	0.01	0.07	0.01	0.01	0.00	0.00	0.00	0.00	21.15	0.00	0.00	0.00	0.31	21.46
		Main Engine (Maneuvering)	25	100%	19,973	3.29	0.09	0.76	0.12	0.11	0.03	0.00	0.01	0.00	220.14	0.00	0.01	0.03	3.20	223.38
		Auxiliary Engine (Transit)	25	27%	39	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.01	0.45
		Auxiliary Engine (Maneuvering)	25	100%	1,690	0.29	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	19.01	0.00	0.00	0.00	0.27	19.29
Cable survey vessel - export cable																				
Cable survey vessel	Survey Vessel	Main Engine (Transit)	25	27%	1,002	0.17	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	11.10	0.00	0.00	0.00	0.16	11.26
		Main Engine (Maneuvering)	25	51%	8,286	1.42	0.03	0.32	0.05	0.05	0.01	0.00	0.00	0.00	91.80	0.00	0.00	0.01	1.33	93.14
		Auxiliary Engine (Transit)	25	27%	27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.31
		Auxiliary Engine (Maneuvering)	25	51%	928	0.16	0.00	0.04	0.01	0.00	0.00	0.00	0.00	0.00	10.44	0.00	0.00	0.00	0.15	10.59
Cable survey vessel - arrray cable																				
Cable survey vessel	Survey Vessel	Main Engine (Transit)	25	27%	2,003	0.34	0.01	0.08	0.01	0.01	0.00	0.00	0.00	0.00	22.19	0.00	0.00	0.00	0.32	22.51
		Main Engine (Maneuvering)	25	100%	19,693	3.37	0.08	0.77	0.12	0.11	0.02	0.00	0.01	0.00	218.16	0.00	0.01	0.03	3.16	221.35
		Auxiliary Engine (Transit)	25	27%	54	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.00	0.01	0.62
		Auxiliary Engine (Maneuvering)	25	100%	2,206	0.39	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	24.82	0.00	0.00	0.00	0.35	25.18

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation below water inspection																				
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	17	100%	2,089	0.36	0.01	0.08	0.01	0.01	0.00	0.00	0.00	0.00	23.14	0.00	0.00	0.00	0.33	23.48
		Main Engine (Maneuvering)	17	100%	22,010	3.77	0.08	0.86	0.13	0.13	0.03	0.00	0.01	0.00	243.83	0.00	0.01	0.04	3.53	247.39
		Auxiliary Engine (Transit)	17	100%	56	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0.00	0.01	0.64
		Auxiliary Engine (Maneuvering)	17	100%	2,466	0.44	0.01	0.11	0.01	0.01	0.00	0.00	0.00	0.00	27.74	0.00	0.00	0.00	0.40	28.14
Other vessels																				
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	17	100%	2,295	0.36	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	25.82	0.00	0.00	0.00	0.37	26.19
		Main Engine (Maneuvering)	17	100%	2,546	0.40	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.00	28.64	0.00	0.00	0.00	0.41	29.06
		Auxiliary Engine (Transit)	17	100%	31	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.35
		Auxiliary Engine (Maneuvering)	17	100%	142	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0.00	0.02	1.62
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	25	27%	16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.17
		Main Engine (Maneuvering)	25	100%	4,393	0.72	0.02	0.17	0.03	0.03	0.01	0.00	0.00	0.00	48.42	0.00	0.00	0.01	0.70	49.13
		Auxiliary Engine (Transit)	25	27%	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.15
		Auxiliary Engine (Maneuvering)	25	100%	3,810	0.65	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	42.86	0.00	0.00	0.01	0.61	43.48
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	25	27%	159	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.97	0.00	0.00	0.00	0.03	2.00
		Main Engine (Maneuvering)	25	100%	16,544	3.18	0.04	0.73	0.10	0.10	0.00	0.00	0.01	0.00	205.43	0.00	0.01	0.03	2.93	208.39
		Auxiliary Engine (Transit)	25	27%	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.22
		Auxiliary Engine (Maneuvering)	25	100%	8,733	1.65	0.02	0.35	0.05	0.04	0.00	0.00	0.00	0.00	92.60	0.00	0.00	0.01	1.32	93.94
Miscellaneous																				
SF6 Loss	N/A	N/A	N/A	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,256.92
OSS Generators	Generator	Marine Tier 3 Generator	N/A	100%	2,571	0.23	0.03	0.20	0.00	0.00	0.00	0.00	0.00	0.00	29.35	0.00	0.00	0.03	0.07	29.45

OCS Total Ton/yr	**1,666,986**	**287.49**	**5.23**	**68.31**	**9.48**	**9.19**	**1.01**	**0.00**	**0.62**	**0.05**	**18,849.14**	**0.12**	**0.91**	**2.95**	**270.26**	**21,379.28**
OCS Total Tons over life	**50,009,586**	**8,624.74**	**156.86**	**2,049.24**	**284.45**	**275.67**	**30.26**	**0.04**	**18.47**	**1.39**	**565,474.24**	**3.55**	**27.21**	**88.64**	**8,107.94**	**641,378.30**

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Round Trips (per year)	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Emissions During Operations (SOV Scenario)																	
WTG and BoP Crew logistics																	
CTV All-Year 1	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	119	17	4,136	20	207	0	0	0	207	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	119	12	1,428	1,428	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		119	17	4,136	20	207	0	0	0	207	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	119	12	1,428	1,428	4A
SOV All-Year 1	Service Operation Vessel	Main Engine (Transit)	4	2,306	9,224	1 & 2 main	Atlantic City	24	17	834	20	42	0	0	0	42	3M
		Main Engine (Maneuvering)	4	2,306	9,224	1 & 2 main		0	17	0	0	0	341	24	8,184	8,184	3M
		Auxiliary Engine (Transit)	4	2,000	8,000	1 & 2 auxiliary		24	17	834	20	42	0	0	0	42	3A
		Auxiliary Engine (Maneuvering)	4	2,000	8,000	1 & 2 auxiliary		0	17	0	0	0	341	24	8,184	8,184	3A
SOV Daughter Craft 1	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	N/A	0	0	0	20	0	0	0	0	0	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	0	0	0	0	105	8	840	840	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		0	0	0	20	0	0	0	0	0	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	0	0	0	0	105	8	840	840	4A
WTG heavy logistics / jack-up																	
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	NJWP	3	91	547	10	55	0	0	0	55	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	91	0	0	0	12	24	288	288	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		3	91	547	10	55	0	0	0	55	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	91	0	0	0	12	24	288	288	7A
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	2	2350	4,700	3 main	NJWP	3	91	547	10	55	0	0	0	55	7M
		Main Engine (Maneuvering)	2	2350	4,700	3 main		0	91	0	0	0	12	24	288	288	7M
		Auxiliary Engine (Transit)	2	1000	2,000	3 auxiliary		3	91	547	10	55	0	0	0	55	7A
		Auxiliary Engine (Maneuvering)	2	1000	2,000	3 auxiliary		0	91	0	0	0	12	24	288	288	7A
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	Europe	3	250	1,500	10	150	0	0	0	150	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	250	0	0	0	12	24	288	288	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		3	250	1,500	10	150	0	0	0	150	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	250	0	0	0	12	24	288	288	7A
Cable repair vessel - export cable																	
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0	0	7,280	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	3M
		Main Engine (Maneuvering)	0	0	7,280	1 & 2 main		0	91	0	0	0	5	24	120	120	3M
		Auxiliary Engine (Transit)	0	0	220	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	3A
		Auxiliary Engine (Maneuvering)	0	0	220	1 & 2 auxiliary		0	91	0	0	0	5	24	120	120	3A
Cable repair vessel - arrray cable																	
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0	0	7,280	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	3M
		Main Engine (Maneuvering)	0	0	7,280	1 & 2 main		0	91	0	0	0	7	24	168	168	3M
		Auxiliary Engine (Transit)	0	0	220	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	3A
		Auxiliary Engine (Maneuvering)	0	0	220	1 & 2 auxiliary		0	91	0	0	0	7	24	168	168	3A
Cable survey vessel - export cable																	
Cable survey vessel	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	91	0	0	0	10	24	240	240	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	91	0	0	0	10	24	240	240	8A
Cable survey vessel - arrray cable																	
Cable survey vessel	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	NJWP	1	91	182	10	18	0	0	0	18	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	91	0	0	0	12	24	288	288	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		1	91	182	10	18	0	0	0	18	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	91	0	0	0	12	24	288	288	8A

Activity	Representative Vessel Type	Engine Type	Engine Count	Engine Size (kW)	Total Size (kW)	Engine Category	Home Port	Vessel Round Trips (per year)	One-Way Trip Distance (NM)	Total Distance Traveled (NM)	Vessel Transit Speed (knots)	Hours in Transit/Year	Operating Days in WTA/Year	Operating Hours/Day	Total Non-Transit Hours	Total Operating Hours	Emission Factors Ref
Foundation below water inspection																	
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	2	1,900	3,800	1 & 2 main	Atlantic City	2	17	70	10	7	0	0	0	7	8M
		Main Engine (Maneuvering)	2	1,900	3,800	1 & 2 main		0	17	0	0	0	13	24	312	312	8M
		Auxiliary Engine (Transit)	2	99	198	1 & 2 auxiliary		2	17	70	10	7	0	0	0	7	8A
		Auxiliary Engine (Maneuvering)	2	99	198	1 & 2 auxiliary		0	17	0	0	0	13	24	312	312	8A
Other vessels																	
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	4	522	2,088	1 & 2 main	Atlantic City	12	17	417	20	21	0	0	0	21	4M
		Main Engine (Maneuvering)	4	522	2,088	1 & 2 main		0	17	0	0	0	12	8	96	96	4M
		Auxiliary Engine (Transit)	2	27	54	1 & 2 auxiliary		12	17	417	20	21	0	0	0	21	4A
		Auxiliary Engine (Maneuvering)	2	27	54	1 & 2 auxiliary		0	17	0	0	0	12	8	96	96	4A
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	4	2,306	9,224	1 & 2 main	NJWP	0.03	91	6	10	1	0	0	0	1	3M
		Main Engine (Maneuvering)	4	2,306	9,224	1 & 2 main		0	91	0	0	0	3	24	72	72	3M
		Auxiliary Engine (Transit)	4	2,000	8,000	1 & 2 auxiliary		0.03	91	6	10	1	0	0	0	1	3A
		Auxiliary Engine (Maneuvering)	4	2,000	8,000	1 & 2 auxiliary		0	91	0	0	0	3	24	72	72	3A
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	5	4000	20,000	3 main	NJWP	0.03	91	6	10	1	0	0	0	1	7M
		Main Engine (Maneuvering)	5	4000	20,000	3 main		0	91	0	0	0	3	24	72	72	7M
		Auxiliary Engine (Transit)	1	4000	4,000	3 auxiliary		0.03	91	6	10	1	0	0	0	1	7A
		Auxiliary Engine (Maneuvering)	1	4000	4,000	3 auxiliary		0	91	0	0	0	3	24	72	72	7A
Miscellaneous																	
SF6 Loss	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OSS Generators	Generator	Marine Tier 3 Generator	4	500	2,000	Marine Tier 3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24	24	31

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Operations (SOV Scenario)																			
WTG and BoP Crew logistics																			
CTV All-Year 1	Crew Transfer Vessel	Main Engine (Transit)	0.83	22,762	3.62	0.06	0.91	0.12	0.12	0.00	0.00	0.01	0.00	256.08	0.00	0.01	0.04	3.65	259.77
		Main Engine (Maneuvering)	0.20	37,872	6.01	0.09	1.51	0.20	0.20	0.00	0.00	0.01	0.00	426.06	0.00	0.02	0.07	6.07	432.19
		Auxiliary Engine (Transit)	0.43	305	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.43	0.00	0.00	0.00	0.05	3.48
		Auxiliary Engine (Maneuvering)	0.43	2,106	0.38	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	23.69	0.00	0.00	0.00	0.34	24.03
SOV All-Year 1	Service Operation Vessel	Main Engine (Transit)	0.16	3,910	0.64	0.02	0.15	0.02	0.02	0.01	0.00	0.00	0.00	43.09	0.00	0.00	0.01	0.63	43.72
		Main Engine (Maneuvering)	0.10	499,313	82.25	2.17	19.07	2.95	2.86	0.74	0.00	0.24	0.03	5,503.40	0.03	0.27	0.87	80.06	5,584.33
		Auxiliary Engine (Transit)	0.16	3,391	0.58	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.00	38.15	0.00	0.00	0.01	0.54	38.70
		Auxiliary Engine (Maneuvering)	0.10	433,055	74.34	1.05	18.64	2.41	2.33	0.05	0.00	0.13	0.00	4,872.18	0.03	0.23	0.75	69.44	4,942.37
SOV Daughter Craft 1	Crew Transfer Vessel	Main Engine (Transit)	0.83	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Main Engine (Maneuvering)	0.20	22,277	3.54	0.05	0.89	0.12	0.12	0.00	0.00	0.01	0.00	250.62	0.00	0.01	0.04	3.57	254.23
		Auxiliary Engine (Transit)	0.43	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Auxiliary Engine (Maneuvering)	0.43	1,239	0.22	0.00	0.05	0.01	0.01	0.00	0.00	0.00	0.00	13.94	0.00	0.00	0.00	0.20	14.14
WTG heavy logistics / jack-up																			
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	0.83	52,204	10.05	0.14	2.30	0.31	0.30	0.01	0.00	0.02	0.00	648.21	0.00	0.03	0.10	9.25	657.57
		Main Engine (Maneuvering)	0.20	66,176	12.74	0.18	2.92	0.39	0.38	0.02	0.00	0.02	0.00	821.70	0.01	0.04	0.13	11.73	833.56
		Auxiliary Engine (Transit)	0.43	6,345	1.20	0.01	0.26	0.03	0.03	0.00	0.00	0.00	0.00	67.28	0.00	0.00	0.01	0.96	68.25
		Auxiliary Engine (Maneuvering)	0.43	33,378	6.31	0.08	1.35	0.17	0.17	0.00	0.00	0.01	0.00	353.94	0.00	0.02	0.05	5.04	359.04
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	0.83	12,268	2.36	0.03	0.54	0.07	0.07	0.00	0.00	0.00	0.00	152.33	0.00	0.01	0.02	2.17	154.53
		Main Engine (Maneuvering)	0.20	15,551	2.99	0.04	0.69	0.09	0.09	0.00	0.00	0.01	0.00	193.10	0.00	0.01	0.03	2.76	195.89
		Auxiliary Engine (Transit)	0.45	3,320	0.63	0.01	0.13	0.02	0.02	0.00	0.00	0.00	0.00	35.20	0.00	0.00	0.01	0.50	35.71
		Auxiliary Engine (Maneuvering)	0.45	17,465	3.30	0.04	0.71	0.09	0.09	0.00	0.00	0.01	0.00	185.20	0.00	0.01	0.03	2.64	187.87
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	0.83	143,037	27.53	0.38	6.31	0.85	0.82	0.04	0.00	0.05	0.00	1,776.08	0.01	0.09	0.27	25.36	1,801.71
		Main Engine (Maneuvering)	0.20	66,176	12.74	0.18	2.92	0.39	0.38	0.02	0.00	0.02	0.00	821.70	0.01	0.04	0.13	11.73	833.56
		Auxiliary Engine (Transit)	0.43	17,384	3.28	0.04	0.71	0.09	0.09	0.00	0.00	0.01	0.00	184.35	0.00	0.01	0.03	2.63	187.00
		Auxiliary Engine (Maneuvering)	0.43	33,378	6.31	0.08	1.35	0.17	0.17	0.00	0.00	0.01	0.00	353.94	0.00	0.02	0.05	5.04	359.04
Cable repair vessel - export cable																			
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0.83	7,003	1.15	0.03	0.27	0.04	0.04	0.01	0.00	0.00	0.00	77.18	0.00	0.00	0.01	1.12	78.32
		Main Engine (Maneuvering)	0.20	11,096	1.83	0.05	0.42	0.07	0.06	0.02	0.00	0.01	0.00	122.30	0.00	0.01	0.02	1.78	124.10
		Auxiliary Engine (Transit)	0.56	143	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.61	0.00	0.00	0.00	0.02	1.63
		Auxiliary Engine (Maneuvering)	0.56	939	0.16	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	10.56	0.00	0.00	0.00	0.15	10.72
Cable repair vessel - arrray cable																			
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	0.83	7,003	1.15	0.03	0.27	0.04	0.04	0.01	0.00	0.00	0.00	77.18	0.00	0.00	0.01	1.12	78.32
		Main Engine (Maneuvering)	0.20	15,535	2.56	0.07	0.59	0.09	0.09	0.02	0.00	0.01	0.00	171.22	0.00	0.01	0.03	2.49	173.74
		Auxiliary Engine (Transit)	0.56	143	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.61	0.00	0.00	0.00	0.02	1.63
		Auxiliary Engine (Maneuvering)	0.56	1,314	0.23	0.00	0.06	0.01	0.01	0.00	0.00	0.00	0.00	14.79	0.00	0.00	0.00	0.21	15.00
Cable survey vessel - export cable																			
Cable survey vessel	Survey Vessel	Main Engine (Transit)	0.83	3,655	0.63	0.01	0.14	0.02	0.02	0.00	0.00	0.00	0.00	40.49	0.00	0.00	0.01	0.59	41.09
		Main Engine (Maneuvering)	0.20	11,584	1.98	0.04	0.45	0.07	0.07	0.01	0.00	0.00	0.00	128.33	0.00	0.01	0.02	1.86	130.21
		Auxiliary Engine (Transit)	0.43	99	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0.00	0.02	1.13
		Auxiliary Engine (Maneuvering)	0.43	1,298	0.23	0.00	0.06	0.01	0.01	0.00	0.00	0.00	0.00	14.60	0.00	0.00	0.00	0.21	14.81
Cable survey vessel - arrray cable																			
Cable survey vessel	Survey Vessel	Main Engine (Transit)	0.83	3,655	0.63	0.01	0.14	0.02	0.02	0.00	0.00	0.00	0.00	40.49	0.00	0.00	0.01	0.59	41.09
		Main Engine (Maneuvering)	0.20	13,901	2.38	0.05	0.54	0.08	0.08	0.02	0.00	0.01	0.00	154.00	0.00	0.01	0.02	2.23	156.25
		Auxiliary Engine (Transit)	0.43	99	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0.00	0.02	1.13
		Auxiliary Engine (Maneuvering)	0.43	1,557	0.28	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	17.52	0.00	0.00	0.00	0.25	17.77

Activity	Representative Vessel Type	Engine Type	Load Factor	Fuel Consumption (gal)	Emissions (tons)														
					NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation below water inspection																			
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	0.83	1,392	0.24	0.01	0.05	0.01	0.01	0.00	0.00	0.00	0.00	15.43	0.00	0.00	0.00	0.22	15.65
		Main Engine (Maneuvering)	0.20	15,059	2.58	0.06	0.59	0.09	0.09	0.02	0.00	0.01	0.00	166.83	0.00	0.01	0.03	2.41	169.27
		Auxiliary Engine (Transit)	0.43	38	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.01	0.43
		Auxiliary Engine (Maneuvering)	0.43	1,687	0.30	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	18.98	0.00	0.00	0.00	0.27	19.25
Other vessels																			
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	0.83	2,295	0.36	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	25.82	0.00	0.00	0	0	26
		Main Engine (Maneuvering)	0.20	2,546	0.40	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.00	28.64	0.00	0.00	0	0	29
		Auxiliary Engine (Transit)	0.43	31	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0	0	0
		Auxiliary Engine (Maneuvering)	0.43	142	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0	0	2
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	0.16	57	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0	0	1
		Main Engine (Maneuvering)	0.10	4,393	0.72	0.02	0.17	0.03	0.03	0.01	0.00	0.00	0.00	48.42	0.00	0.00	0	1	49
		Auxiliary Engine (Transit)	0.16	49	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.10	3,810	0.65	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	42.86	0.00	0.00	0	1	43
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	0.83	580	0.11	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.20	0.00	0.00	0	0	7
		Main Engine (Maneuvering)	0.20	16,544	3.18	0.04	0.73	0.10	0.10	0.00	0.00	0.01	0.00	205.43	0.00	0.01	0	3	208
		Auxiliary Engine (Transit)	0.45	74	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0	0	1
		Auxiliary Engine (Maneuvering)	0.45	8,733	1.65	0.02	0.35	0.05	0.04	0.00	0.00	0.00	0.00	92.60	0.00	0.00	0	1	94
Miscellaneous																			
SF6 Loss	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,690
OSS Generators	Generator	Marine Tier 3 Generator	0.75	2,571	0.23	0.03	0.20	0.00	0.00	0.00	0.00	0.00	0.00	29.35	0.00	0.00	0	0	29.5

Total/yr	1,631,935	284.9	5.2	67.3	9.4	9.1	1.0	0.0	0.6	0.0	18,583.7	0.1	0.9	2.9	266.5	20,543.3
Total over Project Life	48,958,036	8,545.6	155.4	2,019.2	280.6	272.0	30.8	0.0	18.3	1.4	557,510.8	3.5	26.8	87.4	7,995.8	616,299.2

Vessels	1,629,363	284.6	5.2	67.1	9.4	9.1	1.0	0.0	0.6	0.0	18,554.3	0.1	0.9	2.9	266.5	18,823.7
	48,880,894	8,538.7	154.6	2,013.3	280.5	271.9	30.8	0.0	18.3	1.4	556,630.3	3.5	26.8	86.5	7,993.7	564,710.5
Non-vessel	2,571	0.23	0.03	0.20	0.00	0.00	0.00	0.00	0.00	0.00	29.35	0.00	0.00	0.03	0.07	1,719.62
	77,143	6.9	0.8	6.0	0.1	0.1	0.0	0.0	0.0	0.0	880.5	0.0	0.0	0.9	2.1	51,588.7

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)														
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Emissions During Operations (SOV Scenario)																				
WTG and BoP Crew logistics																				
CTV All-Year 1	Crew Transfer Vessel	Main Engine (Transit)	17	100%	22,762	3.62	0.06	0.91	0.12	0.12	0.00	0.00	0.01	0.00	256.08	0.00	0.01	0.04	3.65	259.77
		Main Engine (Maneuvering)	17	100%	37,872	6.01	0.09	1.51	0.20	0.20	0.00	0.00	0.01	0.00	426.06	0.00	0.02	0.07	6.07	432.19
		Auxiliary Engine (Transit)	17	100%	305	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.43	0.00	0.00	0.00	0.05	3.48
		Auxiliary Engine (Maneuvering)	17	100%	2,106	0.38	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	23.69	0.00	0.00	0.00	0.34	24.03
SOV All-Year 1	Service Operation Vessel	Main Engine (Transit)	17	100%	3,910	0.64	0.02	0.15	0.02	0.02	0.01	0.00	0.00	0.00	43.09	0.00	0.00	0.01	0.63	43.72
		Main Engine (Maneuvering)	17	100%	499,313	82.25	2.17	19.07	2.95	2.86	0.74	0.00	0.24	0.03	5,503.40	0.03	0.27	0.87	80.06	5,584.33
		Auxiliary Engine (Transit)	17	100%	3,391	0.58	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.00	38.15	0.00	0.00	0.01	0.54	38.70
		Auxiliary Engine (Maneuvering)	17	100%	433,055	74.34	1.05	18.64	2.41	2.33	0.05	0.00	0.13	0.00	4,872.18	0.03	0.23	0.75	69.44	4,942.37
SOV Daughter Craft 1	Crew Transfer Vessel	Main Engine (Transit)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		Main Engine (Maneuvering)	N/A	100%	22,277	3.54	0.05	0.89	0.12	0.12	0.00	0.00	0.01	0.00	250.62	0.00	0.01	0.04	3.57	254.23
		Auxiliary Engine (Transit)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		Auxiliary Engine (Maneuvering)	N/A	100%	1,239	0.22	0.00	0.05	0.01	0.01	0.00	0.00	0.00	0.00	13.94	0.00	0.00	0.00	0.20	14.14
WTG heavy logistics / jack-up																				
US Jack-Up	Jack-Up Vessel	Main Engine (Transit)	25	27%	14,304	2.75	0.04	0.63	0.09	0.08	0.00	0.00	0.00	0.00	177.61	0.00	0.01	0.03	2.54	180.17
		Main Engine (Maneuvering)	25	100%	66,176	12.74	0.18	2.92	0.39	0.38	0.02	0.00	0.02	0.00	821.70	0.01	0.04	0.13	11.73	833.56
		Auxiliary Engine (Transit)	25	27%	1,738	0.33	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	18.43	0.00	0.00	0.00	0.26	18.70
		Auxiliary Engine (Maneuvering)	25	100%	33,378	6.31	0.08	1.35	0.17	0.17	0.00	0.00	0.01	0.00	353.94	0.00	0.02	0.05	5.04	359.04
US Feeder Vessel	Feeder/Jack-up	Main Engine (Transit)	25	27%	3,361	0.65	0.01	0.15	0.02	0.02	0.00	0.00	0.00	0.00	41.74	0.00	0.00	0.01	0.60	42.34
		Main Engine (Maneuvering)	25	100%	15,551	2.99	0.04	0.69	0.09	0.09	0.00	0.00	0.01	0.00	193.10	0.00	0.01	0.03	2.76	195.89
		Auxiliary Engine (Transit)	25	27%	910	0.17	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	9.65	0.00	0.00	0.00	0.14	9.78
		Auxiliary Engine (Maneuvering)	25	100%	17,465	3.30	0.04	0.71	0.09	0.09	0.00	0.00	0.01	0.00	185.20	0.00	0.01	0.03	2.64	187.87
European Jack-up	Jack-Up Vessel	Main Engine (Transit)	25	10%	14,304	2.75	0.04	0.63	0.09	0.08	0.00	0.00	0.00	0.00	177.61	0.00	0.01	0.03	2.54	180.17
		Main Engine (Maneuvering)	25	100%	66,176	12.74	0.18	2.92	0.39	0.38	0.02	0.00	0.02	0.00	821.70	0.01	0.04	0.13	11.73	833.56
		Auxiliary Engine (Transit)	25	10%	1,738	0.33	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	18.43	0.00	0.00	0.00	0.26	18.70
		Auxiliary Engine (Maneuvering)	25	100%	33,378	6.31	0.08	1.35	0.17	0.17	0.00	0.00	0.01	0.00	353.94	0.00	0.02	0.05	5.04	359.04
Cable repair vessel - export cable																				
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	25	27%	1,919	0.32	0.01	0.07	0.01	0.01	0.00	0.00	0.00	0.00	21.15	0.00	0.00	0.00	0.31	21.46
		Main Engine (Maneuvering)	25	51%	5,669	0.93	0.02	0.22	0.03	0.03	0.01	0.00	0.00	0.00	62.49	0.00	0.00	0.01	0.91	63.41
		Auxiliary Engine (Transit)	25	27%	39	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.01	0.45
		Auxiliary Engine (Maneuvering)	25	51%	480	0.08	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	5.40	0.00	0.00	0.00	0.08	5.47
Cable repair vessel - arrray cable																				
Cable repair vessel	Cable Lay Vessel	Main Engine (Transit)	25	27%	1,919	0.32	0.01	0.07	0.01	0.01	0.00	0.00	0.00	0.00	21.15	0.00	0.00	0.00	0.31	21.46
		Main Engine (Maneuvering)	25	100%	15,535	2.56	0.07	0.59	0.09	0.09	0.02	0.00	0.01	0.00	171.22	0.00	0.01	0.03	2.49	173.74
		Auxiliary Engine (Transit)	25	27%	39	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.01	0.45
		Auxiliary Engine (Maneuvering)	25	100%	1,314	0.23	0.00	0.06	0.01	0.01	0.00	0.00	0.00	0.00	14.79	0.00	0.00	0.00	0.21	15.00
Cable survey vessel - export cable																				
Cable survey vessel	Survey Vessel	Main Engine (Transit)	25	27%	1,002	0.17	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	11.10	0.00	0.00	0.00	0.16	11.26
		Main Engine (Maneuvering)	25	51%	5,919	1.01	0.02	0.23	0.03	0.03	0.01	0.00	0.00	0.00	65.57	0.00	0.00	0.01	0.95	66.53
		Auxiliary Engine (Transit)	25	27%	27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.31
		Auxiliary Engine (Maneuvering)	25	51%	663	0.12	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	7.46	0.00	0.00	0.00	0.11	7.57
Cable survey vessel - arrray cable																				
Cable survey vessel	Survey Vessel	Main Engine (Transit)	25	27%	1,002	0.17	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	11.10	0.00	0.00	0.00	0.16	11.26
		Main Engine (Maneuvering)	25	100%	13,901	2.38	0.05	0.54	0.08	0.08	0.02	0.00	0.01	0.00	154.00	0.00	0.01	0.02	2.23	156.25
		Auxiliary Engine (Transit)	25	27%	27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.31
		Auxiliary Engine (Maneuvering)	25	100%	1,557	0.28	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	17.52	0.00	0.00	0.00	0.25	17.77

Activity	Representative Vessel Type	Engine Type	OCS Trip Distance (NM)	Percentage OCS	Fuel Consumption (gal)	OCS Emissions (tons)													
						NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	H2SO4	CO2	CH4	N2O	CH4 as CO2e	N2O as CO2e	CO2e
Foundation below water inspection																				
Vessel for subsea inspection	Survey Vessel	Main Engine (Transit)	17	100%	1,392	0.24	0.01	0.05	0.01	0.01	0.00	0.00	0.00	0.00	15.43	0.00	0.00	0.00	0.22	15.65
		Main Engine (Maneuvering)	17	100%	15,059	2.58	0.06	0.59	0.09	0.09	0.02	0.00	0.01	0.00	166.83	0.00	0.01	0.03	2.41	169.27
		Auxiliary Engine (Transit)	17	100%	38	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.01	0.43
		Auxiliary Engine (Maneuvering)	17	100%	1,687	0.30	0.00	0.07	0.01	0.01	0.00	0.00	0.00	0.00	18.98	0.00	0.00	0.00	0.27	19.25
Other vessels																				
Environmental monitoring vessel	Crew Transfer Vessel	Main Engine (Transit)	17	100%	2,295	0.36	0.01	0.09	0.01	0.01	0.00	0.00	0.00	0.00	25.82	0.00	0.00	0.00	0.37	26.19
		Main Engine (Maneuvering)	17	100%	2,546	0.40	0.01	0.10	0.01	0.01	0.00	0.00	0.00	0.00	28.64	0.00	0.00	0.00	0.41	29.06
		Auxiliary Engine (Transit)	17	100%	31	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.35
		Auxiliary Engine (Maneuvering)	17	100%	142	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.00	0.00	0.02	1.62
SOV campaign (e.g., for retrofit campaign)	Service Operation Vessel	Main Engine (Transit)	25	27%	16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.17
		Main Engine (Maneuvering)	25	100%	4,393	0.72	0.02	0.17	0.03	0.03	0.01	0.00	0.00	0.00	48.42	0.00	0.00	0.01	0.70	49.13
		Auxiliary Engine (Transit)	25	27%	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.15
		Auxiliary Engine (Maneuvering)	25	100%	3,810	0.65	0.01	0.16	0.02	0.02	0.00	0.00	0.00	0.00	42.86	0.00	0.00	0.01	0.61	43.48
OSS repair vessel (major repair)	Jack-Up Vessel	Main Engine (Transit)	25	27%	159	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.97	0.00	0.00	0.00	0.03	2.00
		Main Engine (Maneuvering)	25	100%	16,544	3.18	0.04	0.73	0.10	0.10	0.00	0.00	0.01	0.00	205.43	0.00	0.01	0.03	2.93	208.39
		Auxiliary Engine (Transit)	25	27%	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.22
		Auxiliary Engine (Maneuvering)	25	100%	8,733	1.65	0.02	0.35	0.05	0.04	0.00	0.00	0.00	0.00	92.60	0.00	0.00	0.01	1.32	93.94
Miscellaneous																				
SF6 Loss	N/A	N/A	N/A	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,690.17
OSS Generators	Generator	Marine Tier 3 Generator	N/A	100%	2,571	0.23	0.03	0.20	0.00	0.00	0.00	0.00	0.00	0.00	29.35	0.00	0.00	0.03	0.07	29.45

OCS Total Ton/yr	**1,405,168**	**241.98**	**4.54**	**57.53**	**8.02**	**7.78**	**0.94**	**0.00**	**0.53**	**0.04**	**15,847.35**	**0.10**	**0.76**	**2.49**	**227.40**	**17,767.42**
OCS Total Tons over life	**42,155,046**	**7,259.49**	**136.29**	**1,725.93**	**240.71**	**233.32**	**28.34**	**0.03**	**15.91**	**1.30**	**475,420.64**	**2.99**	**22.89**	**74.72**	**6,821.92**	**533,022.50**

Vessels													
EF Ref	Vessel Type	Engine type	Emission Factors (g/kWh)										
			NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	CO2	CH4	N2O
1M	Anchor Handling Tugs	Main	9.26	0.24	2.16	0.34	0.33	0.079	4.0E-05	2.64E-02	636.09	0.004	0.031
1A		Auxiliary	9.88	0.14	2.48	0.32	0.31	0.006	4.8E-05	1.79E-02	648.20	0.004	0.031
2M	Barge	Main	13.61	0.63	1.40	0.45	0.42	0.362	1.2E-05	5.98E-02	588.90	0.004	0.031
2A		Auxiliary	12.57	0.14	2.48	0.32	0.31	0.006	4.8E-05	1.79E-02	648.20	0.004	0.031
3M	Cable Laying	Main	9.49	0.25	2.20	0.34	0.33	0.085	3.9E-05	2.72E-02	635.02	0.004	0.031
3A		Auxiliary	9.89	0.14	2.48	0.32	0.31	0.006	4.8E-05	1.79E-02	648.20	0.004	0.031
4M	Crew	Main	9.15	0.14	2.30	0.31	0.30	0.006	4.6E-05	1.77E-02	648.16	0.004	0.031
4A		Auxiliary	10.39	0.14	2.48	0.32	0.31	0.006	4.8E-05	1.79E-02	648.20	0.004	0.031
5M	Dredging	Main	9.60	0.28	2.13	0.36	0.34	0.112	3.7E-05	2.98E-02	630.62	0.004	0.031
5A		Auxiliary	9.85	0.14	2.48	0.32	0.31	0.006	4.8E-05	1.79E-02	648.20	0.004	0.031
6M	Ice Breaker	Main	9.92	0.45	1.78	0.40	0.38	0.230	2.5E-05	4.44E-02	610.83	0.004	0.031
6A		Auxiliary	10.09	0.14	2.48	0.32	0.31	0.006	4.8E-05	1.79E-02	648.20	0.004	0.031
7M	Jackup	Main	10.03	0.14	2.30	0.31	0.30	0.013	4.5E-05	1.77E-02	647.08	0.004	0.031
7A		Auxiliary	11.55	0.14	2.48	0.32	0.31	0.006	4.8E-05	1.79E-02	648.20	0.004	0.031
8M	Research / Survey	Main	9.86	0.22	2.25	0.34	0.33	0.066	4.2E-05	2.48E-02	638.26	0.004	0.031
8A		Auxiliary	10.21	0.14	2.48	0.32	0.31	0.006	4.8E-05	1.79E-02	648.20	0.004	0.031
9M	Shuttle Tanker	Main	9.05	0.63	1.40	0.45	0.42	0.362	1.2E-05	5.98E-02	588.90	0.004	0.031
9A		Auxiliary	9.80	0.14	2.48	0.32	0.31	0.006	4.8E-05	1.79E-02	648.20	0.004	0.031
10M	Supply Ship	Main	9.44	0.17	2.29	0.32	0.31	0.028	4.5E-05	2.03E-02	644.58	0.004	0.031
10A		Auxiliary	10.43	0.14	2.48	0.32	0.31	0.006	4.8E-05	1.79E-02	648.20	0.004	0.031
11M	Tug	Main	9.52	0.18	2.29	0.33	0.32	0.033	4.5E-05	2.13E-02	643.66	0.004	0.031
11A		Auxiliary	10.10	0.14	2.48	0.32	0.31	0.006	4.8E-05	1.79E-02	648.20	0.004	0.031

Helicopters													
EF Ref	Engine	Size (kW)	Emission Factors (lb/hr)										
			NOx	VOC	CO	PM10	PM2.5	SO2	Pb	HAPs	CO2	CH4	N2O
12	Helicopter	Single	2.32	1.63	1.89	0.07	0.07	0.300	0.0E+00	N/A	956.92	0.030	0.030
13	Helicopter	Twin Light	3.14	3.66	4.28	0.10	0.09	0.500	0.0E+00	N/A	1589.69	0.040	0.050
14	Helicopter	Twin Medium	7.22	3.02	3.48	0.20	0.20	0.780	0.0E+00	N/A	2459.92	0.070	0.080
15	Helicopter	Twin heavy	34.66	2.40	2.67	0.82	0.80	2.110	0.0E+00	N/A	6640.46	0.190	0.220

Load Factors for Main Engines

Vessel/Engine	Activity	Load Factor
Cat. 3 Main (Propulsion) Engine	Transit/cruise	0.83
Cat. 3 Main (Propulsion) Engine	Maneuvering	0.2
Cat. 3 Main (Propulsion) Engine	Hoteling	0
Cat. 1/2 Main (Propulsion) Engine	Transit/cruise	0.83
Cat. 1/2 Main (Propulsion) Engine	Maneuvering	0.2
Cat. 1/2 Main (Propulsion) Engine	Hoteling	0

Load Factors for Auxiliary Engines on Vessels w/ Cat. 3 Main Engines

Vessel Type	Maneuver	Hotel
Bulk Carrier	0.45	0.1
Bulk Carrier, Laker	0.45	0.22
Buoy Tender	0.45	0.19
Container	0.48	0.26
Crude Oil Tanker	0.33	0.22
Drilling	0.45	0.22
Fishing	0.45	0.22
Floating Production and Storage Offloading	0.45	0.22
General Cargo	0.45	0.22
Icebreaker	0.45	0.22
Jackup	0.45	0.22
LNG Tanker	0.33	0.26
LPG Tanker	0.33	0.26
Misc.	0.45	0.22
Passenger	0.8	0.64
Pipelaying	0.45	0.22
Reefer	0.67	0.32
Research	0.45	0.22
RORO	0.45	0.26
Supply	0.45	0.22
Support	0.45	0.22
Tanker	0.33	0.26
Tug	0.45	0.22
Vehicle Carrier	0.45	0.22
Well stimulation	0.45	0.22

Table 4-120 of https://www.epa.gov/sites/production/files/2018-07/documents/nei2014v2_tsd_05jul2018.pdf

Engines													
EF Ref	Engine	Size (kW)	Emission Factors (g/kWh)										
			NOx[1]	VOC[2]	CO	PM10	PM2.5	SO2[3]	Pb	HAPs[5]	CO2[4]	CH4[4]	N2O[4]
16	Air Compressor Engines	399	4	0.5	3.5	0.2	0.2	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
17	Motion Compensation Engines	500	4	0.495	3.5	0.2	0.2	0.0068	0.00E+00	7.14E-03	739.60	0.030	0.0060
18	Cat C18 Acert	597	6.4	0.8	3.5	0.2	0.2	0.0068	0.00E+00	7.14E-03	739.60	0.030	0.0060
19	Tier 2 Engines 0-8 kW	0-8	7.5	0.929	8	0.8	0.8	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
20	Tier 2 Engines 8-19 kW	8-19	7.5	0.929	6.6	0.8	0.8	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
21	Tier 2 Engines 19-37 kW	19-37	7.5	0.929	5.5	0.6	0.6	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
22	Tier 3 Engines 37-75 kW	37-75	4.7	0.582	5	0.4	0.4	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
23	Tier 3 Engines 75-130 kW	75-130	4	0.495	5	0.3	0.3	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
24	Tier 3 Engines 130-225 kW	130-225	4	0.495	3.5	0.2	0.2	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
25	Tier 3 Engines 225-450 kW	225-450	4	0.495	3.5	0.2	0.2	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
26	Tier 3 Engines 450-560 kW	450-560	4	0.495	3.5	0.2	0.2	0.0068	0.00E+00	7.14E-03	739.60	0.030	0.0060
27	Tier 2 Engines >560 kW	>560	6.4	0.792	3.5	0.2	0.2	0.0068	0.00E+00	7.14E-03	739.60	0.030	0.0060
30	Tier 4 Engine 130-560 kW	130-560	0.67	0.19	3.5	0.02	0.02	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
31	OSS Generator	500 kW	5.80	0.70	5.00	0.10	0.10	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060
32	WTG Generator	240 kW	5.40	0.65	5.00	0.12	0.12	0.0068	0.00E+00	1.76E-02	739.60	0.030	0.0060

1 NOx emission values are assumed to be 100% of the the relevant tier standard for NOx+NMHC
2 VOC emission values are assumed to be 12% of the the relevant tier standard for NOx+NMHC

3 Based on ULSD Fuel Sulfur of 0.0015%, fuel density of ~7 lb/gal, fuel heat content of ~0.14 MMBtu/gal, and SO2:Sulfur ratio of 2.0
4 Based on GHG emissions and heat content of ULSD from 40 CFR 98 Tables C-1 and C-2 and an assumed engine efficiency of 10,000 Btu/kW
5 HAP Emission Factors are in lb/MMBtu in AP-42 and converted to g/kwH based on an assumed 10,000 btu/kW

Commuting Emissions													
EF Ref	Engine	Fuel	Emission Factors (g/VMT)										
			NOx[1]	VOC[1]	CO[1]	PM10[1]	PM2.5[1]	SO2[2]	Pb	HAPs	CO2[3]	CH4[3]	N2O[3]
28	Light-duty vehicles	Gasoline	0.289	0.35	3.94	0.012	0.012	0.0025	0.00E+00	N/A	393.61	0.017	0.0034
29	Light-duty trucks	Gasoline	0.478	0.421	5.66	0.014	0.014	0.0025	0.00E+00	N/A	393.61	0.017	0.0034

1 2018 values from Table 4-43 "Estimated U.S. Average Vehicle emissions Rates per Vehicle by Vehicle Type Using Gasoline and Diesel" at https://www.bts.gov/content/estimated-national-average-vehicle-emissions-rates-vehicle-vehicle-type-using-gasoline-and
2 Based on 10 ppm sulfur in gasoline, 6.07 lb/gal density, fleet average of 22.3 mpg, and SO2 to Sulfur weight ratio of 2.
3 Based on GHG emissions and heat content of motor gasoline from 40 CFR 98 Tables C-1 and C-2 and fleet average of 22.3 mpg
4 Fleet average MPG is from Table 4-23M from Bureau of Transportation Statistics found here: https://www.bts.gov/content/average-fuel-efficiency-us-passenger-cars-and-light-trucks

Load Factors for Auxiliary Engines on Vessels w/ Cat. 1 & 2 Main	
Vessel Group	Auxiliary Operating Load Factor
Bulk Carrier	0.1
Commercial Fishing	0.43
Container Ship	0.19
Ferry Excursion	0.43
General Cargo	0.22
Government	0.43
Miscellaneous	0.43
Offshore support	0.56
Reefer	0.32
RORO	0.26
Tanker	0.26
Tug	0.43
Work Boat	0.43

Eastern Research Group. 2019. Category 1 and 2 Commercial Marine Vessel 2017 Emissions Inventory (2019). Table 4. Auxiliary and Boiler Power Surrogates.

Load Factors for Auxiliary Engines on Vessels w/ Cat. 3 Main Engines			
EPA Vessel Type (NEI Vessel Types)	Cruise	RSZ	Maneuver
Auto Carrier	0.15	0.3	0.45
Bulk Carrier	0.17	0.27	0.45
Container Ship	0.13	0.25	0.48
Cruise Ship (Passenger)	0.8	0.8	0.8
General Cargo (Supply, Vehicle Carrier)	0.17	0.27	0.45
Miscellaneous (Buoy Tender, Drilling, Fishing, FPSO, Icebreaker, Jackup, Miscellaneous, Pipelaying, Research, Support, Well Stimulation)	0.17	0.27	0.45
OG Tug (Tug)	0.17	0.27	0.45
Reefer	0.2	0.34	0.67
RORO	0.15	0.3	0.45
Tanker (LNG Tanker, LPG Tanker, Crude Oil Tanker)	0.24	0.28	0.33

Sources:
EPA. 2009. Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories: Final
EPA. 2015. Commercial Marine Vessels – 2014 NEI Commercial Marine Vessels Final. Table 4-17: Auxiliary

Fuel Use Factors		
Engine Type	**Fuel Use (g/kWh)**	**Fuel Use (gal/kWh)**
Slow-speed Diesel, Marine Diesel Oil[1]	185	0.057
Medium-speed Diesel, Marine Diesel Oil[1]	203	0.063
Medium-speed Diesel, Marine Diesel Oil Auxiliary[1]	217	0.067
Cat. 1 & 2 (main and auxiliary)[2]	N/A	0.064

1 From "Current Methodologies and Best Practices in Preparing Port Emission Inventories" April 2009, Table 2-9: Emission Factors for OGV Main Engines, Table 2-16: Auxiliary Engine Emission Factors
2 Calculated from BOEM CO2 emission rate for Cat. 1 & 2 Marine Engines below

Fuel Use Calculations	
Diesel Fuel Density (lb/gal)[1]	7.10
Distillate Fuel No. 2 Higher Heating Value (MMBtu/gal)[2]	0.138
Distillate Fuel No. 2 CO2 Emission Factor (kg CO2/MMBtu)[2]	73.96
Cat. 1 & 2 Maine Engine CO2 Emission Factor (g/kW*hr)[3]	648.20
Cat. 1 & 2 (main and auxiliary)) fuel use (gal/kWh)	0.064

1 From Table 3.4-1 AP 42
2 From 40 CFR Part 98 Table C-1: Default CO2 Emission Factors and High Heat Values for Various Types of Fuel
3 From BOEM Offshore Wind Energy Facilities Emission Estimating Tool Technical Documentation Table 3: Weighted Marine Vessel Emission Factors

Global Warming Potentials[1]	
Compound	**GWP**
CH4	25
N2O	298
SF6	22800

1 Table A-1 of 40 CFR 98

Port Name	Lookup	Port Distance (Mi)	Port Distance (NM)
Atlantic City	Atlantic City	20	17
New Jersey Wind Port	NJWP	105	91
Europe	Europe	288	250
Paulsboro	Paulsboro	145	126

Overall COP South Port Distance in OCS Applicability Zone			
Port Name	**Lookup**	**Port Distance (Mi)**	**Port Distance (NM)**
Atlantic City	Atlantic City	20	17
New Jersey Wind Port	NJWP	29	25
Europe	Europe	29	25
Paulsboro	Paulsboro	29	25

Max Export Cable Included in OCS Area	51%	
measured export cable length max in OCS area	37.74	miles
measured export cable length max	73.86	miles
North Export Cable OCS	29.19	miles
North Export Cable Total	61.86	miles
South Export Cable OCS	8.55	miles
South Export Cable Total	12	miles

2017 NEI HAPs for Marine Vessels		
Pollutant	**Basis**	**Fraction**
1,3-Butadiene	VOC	1.01E-03
2,2,4-Trimethylpentane	VOC	7.12E-03
Acenaphthene	VOC	5.09E-05
Acenaphthylene	VOC	1.18E-04
Acetaldehyde	VOC	9.78E-03
Acrolein	VOC	1.85E-03
Ammonia	PM2.5	1.92E-02
Anthracene	VOC	3.44E-04
Antimony	PM2.5	6.15E-04
Arsenic	PM2.5	2.59E-05
Benz[a]Anthracene	PM2.5	8.82E-06
Benzene	VOC	4.74E-03
Benzo[a]Pyrene	PM2.5	4.18E-06
Benzo[b]Fluoranthene	PM2.5	8.35E-06
Benzo[k]Fluoranthene	PM2.5	4.18E-06
Benzo(g,h,i)Fluoranthene	PM2.5	1.32E-04
Cadmium	PM2.5	2.36E-04
Chrysene	PM2.5	1.63E-05
Chromium (VI)	PM2.5	7.24E-09
Dibenzo[a,h]anthracene	PM2.5	8.65E-06
Ethyl Benzene	VOC	4.39E-04
Fluoranthene	PM2.5	8.97E-05
Fluorene	VOC	1.64E-04
Formaldehyde	VOC	4.27E-02
Indeno[1,2,3-c,d]Pyrene	PM2.5	8.35E-06
Lead	PM2.5	1.25E-04
Manganese	PM2.5	3.22E-06
Mercury	PM2.5	4.18E-08
Naphthalene	VOC	2.73E-03
Hexane	VOC	2.79E-03
Nickel	PM2.5	6.87E-04
Polychlorinated Biphenyls	PM2.5	4.18E-07
Phenanthrene	VOC	1.36E-03
Propionaldehyde	VOC	1.52E-03
Pyrene	PM2.5	3.37E-05
Selenium	PM2.5	4.38E-08
Toluene	VOC	2.04E-03
Xylenes (Mixed Isomers)	VOC	1.42E-03
o-Xylene	VOC	5.13E-04
Total Fraction of VOC		**0.0807**
Total Fraction of PM2.5		**0.0213**

*Source: EPA 2017 NEI Development Documentation - Methodology Documentation for EPA's Commerical Marine Emissions Estimates

Stationary Internal Combustion Engine (<600 HP) HAPs from AP-42 Chapter 3.3	
Pollutant	**Emission Factor (lb/mmBtu)**
Benzene	9.33E-04
Toluene	4.09E-04
Xylenes	2.85E-04
1,3-Butadiene	3.91E-05
Formaldehyde	1.18E-03
Acetaldehyde	7.67E-04
Acrolein	9.25E-05
Total PAH	1.68E-04
Total HAP	**3.87E-03**

Total HAP Emission Factor	
lb/MMBtu	3.87E-03
g/MMBtu	1.76
Btu/kW	10,000
MMBtu/kW	0.010
g/kW	**1.76E-02**

Stationary Internal Combustion Engine (>600 HP) HAPs from AP-42 Chapter 3.4	
Pollutant	**Emission Factor (lb/mmBtu)**
Benzene	7.76E-04
Toluene	2.81E-04
Xylenes	1.93E-04
Formaldehyde	7.89E-05
Acetaldehyde	2.52E-05
Acrolein	7.88E-06
Total PAH	2.12E-04
Total HAP	**1.57E-03**

Total HAP Emission Factor	
lb/MMBtu	1.57E-03
g/MMBtu	0.71
Btu/kW	10,000
MMBtu/kW	0.010
g/kW	**7.14E-03**

Mode		Yearly Operating Time	Avg. Engine Load Factor	Average Fuel Consumption per Year (L)	% of In Field (maneuvering)	Weighted Maneuvering Load Factor
1	Dynamic Positioning / gangway operations	40%	10%	640,000	42.6%	4.3%
2	Standby in field / hotel	33%	8%	465,000	35.1%	2.8%
3	In field transit	21%	15%	486,000	22.3%	3.4%
4	Transit to/from harbor	2%	**16%**	46,000	0.0%	0.0%
5	Harbor	4%	4%	28,000	0.0%	0.0%
Maneuvering					100.0%	**10.4%**

*Preliminary results for assessment of logistics options

~94% of activities in windfarm each year

85 m “standard” European SOV with 60 PAX and diesel electric propulsion system

Total engine capacity of 6,600 kW made up of 4x 1,650 kW generators

Appendix C

Class I Air Quality Related Values Modeling Report

Exponent®

Atlantic Shores Offshore Wind

Class I Air Quality Related Values Modeling Report

Atlantic Shores Offshore Wind

Class I Air Quality Related Values Modeling Report

Prepared for

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August 2022

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Acronyms and Abbreviations

BART	Best Available Retrofit Technology
BPIP	Building Profile Input Program
DAT	deposition analysis threshold
FLAG	Federal Land Managers' Air Quality Related Values Work Group
FLM	Federal Land Managers
IOA	Index of Agreement
ISD	Integrated Surface Database
K	Kelvin
kg	kilogram
km	kilometers
LCC	Lambert Conformal Conic
m	meters
m/s	meters per second
MMIF	Mesoscale Model Interface Program
N	Nitrogen
NO_x	Nitrogen oxides
NO_2	Nitrogen dioxide
NPS	National Park Service
NWR	National Wildlife Refuge
PM	Particular Matter
RMSE	Root Mean Square Error
S	Sulfur
SO_2	Sulfur dioxide
UTM	Universal Transverse Mercator
U.S. EPA	U.S. Environmental Protection Agency
WRF	Weather Research and Forecast Model

Limitations

This analysis makes use of the CALPUFF model to predict visibility and deposition impacts within Brigantine Class I area. Source emissions and other emission parameters were provided to Exponent, Inc. (Exponent) for use in this modeling study and no evaluation of these parameters was performed. The results presented in this report are based on the best information available at this time. If additional information becomes available, Exponent may update or otherwise revise or amend the findings in this report.

CALPUFF Class I AQRV Analysis Description

Purpose

Atlantic Shores Offshore Wind, LLC ("Atlantic Shores") proposes to construct, operate, and decommission two offshore renewable wind energy projects in Lease Area OCS-A 0499. Brigantine National Wildlife Refuge (NWR) ("Brigantine") is located approximately 15 km from the closest point of the Atlantic Shores lease area. Brigantine is a single Class I area within 300 km from the projects site. During the construction phase of the wind turbine generators and offshore substations, air emissions from vessels and other equipment involved in the construction may impact air quality related values (AQRV) at Brigantine. This modeling report described the procedures used in assessing the impacts on AQRV in Brigantine, namely visibility and deposition, associated with emissions during the construction phase of the Atlantic Shores Offshore Wind Projects located in Lease Area OCS-A 0499 ("Projects").

Model Selection

Modeling to assess the impacts on AQRV in Brigantine was conducted using the CALPUFF non-steady-state air dispersion model. CALPUFF is well suited for situations involving complex flows including spatial changes in meteorological fields due to factors such as the presence of complex terrain or the influence of water bodies, urbanization, plume fumigation (coastal fumigation or inversion break-up conditions), light wind speed or calm wind impacts, or other factors for which a steady-state-straight-line modeling approach is not appropriate (Scire et al., 2000). CALPUFF can account for the cumulative impacts of multiple spatially distributed sources within a large region, transport time, and the potential for stagnation and recirculation. CALPUFF contains a module to compute visibility effects as well as wet and dry acid deposition fluxes. Computation of visibility effects are based on the impact of particulate matter concentration on light extinction and enhanced by the hydroscopic property of particulate matter.

CALPUFF is recommended for Class I area air quality impact assessments by the Federal Land Managers' AQRV Workgroup (FLAG, 2010) and the Interagency Workgroup on Air

Quality Modeling (IWAQM) (U.S. EPA, 1998). CALPUFF is also recommended by the U.S. Environmental Protection Agency (EPA) as the preferred model for Best Available Retrofit Technology (BART) analyses (Federal Register, July 6, 2005).

The IWAQM developed procedures for evaluating visibility impacts (U.S. EPA, 1998) which are referenced in the Federal Land Managers' AQRV Workgroup guidance document on assessing air quality-related values in Class I areas (FLAG, 2010). The procedures focus on the contribution of anthropogenically-generated fine particles such as sulfate and nitrate to visibility degradation. The procedures involve the use of an air quality model to calculate concentrations of particulate matter. The CALPUFF model is recommended for this type of application because of its ability to simulate chemical conversions of SO_2 and NO_x, its treatment of wet and dry deposition, and its ability to represent non-steady-state transport over longer range distances when the assumptions of steady-state models break down.

The modeling was conducted in accordance with procedures in the FLAG (2010) guidance document using CALPUFF version 5.8.5. Version 5.8.5 is the most recent regulatory version of CALPUFF approved and recommended by U.S. EPA and Federal Land Managers (FLM). CALPOST regulatory version 6.221 and POSTUTIL version 1.56 were used for postprocessing. This version of CALPOST implements the FLAG (2010) recommendations for visibility modeling.

Source Data

Emission parameters for sources included in the modeling were provided to Exponent by Epsilon Associates. The source inventory includes vessel and equipment used during development and construction of the projects and is almost exclusively associated with fuel combustion in internal combustion engines. Description of the sources and emissions calculations are provided in the Air Permit Application prepared by Epsilon (Epsilon, 2022). Sources are assumed to have a base elevation of zero meters above sea level. For any source with a non-vertical orientation, only the vertical component of the velocity was used in the modeling.

Meteorological Data

Meteorological data were produced by EPA using the Weather Research and Forecast Model (WRF). Exponent obtained three years of WRF simulations (2018-2020) converted into CALMET format using the Mesoscale Model Interface Program (MMIF) from the FLM. MMIF allows prognostic model data to be reformatted directly into a CALPUFF ready format and by-pass the calculations performed by the CALMET model. MMIF was run to pass through meteorological data fields and to maintain the 12-kilometer horizontal grid resolution of the parent WRF simulations. Default options in MMIF were used for the calculation of stability class and mixing heights. In the vertical, ten CALMET layers were defined consistent with the default layers specified by EPA/FLM guidance (layer tops of 20, 40, 80, 160, 320, 640, 1200, 2000, 3000 and 4000 meters). The Lambert Conformal Conic (LCC) projection from original WRF simulation was maintained by MMIF and was further used in the CALPUFF simulations. The LCC parameters include an origin of 40.574 N, 97.0 W, standard parallels of 33 N and 45 N, and NWS-84 datum.

Exponent evaluated the meteorological data fields supplied by WRF to ensure they reliably represent conditions within the modeling domain. Model performance was evaluated using wind speed, wind direction, temperature, and specific humidity, comparing the observed meteorological data within the modeling domain to WRF simulations to evaluate if the simulations provide a sufficiently representative set of meteorological parameters for air dispersion modeling. The meteorological data evaluation is discussed in more detail in a separate report (Exponent, 2022).

Model Domain

The modeling domain is equivalent to the provided WRF modeling domain. It encompasses the projects site and the Brigantine Class I area, and a broad buffer beyond them. This domain is shown in Figure 1. A large buffer is maintained around the Class I area and the projects site allowing for potential recirculation of pollutants. A 12-km grid resolution, consistent with the WRF simulations processed by MMIF, was used in the CALPUFF modeling. Three years, 2018-2020, were modeled.

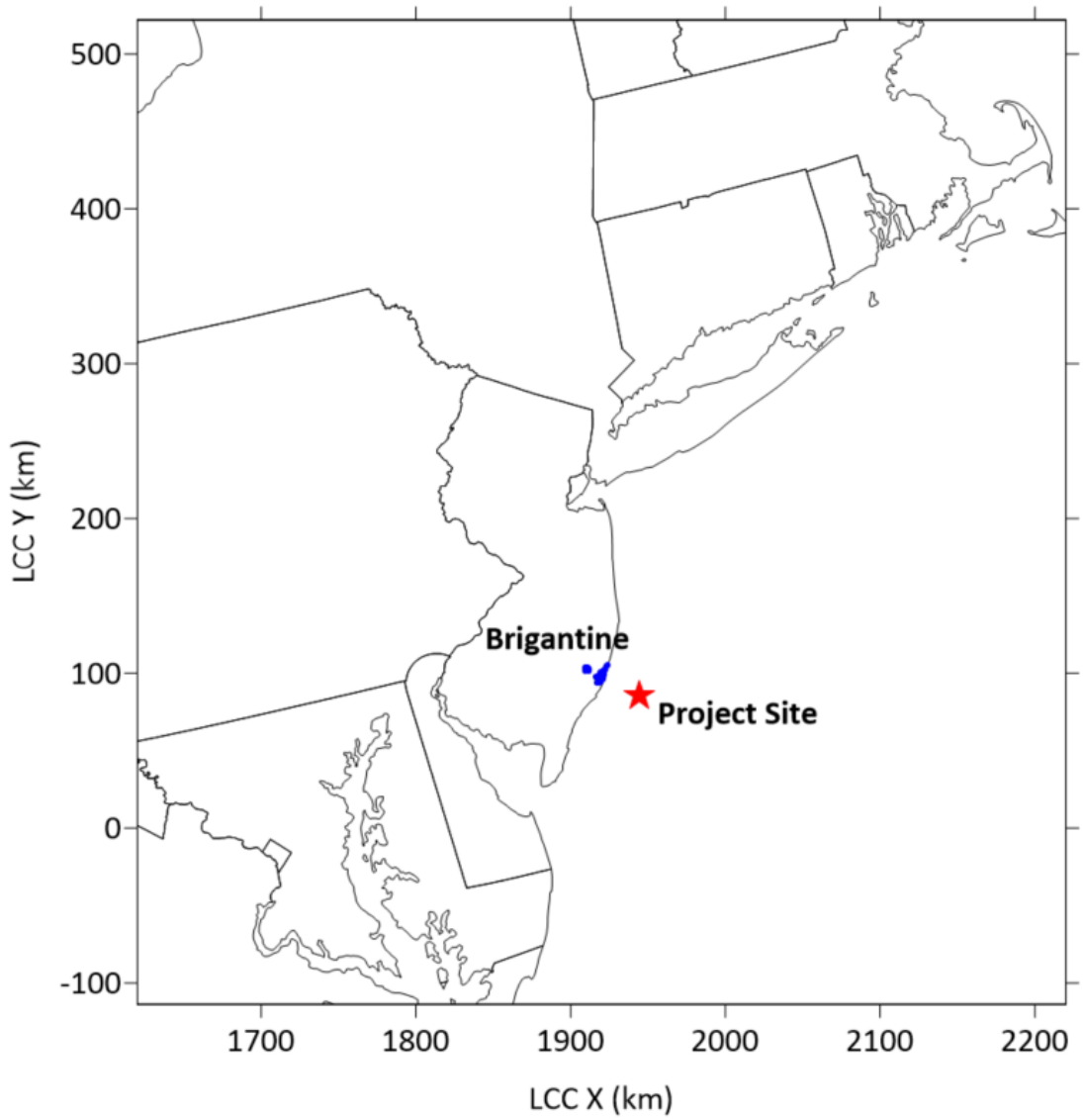

Figure 1 CALPUFF modeling domain including the location of the Project and Brigantine Class I area.

Class I Receptors

The Class I area receptors obtained from the National Park Service (NPS) data (stored at the web site https://irma.nps.gov/DataStore/Reference/Profile/2249830) were used in modeling. The 46 receptors for Brigantine Wilderness Area are shown in Figure 2.

The receptor locations were provided by NPS in latitude and longitude. These locations were converted to LCC coordinates for use in CALPUFF consistent with the original WRF projection. Receptor heights provided in the downloaded receptor file were used in modeling.

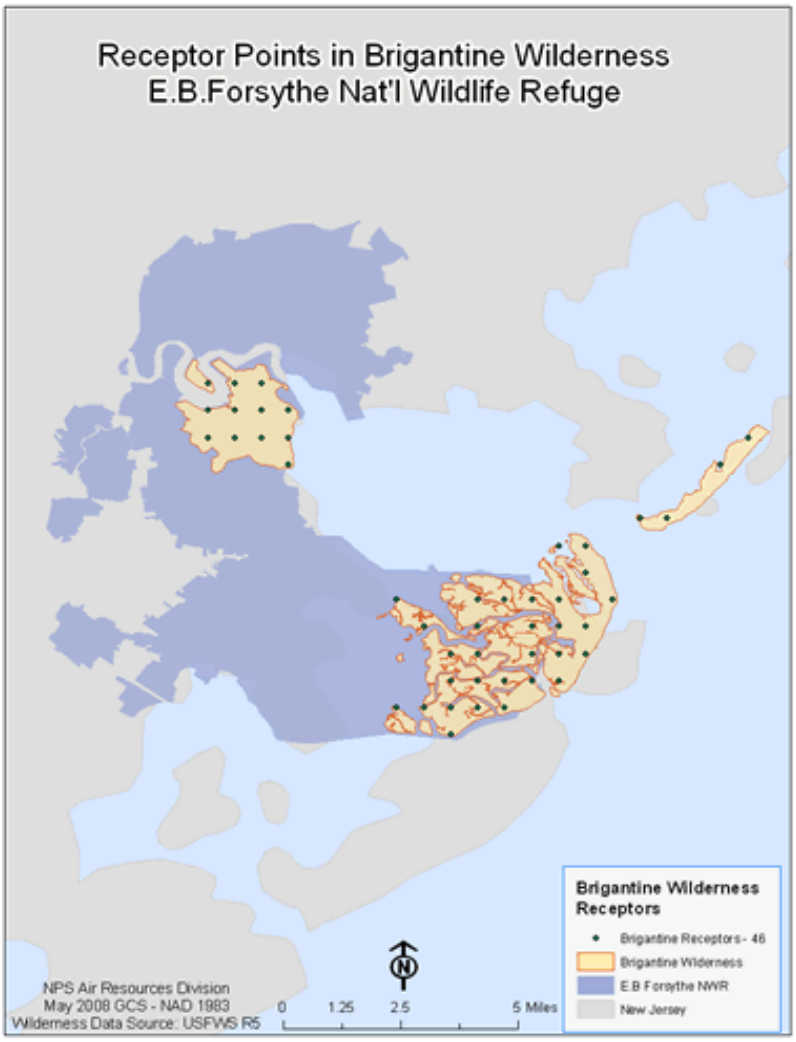

Figure 2 Class I Area Receptors for Brigantine Wilderness Area

CALPUFF Configuration

Modeling was conducted to calculate visibility and deposition. CALPUFF was run in the regulatory mode, MREG =1.

The CALPUFF simulations were conducted using the following model options:

- Gaussian near-field distribution
- Transitional plume rise
- Stack tip downwash
- Pasquill-Gifford (PG) dispersion coefficients (rural areas), McElroy-Pooler coefficients (urban areas)
- Transition of σ_y to time-dependent (Heffter) growth rates
- Partial plume path adjustment for terrain
- Wet deposition, dry deposition, and chemical transformation

The effects of downwash at source-receptor distances of approximately 15 km are expected to be small. Nevertheless, downwash was addressed consistent with the modeling conducted for Class II impacts, using the same BPIP output.

Deposition and chemical transformation effects were modeled using the default dry deposition module, the scavenging coefficient wet removal module, and the default chemical transformation mechanism. Eleven species were modeled with CALPUFF for this analysis: SO_2, SO_4, NO_x, HNO_3, NO_3, and six particulate matter (PM) species corresponding to different size categories. The six PM species named PM056, PM081, PM112, PM187, PM425, and PM800 represent the following size categories, respectively: (0.5–0.625, 0.625–1, 1–1.25, 1.25–2.5, 2.5–6, and 6–10 μm). Of the eleven modeled species, nine were emitted by the project sources: SO_2, SO_4, NO_x and six PM categories. Exponent was provided with the speciated emissions of particulate matter including coarse PM, fine PM, elemental carbon, and organic carbon. All six PM categories were emitted with unit emission rate and the appropriate emission scaling to account for emission speciation was done in POSTUTIL for each source

separately. The chemical mechanism, MESOPUFF II, was used to compute transformation rates of SO_2 to SO_4 and NO_x to NO_3/HNO_3.

The default background ammonia concentration (BCKNH3) of 10 ppb was used in CALPUFF modeling. As discussed in the Visibility subsection below, POSTUTIL with MNITRATE=1 was used for nitrate repartitioning, as recommended by the FLM.

Hourly surface ozone measured at the Brigantine AQS Site ID 34-001-0006, located at 39.465N, 74.449W, was used in the CALPUFF modeling. These ozone concentrations, along with radiation intensity, were used as surrogates for the OH concentration during the day, when the gas phase free radical chemistry is active. For a small number of hours when ozone concentrations are missing at this monitor, CALPUFF used monthly background concentration values from the control files. The monthly background ozone concentrations, BCKO3, were defined as a monthly average of daytime (9:00-18:00) monitored ozone concentrations over the 3-year modeling period.

Deposition

To assess potential impacts on soil and vegetation, modeling of deposition due to the project's emissions was conducted in accordance with IWAQM Phase 2 recommended procedures accepted by FLAG. The deposition of nitrogen (N) and sulfur (S) was predicted in terms of kilograms per hectare per year (kg/ha/yr). The predicted deposition rate for each species is compared to the applicable deposition analysis threshold (DAT) appropriate for eastern areas, 0.010 kg/ha/yr for each species. These nitrogen and sulfur DATs are not adverse impact thresholds; but do represent conservative screening criteria which allow the FLMs to identify potential deposition fluxes requiring further consideration on a case-by-case basis.

Visibility

The FLAG Method 8 procedure was applied to determine the impacts on visibility within Brigantine. Natural visibility is affected by Rayleigh scattering (scattering of light by air molecules) and by naturally occurring aerosols. Most natural and anthropogenic aerosols that can affect light extinction fall into the following categories: sulfates ($(NH_4)_2SO_4$), nitrates

(NH_4NO_3), organic mass (OM), elemental carbon (EC), soil, sea salt, and coarse mass (CM). The recommended FLAG (2010) procedures examine thresholds of visibility degradation as measured in terms of light extinction to evaluate far-field source impacts to haze. Visibility conditions are based on the average of the extinction efficiencies of several individual constituents that affect total extinction. The analysis used the CALPOST postprocessor with parameter MVISBK set to 8, which represents a default Method 8 for visibility extinction calculations. For nitrate partitioning, MNITRATE = 1 was used in POSTUTIL with the ammonia background concentration of 1.5 ppb, as recommended by the FLM. This value is appropriate for the area where Brigantine is located. The ammonia limiting method is accepted by the FLM in order to prevent overestimation of nitrate which can occur within CALPUFF when every puff is allowed to independently see the full background ammonia concentration.

In the visibility impact assessment analysis, background extinction coefficients were calculated using annual average natural concentration values for Brigantine (Table 6 of the FLAG guidance). Monthly relative humidity adjustment factors were used to account for hygroscopic effects (Tables 7 through 9 of the FLAG guidance).

Under the FLAG (2010) guidance, the visibility threshold of concern is not exceeded if the 98th percentile change in light extinction is < 5% for each year modeled when compared to the annual average natural conditions value for a particular Class I area. In this study, calculation of the annual 98th percentile (8th highest daily impact per year) maximum 24-hour change in light extinction over clean natural visibility conditions for Brigantine was performed.

CALPUFF Class I AQRV Analysis Results

Deposition

Total nitrogen and sulfur deposition were computed for evaluating potential acid deposition impacts from the project. The predicted deposition rate for each species is compared to the applicable deposition analysis threshold (DAT) appropriate for eastern areas, 0.010 kg/ha/yr for each species. Modeled sulfur deposition values are below the DAT, while modeled nitrogen deposition values exceed the DAT (Table 1). The nitrogen and sulfur DATs are not adverse impact thresholds; but do represent conservative screening criteria which allow the FLMs to identify potential deposition fluxes requiring further consideration on a case-by-case basis. It should be noted that the results in Table 1 reflect the maximum 24-hour emission rates from the closest possible locations (the closest wind turbine generator and the closest offshore substation). Annual emissions over the peak year of construction would be approximately 40% lower, and would be spread over 141 wind turbine generators and 5 offshore substations (what would be constructed during the peak year of construction). Consistent with the pre-filing call with USFWS on July 26, 2022, it may be more appropriate to review the deposition flux on an annual, rather than a short term, basis.

Table 1. Deposition Flux Summary Table

Modeled Year	Maximum Annual N Deposition (kg/ha/yr)	Maximum Annual S Deposition (kg/ha/yr)	N and S Deposition Analysis Threshold (kg/ha/yr)
2018	0.024	0.0005	0.010
2019	0.018	0.0003	
2020	0.023	0.0004	

Visibility

The change in light extinction within Brigantine due to primary and secondary particulate matter associated with emissions from the project were computed using the FLAG Method 8 procedure. The annual 98th percentile (8th highest daily impact per year) maximum 24-hour change in light extinction over clean natural visibility conditions for Brigantine is presented in Table 2. The number of days when change in light extinction exceeded 5% and 10% are also presented. The modeling results show the number of exceedances if the maximum 24-hr emissions were emitted every day from the closest sources which is a very conservative scenario.

Table 2. Visibility Summary Table

Modeled Year	98th percentile 24-hour change in light extinction	Number of days with extinction change > 5%	Number of days with extinction change > 10%	98th percentile 24-hour delta-deciview	Number of days with delta-deciview > 0.5	Number of days with delta-deciview > 1.0
2018	15.5%	41	19	1.44	41	16
2019	9.2%	31	6	0.88	30	5
2020	17.0%	36	17	1.57	36	16

References

Epsilon. 2022: Atlantic Shores Offshore Wind, Outer Continental Shelf Air Permit Application.

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Scire, J.S., D.G. Strimaitis, and R.J. Yamartino. 2000. A User's Guide for the CALPUFF Dispersion Model (Version 5). Earth Tech, Inc. Concord, MA.

U.S. Environmental Protection Agency (EPA). 1998. Interagency Workgroup on Air Quality Modeling (IWAQM), Phase 2 Report: Summary Report and Recommendation for Modeling Long Range Transport and Impacts on Regional Visibility.
EPA-454/R-98-019.

Appendix D

Representative Model Inputs and Model Results

Total				
Category	Annual Average NOx (g/s)	Annual Average PM2.5 (g/s)	Annual Average PM10 (g/s)	Annual Average SO2 (g/s)
WTG Install	24.66	0.72	0.74	0.025
WTG Commissioning	1.64	0.055	0.055	0.012
Foundation	12.03	0.41	0.42	0.023
Scour Protection	3.07	0.10	0.11	0.020
OSS Install	2.14	0.068	0.070	0.0034
OSS Commissioning	0.25	0.0041	0.0043	0.00029
IAC Install	4.82	0.16	0.17	0.032
Fuel Bunkering	0.90	0.032	0.033	0.0027
total tons/year	**1,721.3**	**53.9**	**55.5**	**4.1**

Transit (Total)				
Category	Annual Average NOx (g/s)	Annual Average PM2.5 (g/s)	Annual Average PM10 (g/s)	Annual Average SO2 (g/s)
WTG Install	1.33	0.039	0.040	0.0015
WTG Commissioning	0.0027	0.000093	0.00010	0.000021
Foundation	0.82	0.027	0.028	0.0024
Scour Protection	0.044	0.0015	0.0016	0.00036
OSS Install	0.33	0.010	0.011	0.00079
OSS Commissioning	0.00	0.00	0.00	0.00
IAC Install	0.13	0.0045	0.0047	0.00086
Fuel Bunkering	0.078	0.0026	0.0027	0.00026
total tons/year	**95.1**	**3.0**	**3.1**	**0.2**

Transit (NJWP)				
Category	Annual Average NOx (g/s)	Annual Average PM2.5 (g/s)	Annual Average PM10 (g/s)	Annual Average SO2 (g/s)
WTG Install	1.27	0.037	0.038	0.0014
WTG Commissioning	0.0027	0.000093	0.00010	0.000021
Foundation	0.68	0.023	0.024	0.0023
Scour Protection	0.003	0.0001	0.0001	0.00003
OSS Install	0.32	0.010	0.010	0.00079
OSS Commissioning	0.00	0.00	0.00	0.00
IAC Install	0.05	0.0016	0.0016	0.00016
Fuel Bunkering	0.078	0.0026	0.0027	0.00026
total tons/year	**83.5**	**2.6**	**2.7**	**0.2**

Transit (Europe)				
Category	Annual Average NOx (g/s)	Annual Average PM2.5 (g/s)	Annual Average PM10 (g/s)	Annual Average SO2 (g/s)
WTG Install	0.00	0.000	0.000	0.0000
WTG Commissioning	0.0000	0.000000	0.00000	0.000000
Foundation	0.07	0.002	0.002	0.0001
Scour Protection	0.041	0.0014	0.0015	0.00034
OSS Install	0.00	0.000	0.000	0.00000
OSS Commissioning	0.00	0.00	0.00	0.00
IAC Install	0.08	0.0029	0.0030	0.00070
Fuel Bunkering	0.000	0.0000	0.0000	0.00000
total tons/year	**6.7**	**0.2**	**0.2**	**0.0**

Transit (Atlantic City)				
Category	Annual Average NOx (g/s)	Annual Average PM2.5 (g/s)	Annual Average PM10 (g/s)	Annual Average SO2 (g/s)
WTG Install	0.06	0.002	0.002	0.0000
WTG Commissioning	0.0000	0.000000	0.00000	0.000000
Foundation	0.07	0.002	0.002	0.0000
Scour Protection	0.000	0.0000	0.0000	0.00000
OSS Install	0.01	0.000	0.000	0.00001
OSS Commissioning	0.00	0.00	0.00	0.00
IAC Install	0.00	0.0000	0.0000	0.00000
Fuel Bunkering	0.000	0.0000	0.0000	0.00000
total tons/year	**4.8**	**0.2**	**0.2**	**0.0**

Operational				
Category	Annual Average NOx (g/s)	Annual Average PM2.5 (g/s)	Annual Average PM10 (g/s)	Annual Average SO2 (g/s)
WTG Install	23.33	0.68	0.70	0.024
WTG Commissioning	1.64	0.055	0.055	0.012
Foundation	11.21	0.38	0.39	0.021
Scour Protection	3.03	0.10	0.11	0.019
OSS Install	1.82	0.058	0.059	0.0026
OSS Commissioning	0.25	0.0041	0.0043	0.00029
IAC Install	4.69	0.16	0.16	0.032
Fuel Bunkering	0.83	0.029	0.030	0.0024
total tons/year	**1,626.2**	**50.9**	**52.4**	**3.9**

Identifier	Activity Type	Vessel	Engine	Activity	Source Type	Exhaust Temp (K)	Stack Height above ocean (m)	Exhaust Diameter (m)	Stack Velocity (m/s)	Vertical Velocity (m/s)	Stack Angle	Vessel Width (m)	Hours / Day
Transits													
WTG_IV_T	WTG Installation Vessel	Jackup Vessel	Engines	Transit	Line Volume	N/A	65.00	N/A	N/A	N/A	N/A	60	24
WTG_Feed_T	US Jack Up Feeder	Jackup Vessel	Engines	Transit	Line Volume	N/A	65.00	N/A	N/A	N/A	N/A	40	24
WTG_CTV_T	Crew Transfer Vessel	Crew Transfer Vessel	Engines	Transit	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	10	24
WTG_SOV_T	WTG Commissioning SOV	Service Operation Vessel	Engines	Transit	Line Volume	N/A	16.00	N/A	N/A	N/A	N/A	16	24
B02_HLV_T	Medium HLV	Heavy Lift Vessel	Engines	Transit	Line Volume	N/A	40.6	N/A	N/A	N/A	N/A	43	24
B02_BCSV_T	Bubble Curtain Support Vessel	Tug	Engines	Transit	Line Volume	N/A	13.00	N/A	N/A	N/A	N/A	16	24
B02_Barge_T	Barge	Barge	Auxiliary Engine	Transit	Line Volume	N/A	3.00	N/A	N/A	N/A	N/A	35	24
B02_Tug_T	Towing Tug	Tug	Engines	Transit	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	15	24
B02_CTV_T	Crew Transfer / PSO / Noise Monitoring Vessel	Crew Transfer Vessel	Engines	Transit	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	10	24
Scour_FPV_T	Fall Pipe Vessel	Fall Pipe Vessel	Engines	Transit	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	40	24
Scour_Dredge_T	Dredging	US Dredger	Engines	Transit	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	41	24
OSS_HLV_T	Large HLV	Heavy Lift Vessel	Engines	Transit	Line Volume	N/A	55.00	N/A	N/A	N/A	N/A	87	24
OSS_BCSV_T	Bubble Curtain Support Vessel	Tug	Engines	Transit	Line Volume	N/A	13.00	N/A	N/A	N/A	N/A	16	24
OSS_Barge1_T	Barge 1	Barge	Auxiliary Engine	Transit	Line Volume	N/A	3.00	N/A	N/A	N/A	N/A	35	24
OSS_Barge2_T	Barge 2	Barge	Auxiliary Engine	Transit	Line Volume	N/A	3.00	N/A	N/A	N/A	N/A	35	24
OSS_Tug1_T	Towing Tug 1	Tug	Engines	Transit	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	15	24
OSS_Tug2_T	Towing Tug 2	Tug	Engines	Transit	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	15	24
OSS_CTV_T	Crew Transfer	Crew Transfer Vessel	Engines	Transit	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	10	24
IAC_CIV_T	Cable Installation Vessel	Cable Installation Vessel	Engines	Transit	Line Volume	N/A	43.00	N/A	N/A	N/A	N/A	30	24
IAC_Support_T	Cable Installation Support Activities	Support Vessel/SOV	Engines	Transit	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	16	24
IAC_THSD_T	Sand Wave Clearance	TSHD (Dredger)	Engines	Transit	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	41	24
IAC_PLGR1_T	Pre Lay Grapnel Run AHTS 1	AHTS	Engines	Transit	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	17	24
IAC_PLGR2_T	Pre Lay Grapnel Run AHTS 2	AHTS	Engines	Transit	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	17	24
IAC_FPV_T	Post-Install Rock Protection	Fall Pipe Vessel	Engines	Transit	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	40	24
FB_Barge_T	Barge	Barge	Auxiliary Engine	Transit	Line Volume	N/A	3.00	N/A	N/A	N/A	N/A	35	24
FB_Tug_T	Towing Tug	Tug	Engines	Transit	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	15	24
WTG Installation													
WTG_IV_ME1_1	WTG Installation Vessel	Jackup Vessel	Main Engines 1	Maneuvering	Point	555	65.00	0.80	3.18	2.25	45	N/A	24
WTG_IV_ME1_2	WTG Installation Vessel	Jackup Vessel	Main Engines 1	Maneuvering	Point	555	65.00	0.80	3.18	2.25	45	N/A	24
WTG_IV_ME1_3	WTG Installation Vessel	Jackup Vessel	Main Engines 1	Maneuvering	Point	555	65.00	0.80	3.18	2.25	45	N/A	24
WTG_IV_ME1_4	WTG Installation Vessel	Jackup Vessel	Main Engines 1	Maneuvering	Point	555	65.00	0.80	3.18	2.25	45	N/A	24
WTG_IV_ME2_1	WTG Installation Vessel	Jackup Vessel	Main Engines 2	Maneuvering	Point	555	65.00	0.80	2.39	1.69	45	N/A	24
WTG_IV_ME2_2	WTG Installation Vessel	Jackup Vessel	Main Engines 2	Maneuvering	Point	555	65.00	0.80	2.39	1.69	45	N/A	24
WTG_IV_ME2_3	WTG Installation Vessel	Jackup Vessel	Main Engines 2	Maneuvering	Point	555	65.00	0.80	2.39	1.69	45	N/A	24
WTG_IV_AE_1	WTG Installation Vessel	Jackup Vessel	Auxiliary Engines	Maneuvering	Point	555	65.00	0.80	6.02	4.26	45	N/A	24
WTG_Feed1_ME_1	US Jack Up Feeder 1	Jackup Vessel	Main Engine	Maneuvering	Point	555	65.00	0.80	2.25	1.59	45	N/A	24
WTG_Feed1_ME_2	US Jack Up Feeder 1	Jackup Vessel	Main Engine	Maneuvering	Point	555	65.00	0.80	2.25	1.59	45	N/A	24
WTG_Feed1_AE_1	US Jack Up Feeder 1	Jackup Vessel	Auxiliary Engine	Maneuvering	Point	555	65.00	0.80	5.68	4.02	45	N/A	24
WTG_CTV_ME_1	Crew Transfer Vessel	Crew Transfer Vessel	Engines	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	10	24
WTG Commissioning													
WTG_SOV_ME_1	WTG Commissioning SOV	Service Operation Vessel	Main Engine	Maneuvering	Point	555	16.00	0.46	1.91	1.35	45	N/A	24
WTG_SOV_ME_2	WTG Commissioning SOV	Service Operation Vessel	Main Engine	Maneuvering	Point	555	16.00	0.46	1.91	1.35	45	N/A	24
WTG_SOV_ME_3	WTG Commissioning SOV	Service Operation Vessel	Main Engine	Maneuvering	Point	555	16.00	0.46	1.91	1.35	45	N/A	24
WTG_SOV_ME_4	WTG Commissioning SOV	Service Operation Vessel	Main Engine	Maneuvering	Point	555	16.00	0.46	1.91	1.35	45	N/A	24
WTG_SOV_AE_1	WTG Commissioning SOV	Service Operation Vessel	Auxiliary Engine	Maneuvering	Point	555	16.00	0.46	1.27	0.90	45	N/A	24
WTG_Gen_1	WTG Commissioning Generator	WTG Commissioning Generator	Generator	Maneuvering	Point	658	6.00	0.15	21.97	21.97	Vertical	N/A	12

Identifier	Activity Type	Vessel	Engine	Activity	Source Type	Exhaust Temp (K)	Stack Height above ocean (m)	Exhaust Diameter (m)	Stack Velocity (m/s)	Vertical Velocity (m/s)	Stack Angle	Vessel Width (m)	Hours / Day
Foundation - B02 - MP/TP													
B02_HLV_ME1_1	Medium HLV	Heavy Lift Vessel	Main Engines 1	Maneuvering	Point	583	39	1.00	4.65	3.29	45	N/A	24
B02_HLV_ME2_1	Medium HLV	Heavy Lift Vessel	Main Engines 2	Maneuvering	Point	555	45	0.65	6.55	4.63	45	N/A	24
B02_HLV_AE_1	Medium HLV	Heavy Lift Vessel	Auxiliary Engine	Maneuvering	Point	709	38	0.30	6.36	4.49	45	N/A	24
B02_BCSV_ME_1	Bubble Curtain Support Vessel	Tug	Engines	Maneuvering	Point	625	13	0.86	26.04	18.41	45	N/A	24
B02_Barge1_AE1	Barge 1	Barge	Engines	Maneuvering	Line Volume	N/A	3	N/A	N/A	N/A	N/A	35	24
B02_Tug1_ME1	Towing Tug 1	Tug	Engines	Maneuvering	Line Volume	N/A	6	N/A	N/A	N/A	N/A	15	24
B02_CTV_ME1	Crew Transfer / PSO / Noise Monitoring Vessel	Crew Transfer Vessel	Engines	Maneuvering	Line Volume	N/A	6	N/A	N/A	N/A	N/A	10	24
B02_Compress1	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress2	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress3	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress4	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress5	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress6	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress7	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress8	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress9	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress10	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress11	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress12	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress13	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress14	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress15	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress16	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress17	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress18	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress19	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Compress20	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8
B02_Hammer1	Hydraulic Hammer Power	Hydraulic Hammer Engine	Hammer Engines	Maneuvering	Point	755	6	0.35	70.57	70.57	Vertical	N/A	8
Scour Protection													
Scour_FPV_ME1_1	Fall Pipe Vessel	Fall Pipe Vessel	Engines	Maneuvering	Point	555	6.00	1.83	5.65	5.65	Vertical	N/A	24
Scour_Dredge_ME_1	Dredging	US Dredger	Main Engine	Maneuvering	Point	555	6.00	0.46	1.95	1.95	Vertical	N/A	24
Scour_Dredge_ME_2	Dredging	US Dredger	Main Engine	Maneuvering	Point	555	6.00	0.46	1.95	1.95	Vertical	N/A	24
Scour_Dredge_AE_1	Dredging	US Dredger	Auxiliary Engine	Maneuvering	Point	555	6.00	0.46	8.15	8.15	Vertical	N/A	24

Identifier	Activity Type	Vessel	Engine	Activity	Source Type	Exhaust Temp (K)	Stack Height above ocean (m)	Exhaust Diameter (m)	Stack Velocity (m/s)	Vertical Velocity (m/s)	Stack Angle	Vessel Width (m)	Hours / Day
OSS Installation													
OSS_HLV_ME_1	Large HLV	Heavy Lift Vessel	6 Main Engines	Maneuvering	Point	555	55.00	1.49	3.24	3.24	Vertical	N/A	24
OSS_HLV_ME_7	Large HLV	Heavy Lift Vessel	5 Main 1 Aux Engine	Maneuvering	Point	555	55.00	1.49	7.66	7.66	Vertical	N/A	24
OSS_BCSV_ME_1	Bubble Curtain Support Vessel	Tug	Main Engine	Maneuvering	Point	625	13.00	0.86	26.04	18.41	45	N/A	24
OSS_Barge1_AE_1	Barge 1	Barge	Auxiliary Engine	Maneuvering	Line Volume	N/A	3.00	N/A	N/A	N/A	N/A	35	24
OSS_Barge2_AE_1	Barge 2	Barge	Auxiliary Engine	Maneuvering	Line Volume	N/A	3.00	N/A	N/A	N/A	N/A	35	24
OSS_Tug1_ME_1	Towing Tug 1	Tug	Main Engine	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	15	24
OSS_Tug2_ME_1	Towing Tug 2	Tug	Main Engine	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	15	24
OSS_CTV_ME_1	Crew Transfer	Crew Transfer Vessel	Main Engine	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	10	24
OSS_Compress_1	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_2	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_3	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_4	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_5	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_6	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_7	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_8	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_9	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_10	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_11	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_12	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_13	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_14	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_15	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_16	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_17	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_18	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_19	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Compress_20	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10
OSS_Hammer_1	Hydraulic Hammer Power	Hydraulic Hammer Engine	Hammer Engine	Maneuvering	Point	755	6.00	0.35	70.57	70.57	Vertical	N/A	10
OSS Commissioning													
OSS_Gen_1	OSS Commissioning Generator	OSS Commissioning Generator	Generator	Maneuvering	Point	755	6.00	0.20	29.55	29.55	Vertical	N/A	12
OSS_Gen_2	OSS Commissioning Generator	OSS Commissioning Generator	Generator	Maneuvering	Point	755	6.00	0.20	29.55	29.55	Vertical	N/A	12
OSS_Gen_3	OSS Commissioning Generator	OSS Commissioning Generator	Generator	Maneuvering	Point	755	6.00	0.20	29.55	29.55	Vertical	N/A	12
OSS_Gen_4	OSS Commissioning Generator	OSS Commissioning Generator	Generator	Maneuvering	Point	755	6.00	0.20	29.55	29.55	Vertical	N/A	12
OSS_Gen_5	OSS Commissioning Generator	OSS Commissioning Generator	Generator	Maneuvering	Point	755	6.00	0.20	29.55	29.55	Vertical	N/A	12
OSS_Gen_6	OSS Commissioning Generator	OSS Commissioning Generator	Generator	Maneuvering	Point	755	6.00	0.20	29.55	29.55	Vertical	N/A	12
OSS_Gen_7	OSS Commissioning Generator	OSS Commissioning Generator	Generator	Maneuvering	Point	755	6.00	0.20	29.55	29.55	Vertical	N/A	12
OSS_Gen_8	OSS Commissioning Generator	OSS Commissioning Generator	Generator	Maneuvering	Point	755	6.00	0.20	29.55	29.55	Vertical	N/A	12
Inter Array Cable Installation													
IAC_CIV_ME_1	Cable Installation Vessel	Cable Installation Vessel	IAC Install	Maneuvering	Point	555	43.00	1.50	2.06	1.46	45	N/A	24
IAC_CIV_AE_1	Cable Installation Vessel	Cable Installation Vessel	IAC Install	Maneuvering	Point	555	43.00	0.20	7.30	5.16	45	N/A	24
IAC_Support	Cable Installation Support Activities	Support Vessel/SOV	Engines	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	16	24
IAC_THSD	Sand Wave Clearance	TSHD (Dredger)	Engines	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	41	24
IAC_PLGR1	Pre Lay Grapnel Run AHTS 1	AHTS	Engines	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	17	24
IAC_PLGR2	Pre Lay Grapnel Run AHTS 2	AHTS	Engines	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	17	24
IAC_FPV	Post-Install Rock Protection	Fall Pipe Vessel	Engines	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	40	24
Fuel Bunkering													
FB_Barge_AE_1	Barge	Barge	Auxiliary Engine	Maneuvering	Point	698	3.00	0.15	3.71	3.71	Vertical	N/A	24
FB_Tug_ME_1	Towing Tug	Tug	Main Engine	Maneuvering	Point	733	6.00	0.61	5.72	4.05	45	N/A	24
FB_Tug_ME_2	Towing Tug	Tug	Main Engine	Maneuvering	Point	733	6.00	0.61	5.72	4.05	45	N/A	24
FB_Tug_AE_1	Towing Tug	Tug	Auxiliary Engine	Maneuvering	Point	698	6.00	0.20	3.30	2.33	45	N/A	24
FB_Tug_AE_2	Towing Tug	Tug	Auxiliary Engine	Maneuvering	Point	698	6.00	0.20	3.30	2.33	45	N/A	24
FB_Tug_AE_3	Towing Tug	Tug	Auxiliary Engine	Maneuvering	Point	698	6.00	0.20	3.30	2.33	45	N/A	24
FB_MC_1	Motion Compensation	Motion Compensation	Main Engine	Maneuvering	Point	755	3.00	0.20	59.10	59.10	Vertical	N/A	24

Identifier	Activity Type	Vessel	Engine	Annual Average NOx (g/s)	Annual Average PM2.5 (g/s)	Annual Average SO2 (g/s)	Annual Average PM10 (g/s)	Annual Average CO (g/s)	Group	Transit Port
Transits										
WTG_IV_T	WTG Installation Vessel	Jackup Vessel	Engines	6.25E-02	1.86E-03	7.77E-05	1.92E-03	1.43E-02	WTG Install	NJWP
WTG_Feed_T	US Jack Up Feeder	Jackup Vessel	Engines	1.21E+00	3.53E-02	1.35E-03	3.65E-02	2.73E-01	WTG Install	NJWP
WTG_CTV_T	Crew Transfer Vessel	Crew Transfer Vessel	Engines	5.58E-02	1.83E-03	3.65E-05	1.89E-03	1.40E-02	WTG Install	Atlantic City
WTG_SOV_T	WTG Commissioning SOV	Service Operation Vessel	Engines	2.71E-03	9.29E-05	2.09E-05	9.58E-05	6.36E-04	WTG Commissioning	NJWP
B02_HLV_T	Medium HLV	Heavy Lift Vessel	Engines	6.82E-02	2.03E-03	8.66E-05	2.10E-03	1.56E-02	Foundation	Europe
B02_BCSV_T	Bubble Curtain Support Vessel	Tug	Engines	2.77E-02	9.31E-04	9.61E-05	9.61E-04	6.67E-03	Foundation	NJWP
B02_Barge_T	Barge	Barge	Auxiliary Engine	4.28E-03	1.06E-04	2.05E-06	1.09E-04	8.45E-04	Foundation	NJWP
B02_Tug_T	Towing Tug	Tug	Engines	6.49E-01	2.18E-02	2.20E-03	2.24E-02	1.56E-01	Foundation	NJWP
B02_CTV_T	Crew Transfer / PSO / Noise Monitoring Vessel	Crew Transfer Vessel	Engines	7.37E-02	2.41E-03	4.82E-05	2.49E-03	1.85E-02	Foundation	Atlantic City
Scour_FPV_T	Fall Pipe Vessel	Fall Pipe Vessel	Engines	4.10E-02	1.41E-03	3.37E-04	1.46E-03	9.58E-03	Scour Protection	Europe
Scour_Dredge_T	Dredging	US Dredger	Engines	3.44E-03	1.17E-04	2.72E-05	1.23E-04	7.97E-04	Scour Protection	NJWP
OSS_HLV_T	Large HLV	Heavy Lift Vessel	Engines	1.33E-01	3.95E-03	1.64E-04	4.08E-03	3.04E-02	OSS Install	NJWP
OSS_BCSV_T	Bubble Curtain Support Vessel	Tug	Engines	2.77E-02	9.31E-04	9.61E-05	9.61E-04	6.67E-03	OSS Install	NJWP
OSS_Barge1_T	Barge 1	Barge	Auxiliary Engine	5.14E-04	1.27E-05	2.45E-07	1.31E-05	1.01E-04	OSS Install	NJWP
OSS_Barge2_T	Barge 2	Barge	Auxiliary Engine	5.14E-04	1.27E-05	2.45E-07	1.31E-05	1.01E-04	OSS Install	NJWP
OSS_Tug1_T	Towing Tug 1	Tug	Engines	7.79E-02	2.61E-03	2.64E-04	2.69E-03	1.87E-02	OSS Install	NJWP
OSS_Tug2_T	Towing Tug 2	Tug	Engines	7.79E-02	2.61E-03	2.64E-04	2.69E-03	1.87E-02	OSS Install	NJWP
OSS_CTV_T	Crew Transfer	Crew Transfer Vessel	Engines	8.72E-03	2.85E-04	5.71E-06	2.95E-04	2.19E-03	OSS Install	Atlantic City
IAC_CIV_T	Cable Installation Vessel	Cable Installation Vessel	Engines	1.85E-02	6.42E-04	1.63E-04	6.61E-04	4.29E-03	IAC Install	Europe
IAC_Support_T	Cable Installation Support Activities	Support Vessel/SOV	Engines	2.71E-03	9.29E-05	2.09E-05	9.58E-05	6.36E-04	IAC Install	Europe
IAC_THSD_T	Sand Wave Clearance	TSHD (Dredger)	Engines	4.91E-03	1.67E-04	3.88E-05	1.76E-04	1.14E-03	IAC Install	Europe
IAC_PLGR1_T	Pre Lay Grapnel Run AHTS 1	AHTS	Engines	2.37E-02	7.93E-04	7.88E-05	8.17E-04	5.70E-03	IAC Install	NJWP
IAC_PLGR2_T	Pre Lay Grapnel Run AHTS 2	AHTS	Engines	2.37E-02	7.93E-04	7.88E-05	8.17E-04	5.70E-03	IAC Install	NJWP
IAC_FPV_T	Post-Install Rock Protection	Fall Pipe Vessel	Engines	5.86E-02	2.02E-03	4.82E-04	2.08E-03	1.37E-02	IAC Install	Europe
FB_Barge_T	Barge	Barge	Auxiliary Engine	5.14E-04	1.27E-05	2.45E-07	1.31E-05	1.01E-04	Fuel Bunkering	NJWP
FB_Tug_T	Towing Tug	Tug	Engines	7.79E-02	2.61E-03	2.64E-04	2.69E-03	1.87E-02	Fuel Bunkering	NJWP
WTG Installation										
WTG_IV_ME1_1	WTG Installation Vessel	Jackup Vessel	Main Engines 1	1.97E+00	5.89E-02	2.55E-03	6.09E-02	4.52E-01	WTG Install	N/A
WTG_IV_ME1_2	WTG Installation Vessel	Jackup Vessel	Main Engines 1	1.97E+00	5.89E-02	2.55E-03	6.09E-02	4.52E-01	WTG Install	N/A
WTG_IV_ME1_3	WTG Installation Vessel	Jackup Vessel	Main Engines 1	1.97E+00	5.89E-02	2.55E-03	6.09E-02	4.52E-01	WTG Install	N/A
WTG_IV_ME1_4	WTG Installation Vessel	Jackup Vessel	Main Engines 1	1.97E+00	5.89E-02	2.55E-03	6.09E-02	4.52E-01	WTG Install	N/A
WTG_IV_ME2_1	WTG Installation Vessel	Jackup Vessel	Main Engines 2	1.48E+00	4.42E-02	1.91E-03	4.56E-02	3.39E-01	WTG Install	N/A
WTG_IV_ME2_2	WTG Installation Vessel	Jackup Vessel	Main Engines 2	1.48E+00	4.42E-02	1.91E-03	4.56E-02	3.39E-01	WTG Install	N/A
WTG_IV_ME2_3	WTG Installation Vessel	Jackup Vessel	Main Engines 2	1.48E+00	4.42E-02	1.91E-03	4.56E-02	3.39E-01	WTG Install	N/A
WTG_IV_AE_1	WTG Installation Vessel	Jackup Vessel	Auxiliary Engines	3.66E+00	9.81E-02	1.90E-03	1.01E-01	7.85E-01	WTG Install	N/A
WTG_Feed1_ME_1	US Jack Up Feeder 1	Jackup Vessel	Main Engine	1.39E+00	4.17E-02	1.81E-03	4.31E-02	3.19E-01	WTG Install	N/A
WTG_Feed1_ME_2	US Jack Up Feeder 1	Jackup Vessel	Main Engine	1.39E+00	4.17E-02	1.81E-03	4.31E-02	3.19E-01	WTG Install	N/A
WTG_Feed1_AE_1	US Jack Up Feeder 1	Jackup Vessel	Auxiliary Engine	3.45E+00	9.26E-02	1.79E-03	9.56E-02	7.41E-01	WTG Install	N/A
WTG_CTV_ME_1	Crew Transfer Vessel	Crew Transfer Vessel	Engines	1.13E+00	3.68E-02	7.35E-04	3.80E-02	2.83E-01	WTG Install	N/A
WTG Commissioning										
WTG_SOV_ME_1	WTG Commissioning SOV	Service Operation Vessel	Main Engine	3.29E-01	1.15E-02	2.95E-03	1.18E-02	7.64E-02	WTG Commissioning	N/A
WTG_SOV_ME_2	WTG Commissioning SOV	Service Operation Vessel	Main Engine	3.29E-01	1.15E-02	2.95E-03	1.18E-02	7.64E-02	WTG Commissioning	N/A
WTG_SOV_ME_3	WTG Commissioning SOV	Service Operation Vessel	Main Engine	3.29E-01	1.15E-02	2.95E-03	1.18E-02	7.64E-02	WTG Commissioning	N/A
WTG_SOV_ME_4	WTG Commissioning SOV	Service Operation Vessel	Main Engine	3.29E-01	1.15E-02	2.95E-03	1.18E-02	7.64E-02	WTG Commissioning	N/A
WTG_SOV_AE_1	WTG Commissioning SOV	Service Operation Vessel	Auxiliary Engine	2.29E-01	7.17E-03	1.39E-04	7.41E-03	5.74E-02	WTG Commissioning	N/A
WTG_Gen_1	WTG Commissioning Generator	WTG Commissioning Generator	Generator	9.00E-02	1.94E-03	8.50E-07	3.23E-07	5.91E-09	WTG Commissioning	N/A

Identifier	Activity Type	Vessel	Engine	Annual Average NOx (g/s)	Annual Average PM2.5 (g/s)	Annual Average SO2 (g/s)	Annual Average PM10 (g/s)	Annual Average CO (g/s)	Group	Transit Port
Foundation - B02 - MP/TP										
B02_HLV_ME1_1	Medium HLV	Heavy Lift Vessel	Main Engines 1	2.41E+00	7.22E-02	3.13E-03	7.46E-02	5.53E-01	Foundation	N/A
B02_HLV_ME2_1	Medium HLV	Heavy Lift Vessel	Main Engines 2	1.51E+00	4.51E-02	1.95E-03	4.66E-02	3.46E-01	Foundation	N/A
B02_HLV_AE_1	Medium HLV	Heavy Lift Vessel	Auxiliary Engine	1.12E+00	3.02E-02	5.84E-04	3.12E-02	2.41E-01	Foundation	N/A
B02_BCSV_ME_1	Bubble Curtain Support Vessel	Tug	Engines	1.65E+00	5.54E-02	5.72E-03	5.72E-02	3.97E-01	Foundation	N/A
B02_Barge1_AE1	Barge 1	Barge	Engines	8.47E-02	2.09E-03	4.04E-05	2.16E-03	1.67E-02	Foundation	N/A
B02_Tug1_ME1	Towing Tug 1	Tug	Engines	1.83E+00	6.05E-02	5.41E-03	6.24E-02	4.41E-01	Foundation	N/A
B02_CTV_ME1	Crew Transfer / PSO / Noise Monitoring Vessel	Crew Transfer Vessel	Engines	3.37E-01	1.09E-02	2.18E-04	1.13E-02	8.42E-02	Foundation	N/A
B02_Compress1	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress2	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress3	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress4	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress5	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress6	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress7	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress8	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress9	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress10	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress11	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress12	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress13	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress14	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress15	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress16	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress17	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress18	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress19	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Compress20	Bubble Curtain Power	Air Compressor	Air Compressor	8.33E-02	4.17E-03	1.42E-04	4.17E-03	7.29E-02	Foundation	N/A
B02_Hammer1	Hydraulic Hammer Power	Hydraulic Hammer Engine	Hammer Engines	5.98E-01	1.87E-02	6.36E-04	1.87E-02	3.27E-01	Foundation	N/A
Scour Protection										
Scour_FPV_ME1_1	Fall Pipe Vessel	Fall Pipe Vessel	Engines	2.79E+00	9.43E-02	1.83E-02	9.72E-02	6.62E-01	Scour Protection	N/A
Scour_Dredge_ME_1	Dredging	US Dredger	Main Engine	3.80E-02	1.35E-03	4.44E-04	1.43E-03	8.44E-03	Scour Protection	N/A
Scour_Dredge_ME_2	Dredging	US Dredger	Main Engine	3.80E-02	1.35E-03	4.44E-04	1.43E-03	8.44E-03	Scour Protection	N/A
Scour_Dredge_AE_1	Dredging	US Dredger	Auxiliary Engine	1.63E-01	5.12E-03	9.90E-05	5.28E-03	4.09E-02	Scour Protection	N/A

Identifier	Activity Type	Vessel	Engine	Annual Average NOx (g/s)	Annual Average PM2.5 (g/s)	Annual Average SO2 (g/s)	Annual Average PM10 (g/s)	Annual Average CO (g/s)	Group	Transit Port
OSS Installation										
OSS_HLV_ME_1	Large HLV	Heavy Lift Vessel	6 Main Engines	3.45E-01	1.03E-02	4.47E-04	1.07E-02	7.91E-02	OSS Install	N/A
OSS_HLV_ME_7	Large HLV	Heavy Lift Vessel	5 Main 1 Aux Engine	8.04E-01	2.25E-02	6.41E-04	2.32E-02	1.77E-01	OSS Install	N/A
OSS_BCSV_ME_1	Bubble Curtain Support Vessel	Tug	Main Engine	1.44E-01	4.85E-03	5.00E-04	5.00E-03	3.47E-02	OSS Install	N/A
OSS_Barge1_AE_1	Barge 1	Barge	Auxiliary Engine	4.11E-03	1.01E-04	1.96E-06	1.05E-04	8.12E-04	OSS Install	N/A
OSS_Barge2_AE_1	Barge 2	Barge	Auxiliary Engine	4.11E-03	1.01E-04	1.96E-06	1.05E-04	8.12E-04	OSS Install	N/A
OSS_Tug1_ME_1	Towing Tug 1	Tug	Main Engine	8.88E-02	2.94E-03	2.63E-04	3.03E-03	2.14E-02	OSS Install	N/A
OSS_Tug2_ME_1	Towing Tug 2	Tug	Main Engine	8.88E-02	2.94E-03	2.63E-04	3.03E-03	2.14E-02	OSS Install	N/A
OSS_CTV_ME_1	Crew Transfer	Crew Transfer Vessel	Main Engine	9.17E-02	2.98E-03	5.93E-05	3.08E-03	2.29E-02	OSS Install	N/A
OSS_Compress_1	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_2	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_3	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_4	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_5	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_6	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_7	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_8	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_9	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_10	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_11	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_12	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_13	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_14	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_15	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_16	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_17	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_18	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_19	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Compress_20	Bubble Curtain Power	Air Compressor	Air Compressor	9.11E-03	4.55E-04	1.55E-05	4.55E-04	7.97E-03	OSS Install	N/A
OSS_Hammer_1	Hydraulic Hammer Power	Hydraulic Hammer Engine	Hammer Engine	6.54E-02	2.04E-03	6.96E-05	2.04E-03	3.58E-02	OSS Install	N/A
OSS Commissioning										
OSS_Gen_1	OSS Commissioning Generator	OSS Commissioning Generator	Generator	3.09E-02	5.17E-04	3.62E-05	5.33E-04	2.66E-02	OSS Commissioning	N/A
OSS_Gen_2	OSS Commissioning Generator	OSS Commissioning Generator	Generator	3.09E-02	5.17E-04	3.62E-05	5.33E-04	2.66E-02	OSS Commissioning	N/A
OSS_Gen_3	OSS Commissioning Generator	OSS Commissioning Generator	Generator	3.09E-02	5.17E-04	3.62E-05	5.33E-04	2.66E-02	OSS Commissioning	N/A
OSS_Gen_4	OSS Commissioning Generator	OSS Commissioning Generator	Generator	3.09E-02	5.17E-04	3.62E-05	5.33E-04	2.66E-02	OSS Commissioning	N/A
OSS_Gen_5	OSS Commissioning Generator	OSS Commissioning Generator	Generator	3.09E-02	5.17E-04	3.62E-05	5.33E-04	2.66E-02	OSS Commissioning	N/A
OSS_Gen_6	OSS Commissioning Generator	OSS Commissioning Generator	Generator	3.09E-02	5.17E-04	3.62E-05	5.33E-04	2.66E-02	OSS Commissioning	N/A
OSS_Gen_7	OSS Commissioning Generator	OSS Commissioning Generator	Generator	3.09E-02	5.17E-04	3.62E-05	5.33E-04	2.66E-02	OSS Commissioning	N/A
OSS_Gen_8	OSS Commissioning Generator	OSS Commissioning Generator	Generator	3.09E-02	5.17E-04	3.62E-05	5.33E-04	2.66E-02	OSS Commissioning	N/A
Inter Array Cable Installation										
IAC_CIV_ME_1	Cable Installation Vessel	Cable Installation Vessel	IAC Install	2.31E+00	8.04E-02	2.07E-02	8.29E-02	5.36E-01	IAC Install	N/A
IAC_CIV_AE_1	Cable Installation Vessel	Cable Installation Vessel	IAC Install	1.57E-01	4.91E-03	9.50E-05	5.07E-03	3.93E-02	IAC Install	N/A
IAC_Support	Cable Installation Support Activities	Support Vessel/SOV	Engines	5.84E-01	2.00E-02	4.51E-03	2.06E-02	1.37E-01	IAC Install	N/A
IAC_THSD	Sand Wave Clearance	TSHD (Dredger)	Engines	8.46E-01	2.77E-02	3.50E-03	2.88E-02	2.05E-01	IAC Install	N/A
IAC_PLGR1	Pre Lay Grapnel Run AHTS 1	AHTS	Engines	3.33E-01	1.10E-02	9.88E-04	1.14E-02	8.03E-02	IAC Install	N/A
IAC_PLGR2	Pre Lay Grapnel Run AHTS 2	AHTS	Engines	3.33E-01	1.10E-02	9.88E-04	1.14E-02	8.03E-02	IAC Install	N/A
IAC_FPV	Post-Install Rock Protection	Fall Pipe Vessel	Engines	1.20E-01	4.07E-03	7.90E-04	4.19E-03	2.86E-02	IAC Install	N/A
Fuel Bunkering										
FB_Barge_AE_1	Barge	Barge	Auxiliary Engine	1.73E-02	4.26E-04	8.25E-06	4.40E-04	3.41E-03	Fuel Bunkering	N/A
FB_Tug_ME_1	Towing Tug	Tug	Main Engine	3.07E-01	1.03E-02	1.07E-03	1.07E-02	7.39E-02	Fuel Bunkering	N/A
FB_Tug_ME_2	Towing Tug	Tug	Main Engine	3.07E-01	1.03E-02	1.07E-03	1.07E-02	7.39E-02	Fuel Bunkering	N/A
FB_Tug_AE_1	Towing Tug	Tug	Auxiliary Engine	2.19E-02	6.73E-04	1.30E-05	6.95E-04	5.39E-03	Fuel Bunkering	N/A
FB_Tug_AE_2	Towing Tug	Tug	Auxiliary Engine	2.19E-02	6.73E-04	1.30E-05	6.95E-04	5.39E-03	Fuel Bunkering	N/A
FB_Tug_AE_3	Towing Tug	Tug	Auxiliary Engine	2.19E-02	6.73E-04	1.30E-05	6.95E-04	5.39E-03	Fuel Bunkering	N/A
FB_MC_1	Motion Compensation	Motion Compensation	Main Engine	1.28E-01	6.39E-03	2.17E-04	6.39E-03	1.12E-01	Fuel Bunkering	N/A

Source Group	Case	NOx Tons during worst-case construction year	SO2 Tons during worst-case construction year	Stack height	distance to Brigantine km	Representative Max Concentration for 1000 tpy NOx Precursor Source	Representative Max Concentration for 1000 tpy SO2 Precursor Source	Secondary PM2.5 ug/m3
WTG Install	NAAQS & Class II increment short-term	857	0.9	High	N/A	0.207	0.603	0.178
B02 Foundation Install	NAAQS & Class II increment short-term	418	0.8	High	N/A	0.207	0.603	0.087
Scour Protection	NAAQS & Class II increment short-term	107	0.7	Low	N/A	0.301	1.138	0.033
WTG Commissioning	NAAQS & Class II increment short-term	57	0.4	Low	N/A	0.301	1.138	0.018
OSS Install	NAAQS & Class II increment short-term	75	0.1	High	N/A	0.207	0.603	0.016
OSS Commissioning	NAAQS & Class II increment short-term	9	0.01	Low	N/A	0.301	1.138	0.003
Pre-Lay IAC	NAAQS & Class II increment short-term	56	0.4	Low	N/A	0.301	1.138	0.017
IAC Install	NAAQS & Class II increment short-term	112	0.8	Low	N/A	0.301	1.138	0.034
Fuel Bunkering	NAAQS & Class II increment short-term	31	0.1	Low	N/A	0.301	1.138	0.010
Annual Construction	NAAQS & Class II increment long-term	1721	4.1	High	N/A	0.009	0.018	0.015
WTG Install	Class I increment short-term	857	0.9	High	20	0.165	0.562	0.142
B02 Foundation Install	Class I increment short-term	418	0.8	High	20	0.165	0.562	0.069
Scour Protection	Class I increment short-term	107	0.7	Low	20	0.248	1.025	0.027
WTG Commissioning	Class I increment short-term	57	0.4	Low	20	0.248	1.025	0.015
OSS Install	Class I increment short-term	75	0.1	High	20	0.165	0.562	0.012
OSS Commissioning	Class I increment short-term	9	0.01	Low	20	0.248	1.025	0.002
Pre-Lay IAC	Class I increment short-term	56	0.4	Low	20	0.248	1.025	0.014
IAC Install	Class I increment short-term	112	0.8	Low	20	0.248	1.025	0.028
Fuel Bunkering	Class I increment short-term	31	0.1	Low	20	0.248	1.025	0.008
Annual Construction	Class I increment long-term	1721	4.1	High	40	0.005	0.010	0.009

MERPS View QLIK Data for Representative Source

State	County	Metric	Precursor	Emissions	Stack	MERP	MaxConc
Delaware	Kent Co	Annual PM2.5	NOx	1000	10	9647	0.0207
Delaware	Kent Co	Annual PM2.5	NOx	1000	90	22986	0.0087
Delaware	Kent Co	Annual PM2.5	SO2	1000	10	4748	0.0421
Delaware	Kent Co	Annual PM2.5	SO2	1000	90	11224	0.0178
Delaware	Kent Co	Daily PM2.5	NOx	1000	10	3990	0.3008
Delaware	Kent Co	Daily PM2.5	NOx	1000	90	5787	0.2074
Delaware	Kent Co	Daily PM2.5	SO2	1000	10	1055	1.1377
Delaware	Kent Co	Daily PM2.5	SO2	1000	90	1990	0.6030

State	County	Distance	Metric	Precursor	Emissions	Stack	Concentration
Delaware	Kent Co	10	Annual PM2.5	NOx	1000	10	0.0207
Delaware	Kent Co	10	Annual PM2.5	NOx	1000	90	0.0087
Delaware	Kent Co	10	Annual PM2.5	SO2	1000	10	0.0421
Delaware	Kent Co	10	Annual PM2.5	SO2	1000	90	0.0178
Delaware	Kent Co	10	Daily PM2.5	NOx	1000	10	0.3008
Delaware	Kent Co	10	Daily PM2.5	NOx	1000	90	0.2074
Delaware	Kent Co	10	Daily PM2.5	SO2	1000	10	1.1377
Delaware	Kent Co	10	Daily PM2.5	SO2	1000	90	0.6030
Delaware	Kent Co	20	Annual PM2.5	NOx	1000	10	0.0142
Delaware	Kent Co	20	Annual PM2.5	NOx	1000	90	0.0066
Delaware	Kent Co	20	Annual PM2.5	SO2	1000	10	0.0290
Delaware	Kent Co	20	Annual PM2.5	SO2	1000	90	0.0142
Delaware	Kent Co	20	Daily PM2.5	NOx	1000	10	0.2482
Delaware	Kent Co	20	Daily PM2.5	NOx	1000	90	0.1650
Delaware	Kent Co	20	Daily PM2.5	SO2	1000	10	1.0247
Delaware	Kent Co	20	Daily PM2.5	SO2	1000	90	0.5616
Delaware	Kent Co	40	Annual PM2.5	NOx	1000	10	0.0093
Delaware	Kent Co	40	Annual PM2.5	NOx	1000	90	0.0053
Delaware	Kent Co	40	Annual PM2.5	SO2	1000	10	0.0151
Delaware	Kent Co	40	Annual PM2.5	SO2	1000	90	0.0097
Delaware	Kent Co	40	Daily PM2.5	NOx	1000	10	0.2101
Delaware	Kent Co	40	Daily PM2.5	NOx	1000	90	0.1583
Delaware	Kent Co	40	Daily PM2.5	SO2	1000	10	0.6713
Delaware	Kent Co	40	Daily PM2.5	SO2	1000	90	0.5128
Delaware	Kent Co	60	Annual PM2.5	NOx	1000	10	0.0071
Delaware	Kent Co	60	Annual PM2.5	NOx	1000	90	0.0045
Delaware	Kent Co	60	Annual PM2.5	SO2	1000	10	0.0086
Delaware	Kent Co	60	Annual PM2.5	SO2	1000	90	0.0063
Delaware	Kent Co	60	Daily PM2.5	NOx	1000	10	0.1778
Delaware	Kent Co	60	Daily PM2.5	NOx	1000	90	0.1687
Delaware	Kent Co	60	Daily PM2.5	SO2	1000	10	0.4554
Delaware	Kent Co	60	Daily PM2.5	SO2	1000	90	0.3745
Delaware	Kent Co	80	Annual PM2.5	NOx	1000	10	0.0052
Delaware	Kent Co	80	Annual PM2.5	NOx	1000	90	0.0036
Delaware	Kent Co	80	Annual PM2.5	SO2	1000	10	0.0064
Delaware	Kent Co	80	Annual PM2.5	SO2	1000	90	0.0052
Delaware	Kent Co	80	Daily PM2.5	NOx	1000	10	0.1581
Delaware	Kent Co	80	Daily PM2.5	NOx	1000	90	0.1661
Delaware	Kent Co	80	Daily PM2.5	SO2	1000	10	0.3616
Delaware	Kent Co	80	Daily PM2.5	SO2	1000	90	0.3580
Delaware	Kent Co	100	Annual PM2.5	NOx	1000	10	0.0038
Delaware	Kent Co	100	Annual PM2.5	NOx	1000	90	0.0029
Delaware	Kent Co	100	Annual PM2.5	SO2	1000	10	0.0046
Delaware	Kent Co	100	Annual PM2.5	SO2	1000	90	0.0042
Delaware	Kent Co	100	Daily PM2.5	NOx	1000	10	0.0993
Delaware	Kent Co	100	Daily PM2.5	NOx	1000	90	0.1166
Delaware	Kent Co	100	Daily PM2.5	SO2	1000	10	0.2292
Delaware	Kent Co	100	Daily PM2.5	SO2	1000	90	0.2673

Identifier	Activity Type	Vessel	Engine	Activity	Source Type	Exhaust Temp (K)	Stack Height above ocean (m)	Exhaust Diameter (m)	Stack Velocity (m/s)	Vertical Velocity (m/s)	Stack Angle	Vessel Width (m)	Hours / Day	Peak Hour NOx (g/s)	Peak Hour PM2.5 (g/s)	Peak Hour SO2 (g/s)	Peak Hour PM10 (g/s)	Peak Hour CO (g/s)	Total Hours	Total Positions	hr / position	Nox Scaled g/s per position
WTG_IV_ME1_1	WTG Installation Vessel	Jackup Vessel	Main Engines 1	Maneuvering	Point	555	65	0.80	3.18	2.25	45	N/A	24	1.970	0.059	0.0026	0.061	0.45	12,410	200	62.05	0.014
WTG_IV_ME1_2	WTG Installation Vessel	Jackup Vessel	Main Engines 1	Maneuvering	Point	555	65	0.80	3.18	2.25	45	N/A	24	1.970	0.059	0.0026	0.061	0.45	12,410	200	62.05	0.014
WTG_IV_ME1_3	WTG Installation Vessel	Jackup Vessel	Main Engines 1	Maneuvering	Point	555	65	0.80	3.18	2.25	45	N/A	24	1.970	0.059	0.0026	0.061	0.45	12,410	200	62.05	0.014
WTG_IV_ME1_4	WTG Installation Vessel	Jackup Vessel	Main Engines 1	Maneuvering	Point	555	65	0.80	3.18	2.25	45	N/A	24	1.970	0.059	0.0026	0.061	0.45	12,410	200	62.05	0.014
WTG_IV_ME2_1	WTG Installation Vessel	Jackup Vessel	Main Engines 2	Maneuvering	Point	555	65	0.80	2.39	1.69	45	N/A	24	1.477	0.044	0.0019	0.046	0.34	12,410	200	62.05	0.010
WTG_IV_ME2_2	WTG Installation Vessel	Jackup Vessel	Main Engines 2	Maneuvering	Point	555	65	0.80	2.39	1.69	45	N/A	24	1.477	0.044	0.0019	0.046	0.34	12,410	200	62.05	0.010
WTG_IV_ME2_3	WTG Installation Vessel	Jackup Vessel	Main Engines 2	Maneuvering	Point	555	65	0.80	2.39	1.69	45	N/A	24	1.477	0.044	0.0019	0.046	0.34	12,410	200	62.05	0.010
WTG_IV_AE_1	WTG Installation Vessel	Jackup Vessel	Auxiliary Engines	Maneuvering	Point	555	65	0.80	6.02	4.26	45	N/A	24	3.656	0.098	0.0019	0.10	0.78	12,410	200	62.05	0.03
WTG_Feed1_ME_1	US Jack Up Feeder 1	Jackup Vessel	Main Engine	Maneuvering	Point	555	65	0.80	2.25	1.59	45	N/A	24	1.393	0.042	0.0018	0.043	0.32	11,447	200	57.23	0.009
WTG_Feed1_ME_2	US Jack Up Feeder 1	Jackup Vessel	Main Engine	Maneuvering	Point	555	65	0.80	2.25	1.59	45	N/A	24	1.393	0.042	0.0018	0.043	0.32	11,447	200	57.23	0.009
WTG_Feed1_AE_1	US Jack Up Feeder 1	Jackup Vessel	Auxiliary Engine	Maneuvering	Point	555	65	0.80	5.68	4.02	45	N/A	24	3.449	0.093	0.0018	0.096	0.74	11,447	200	57.23	0.023
WTG_CTV_ME_1	Crew Transfer Vessel	Crew Transfer Vessel	Engines	Maneuvering	Line Volume	N/A	6	N/A	N/A	N/A	N/A	10.00	24	1.128	0.0368	0.00073	0.0380	0.283	12,410	200	62.05	0.0080

Identifier	Activity Type	Vessel	Engine	Activity	Source Type	Exhaust Temp (K)	Stack Height above ocean (m)	Exhaust Diameter (m)	Stack Velocity (m/s)	Vertical Velocity (m/s)	Stack Angle	Vessel Width (m)	Hours / Day	Peak Hour NOx (g/s)	Peak Hour PM2.5 (g/s)	Peak Hour SO2 (g/s)	Peak Hour PM10 (g/s)	Peak Hour CO (g/s)	Total Hours	Total Positions	hr / position	Nox Scaled g/s per position
B02_HLV_ME1_1	Medium HLV	Heavy Lift Vessel	Main Engines 1	Maneuvering	Point	583	39	1.00	4.65	3.29	45	N/A	24	4.279	0.128	0.006	1.32E-01	0.98	7056	200	35.28	1.72E-02
B02_HLV_ME2_1	Medium HLV	Heavy Lift Vessel	Main Engines 2	Maneuvering	Point	555	45	0.65	6.55	4.63	45	N/A	24	2.675	0.080	0.003	8.27E-02	0.61	7056	200	35.28	1.08E-02
B02_HLV_AE_1	Medium HLV	Heavy Lift Vessel	Auxiliary Engine	Maneuvering	Point	709	38	0.30	6.36	4.49	45	N/A	24	1.994	0.054	0.0010	5.53E-02	0.43	7056	200	35.28	8.03E-03
B02_BCSV_ME_1	Bubble Curtain Support Vessel	Tug	Engines	Maneuvering	Point	625	13	0.86	26.04	18.41	45	N/A	24	2.925	0.098	0.010	1.01E-01	0.70	7056	200	35.28	1.18E-02
B02_Barge1_AE1	Barge 1	Barge	Engines	Maneuvering	Line Volume	N/A	3	N/A	N/A	N/A	N/A	35	24	0.075	0.0019	0.000036	1.91E-03	0.015	7056	200	35.28	3.02E-04
B02_Tug1_ME1	Towing Tug 1	Tug	Engines	Maneuvering	Line Volume	N/A	6	N/A	N/A	N/A	N/A	15	24	1.621	0.054	0.0048	5.54E-02	0.39	7056	200	35.28	6.53E-03
B02_CTV_ME1	Crew Transfer / PSO / Noise Monitoring Vessel	Crew Transfer Vessel	Engines	Maneuvering	Line Volume	N/A	6	N/A	N/A	N/A	N/A	10	24	0.598	0.019	0.00039	2.00E-02	0.149	7056	200	35.28	2.41E-03
B02_Compress1	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress2	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress3	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress4	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress5	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress6	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress7	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress8	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress9	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress10	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress11	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress12	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress13	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress14	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress15	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress16	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress17	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress18	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress19	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Compress20	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	6	0.15	99.48	99.48	Vertical	N/A	8	0.443	0.022	0.00075	2.22E-02	0.39	2352	200	11.76	5.95E-04
B02_Hammer1	Hydraulic Hammer Power	Hydraulic Hammer Engine	Hammer Engines	Maneuvering	Point	755	6	0.35	70.57	70.57	Vertical	N/A	8	3.184	0.100	0.0034	9.95E-02	1.74	2352	200	11.76	4.27E-03

Identifier	Activity Type	Vessel	Engine	Activity	Source Type	Exhaust Temp (K)	Stack Height above ocean (m)	Exhaust Diameter (m)	Stack Velocity (m/s)	Vertical Velocity (m/s)	Stack Angle	Vessel Width (m)	Hours / Day	Peak Hour NOx (g/s)	Peak Hour PM2.5 (g/s)	Peak Hour SO2 (g/s)	Peak Hour PM10 (g/s)	Peak Hour CO (g/s)	Total Hours	Total Positions	hr / position	Nox Scaled g/s per position	24-hr PM2.5 (g/s)
Scour_FPV_ME1_1	Fall Pipe Vessel	Fall Pipe Vessel	Engines	Maneuvering	Point	555	6.00	1.83	5.65	5.65	Vertical	N/A	24	15.82	0.535	0.104	0.551	3.75	2,208	200	11.04	0.0199	0.2459
Scour_Dredge_ME_1	Dredging	US Dredger	Main Engine	Maneuvering	Point	555	6.00	0.46	1.95	1.95	Vertical	N/A	24	0.342	0.012	0.0040	0.013	0.076	1,392	200	6.96	0.00027	0.00351
Scour_Dredge_ME_2	Dredging	US Dredger	Main Engine	Maneuvering	Point	555	6.00	0.46	1.95	1.95	Vertical	N/A	24	0.342	0.012	0.0040	0.013	0.076	1,392	200	6.96	0.00027	0.00351
Scour_Dredge_AE_1	Dredging	US Dredger	Auxiliary Engine	Maneuvering	Point	555	6.00	0.46	8.15	8.15	Vertical	N/A	24	1.46	0.046	0.00089	0.047	0.37	1,392	200	6.96	0.0012	0.0133

Identifier	Activity Type	Vessel	Engine	Activity	Source Type	Exhaust Temp (K)	Stack Height above ocean (m)	Exhaust Diameter (m)	Stack Velocity (m/s)	Vertical Velocity (m/s)	Stack Angle	Vessel Width (m)	Hours / Day	Peak Hour NOx (g/s)	Peak Hour PM2.5 (g/s)	Peak Hour SO2 (g/s)	Peak Hour PM10 (g/s)	Peak Hour CO (g/s)	Total Hours	Total Positions	hr / position	Nox Scaled g/s per position
WTG_SOV_ME_1	WTG Commissioning SOV	Service Operation Vessel	Main Engine	Maneuvering	Point	555	16.00	0.46	1.91	1.35	45	N/A	24	0.33	0.011	0.003	0.012	0.076	12,410	200	62.1	0.00233
WTG_SOV_ME_2	WTG Commissioning SOV	Service Operation Vessel	Main Engine	Maneuvering	Point	555	16.00	0.46	1.91	1.35	45	N/A	24	0.33	0.011	0.003	0.012	0.076	12,410	200	62.1	0.00233
WTG_SOV_ME_3	WTG Commissioning SOV	Service Operation Vessel	Main Engine	Maneuvering	Point	555	16.00	0.46	1.91	1.35	45	N/A	24	0.33	0.011	0.003	0.012	0.076	12,410	200	62.1	0.00233
WTG_SOV_ME_4	WTG Commissioning SOV	Service Operation Vessel	Main Engine	Maneuvering	Point	555	16.00	0.46	1.91	1.35	45	N/A	24	0.33	0.011	0.003	0.012	0.076	12,410	200	62.1	0.00233
WTG_SOV_AE_1	WTG Commissioning SOV	Service Operation Vessel	Auxiliary Engine	Maneuvering	Point	555	16.00	0.46	1.27	0.90	45	N/A	24	0.23	0.0072	0.0001	0.0074	0.0574	12,410	200	62.1	0.00162
WTG_Gen_1	WTG Commissioning Generator	WTG Commissioning Generator	Generator	Maneuvering	Point	658	6.00	0.15	21.97	21.97	Vertical	N/A	12	0.180	0.00388	0.00023	0.00400	0.17	6,205	200	31.0	0.000638

Identifier	Activity Type	Vessel	Engine	Activity	Source Type	Exhaust Temp (K)	Stack Height above ocean (m)	Exhaust Diameter (m)	Stack Velocity (m/s)	Vertical Velocity (m/s)	Stack Angle	Vessel Width (m)	Hours / Day	Peak Hour NOx (g/s)	Peak Hour PM2.5 (g/s)	Peak Hour SO2 (g/s)	Peak Hour PM10 (g/s)	Peak Hour CO (g/s)	Total Hours	Total Positions	hr / position	Nox Scaled g/s per position
OSS_HLV_ME_1	Large HLV	Heavy Lift Vessel	6 Main Engines	Maneuvering	Point	555	55.00	1.49	3.24	3.24	Vertical	N/A	24	6.99	0.21	0.01	0.22	1.60	432	4	108.0	0.0862
OSS_HLV_ME_7	Large HLV	Heavy Lift Vessel	5 Main 1 Aux Engine	Maneuvering	Point	555	55.00	1.49	7.66	7.66	Vertical	N/A	24	16.31	0.46	0.01	0.47	3.59	432	4	108.0	0.2010
OSS_BCSV_ME_1	Bubble Curtain Support Vessel	Tug	Main Engine	Maneuvering	Point	625	13.00	0.86	26.04	18.41	45	N/A	24	2.92	0.10	0.010	0.10	0.70	432	4	108.0	0.0361
OSS_Barge1_AE_1	Barge 1	Barge	Auxiliary Engine	Maneuvering	Line Volume	N/A	3.00	N/A	N/A	N/A	N/A	35	24	0.08	0.0019	0.000036	0.0019	0.01	480	4	120.0	0.0010
OSS_Barge2_AE_1	Barge 2	Barge	Auxiliary Engine	Maneuvering	Line Volume	N/A	3.00	N/A	N/A	N/A	N/A	35	24	0.08	0.0019	0.000036	0.0019	0.01	480	4	120.0	0.0010
OSS_Tug1_ME_1	Towing Tug 1	Tug	Main Engine	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	15	24	1.62	0.054	0.0048	0.055	0.39	480	4	120.0	0.0222
OSS_Tug2_ME_1	Towing Tug 2	Tug	Main Engine	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	15	24	1.62	0.054	0.0048	0.055	0.39	480	4	120.0	0.0222
OSS_CTV_ME_1	Crew Transfer	Crew Transfer Vessel	Main Engine	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	10	24	0.60	0.019	0.0004	0.020	0.15	1,344	4	336.0	0.0229
OSS_Compress_1	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_2	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_3	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_4	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_5	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_6	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_7	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_8	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_9	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_10	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_11	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_12	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_13	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_14	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_15	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_16	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_17	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_18	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_19	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Compress_20	Bubble Curtain Power	Air Compressor	Air Compressor	Maneuvering	Point	778	18.00	0.15	99.48	99.48	Vertical	N/A	10	0.44	0.022	0.00075	0.022	0.39	180	4	45.0	0.0023
OSS_Hammer_1	Hydraulic Hammer Power	Hydraulic Hammer Engine	Hammer Engine	Maneuvering	Point	755	6.00	0.35	70.57	70.57	Vertical	N/A	10	3.18	0.100	0.0034	0.100	1.74	180	4	45.0	0.0164

Identifier	Activity Type	Vessel	Engine	Activity	Source Type	Exhaust Temp (K)	Stack Height above ocean (m)	Exhaust Diameter (m)	Stack Velocity (m/s)	Vertical Velocity (m/s)	Stack Angle	Vessel Width (m)	Hours / Day	Peak Hour NOx (g/s)	Peak Hour PM2.5 (g/s)	Peak Hour SO2 (g/s)	Peak Hour PM10 (g/s)	Peak Hour CO (g/s)	Total Hours	Total Positions	hr / position	Nox Scaled g/s per position
OSS_Gen_1	OSS Commissioning Generator	OSS Commissioning Generator	Generator	Maneuvering	Point	755	6.00	0.20	29.55	29.55	Vertical	N/A	12	0.403	0.0067	0.00047	0.0069	0.35	672	4	168.0	0.007725
OSS_Gen_2	OSS Commissioning Generator	OSS Commissioning Generator	Generator	Maneuvering	Point	755	6.00	0.20	29.55	29.55	Vertical	N/A	12	0.403	0.0067	0.00047	0.0069	0.35	672	4	168.0	0.007725
OSS_Gen_3	OSS Commissioning Generator	OSS Commissioning Generator	Generator	Maneuvering	Point	755	6.00	0.20	29.55	29.55	Vertical	N/A	12	0.403	0.0067	0.00047	0.0069	0.35	672	4	168.0	0.007725
OSS_Gen_4	OSS Commissioning Generator	OSS Commissioning Generator	Generator	Maneuvering	Point	755	6.00	0.20	29.55	29.55	Vertical	N/A	12	0.403	0.0067	0.00047	0.0069	0.35	672	4	168.0	0.007725
OSS_Gen_5	OSS Commissioning Generator	OSS Commissioning Generator	Generator	Maneuvering	Point	755	6.00	0.20	29.55	29.55	Vertical	N/A	12	0.403	0.0067	0.00047	0.0069	0.35	672	4	168.0	0.007725
OSS_Gen_6	OSS Commissioning Generator	OSS Commissioning Generator	Generator	Maneuvering	Point	755	6.00	0.20	29.55	29.55	Vertical	N/A	12	0.403	0.0067	0.00047	0.0069	0.35	672	4	168.0	0.007725
OSS_Gen_7	OSS Commissioning Generator	OSS Commissioning Generator	Generator	Maneuvering	Point	755	6.00	0.20	29.55	29.55	Vertical	N/A	12	0.403	0.0067	0.00047	0.0069	0.35	672	4	168.0	0.007725
OSS_Gen_8	OSS Commissioning Generator	OSS Commissioning Generator	Generator	Maneuvering	Point	755	6.00	0.20	29.55	29.55	Vertical	N/A	12	0.403	0.0067	0.00047	0.0069	0.35	672	4	168.0	0.007725

Identifier	Activity Type	Vessel	Group	Activity	Source Type	Exhaust Temp (K)	Stack Height above ocean (m)	Exhaust Diameter (m)	Stack Velocity (m/s)	Vertical Velocity (m/s)	Stack Angle	Vessel Width (m)	Hours / Day	Peak Hour NOx (g/s)	Peak Hour PM2.5 (g/s)	Peak Hour SO2 (g/s)	Peak Hour PM10 (g/s)	Peak Hour CO (g/s)	Total Hours	Total Positions	hr / position	Nox Scaled g/s per position	24-hr PM2.5 (g/s)
IAC_CIV_ME_1	Cable Installation Vessel	Cable Installation Vessel	IAC Install	Maneuvering	Point	555	43.00	1.50	2.06	1.46	45	N/A	24	3.84	0.133	0.034	0.138	0.89	5,280	200	26.4	0.0116	0.13
IAC_CIV_AE_1	Cable Installation Vessel	Cable Installation Vessel	IAC Install	Maneuvering	Point	555	43.00	0.20	7.30	5.16	45	N/A	24	0.26	0.008	0.0002	0.008	0.07	5,280	200	26.4	0.0008	0.01
IAC_Support	Cable Installation Support Activities	Support Vessel/SOV	IAC Install	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	16.00	24	1.55	0.05	0.01	0.05	0.363	3,307	200	16.5	0.00292	0.037
IAC_THSD	Sand Wave Clearance	TSHD (Dredger)	IAC Pre-Lay	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	41.00	24	2.15	0.07	0.01	0.07	0.520	3,453	200	17.3	0.00423	0.051
IAC_PLGR1	Pre Lay Grapnel Run AHTS 1	AHTS	IAC Pre-Lay	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	16.80	24	5.75	0.19	0.02	0.20	1.39	507	200	2.5	0.00166	0.020
IAC_PLGR2	Pre Lay Grapnel Run AHTS 2	AHTS	IAC Pre-Lay	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	16.80	24	5.75	0.19	0.02	0.20	1.39	507	200	2.5	0.00166	0.020
IAC_FPV	Post-Install Rock Protection	Fall Pipe Vessel	IAC Install	Maneuvering	Line Volume	N/A	6.00	N/A	N/A	N/A	N/A	40.00	24	15.82	0.53	0.10	0.55	3.75	67	200	0.3	0.000602	0.0074

Identifier	Activity Type	Vessel	Engine	Activity	Source Type	Exhaust Temp (K)	Stack Height above ocean (m)	Exhaust Diameter (m)	Stack Velocity (m/s)	Vertical Velocity (m/s)	Stack Angle	Vessel Width (m)	Hours / Day	Peak Hour NOx (g/s)	Peak Hour PM2.5 (g/s)	Peak Hour SO2 (g/s)	Peak Hour PM10 (g/s)	Peak Hour CO (g/s)	Total Hours	Total Positions	hr / position	Nox Scaled g/s per position
FB_Barge_AE_1	Barge	Barge	Auxiliary Engine	Maneuvering	Point	698	3.00	0.15	3.71	3.71	Vertical	N/A	24	0.075	0.0019	0.000036	0.0019	0.015	4,032	200	20.2	0.00017
FB_Tug_ME_1	Towing Tug	Tug	Main Engine	Maneuvering	Point	733	6.00	0.61	5.72	4.05	45	N/A	24	1.34	0.045	0.0046	0.046	0.32	4,032	200	20.2	0.0031
FB_Tug_ME_2	Towing Tug	Tug	Main Engine	Maneuvering	Point	733	6.00	0.61	5.72	4.05	45	N/A	24	1.34	0.045	0.0046	0.046	0.32	4,032	200	20.2	0.0031
FB_Tug_AE_1	Towing Tug	Tug	Auxiliary Engine	Maneuvering	Point	698	6.00	0.20	3.30	2.33	45	N/A	24	0.095	0.0029	0.000057	0.0030	0.023	4,032	200	20.2	0.00022
FB_Tug_AE_2	Towing Tug	Tug	Auxiliary Engine	Maneuvering	Point	698	6.00	0.20	3.30	2.33	45	N/A	24	0.095	0.0029	0.000057	0.0030	0.023	4,032	200	20.2	0.00022
FB_Tug_AE_3	Towing Tug	Tug	Auxiliary Engine	Maneuvering	Point	698	6.00	0.20	3.30	2.33	45	N/A	24	0.095	0.0029	0.000057	0.0030	0.023	4,032	200	20.2	0.00022
FB_MC_1	Motion Compensation	Motion Compensation	Main Engine	Maneuvering	Point	755	3.00	0.20	59.10	59.10	Vertical	N/A	24	0.56	0.028	0.00094	0.028	0.49	4,032	200	20.2	0.0013

NAAQS Significant Impact Level Results (µg/m^3) for Construction								
Poll.	Averaging Time	Form	Max Modeled Conc. (µg/m^3)	SIL (µg/m^3)	% of SIL	Period	Receptor Location (m)	Significant Impact Area (km)
WTG Install								
CO	1-hour	H	199.1	2000	10%	11/27/20 Hr: 15	570034.89, 4357592.26, 0.00	N/A
	8-Hour	H	87.1	500	17%	8/19/20 Hr: 24	569802.60, 4357489.30, 0.00	N/A
NO_2	1-Hour	H	4.41	7.5	59%	2018-2020	570034.89, 4357592.26, 0.00	N/A
PM2.5	24-Hour	H	8.0	1.2	666%	10/19/20 Hr: 24	569173.99, 4358241.19, 0.00	4.89
PM10	24-Hour	H	8.3	5	165%	10/19/20 Hr: 24	569173.99, 4358241.19, 0.00	1.025
B02								
CO	1-hour	H	1400.3	2000	70%	6/4/20 Hr: 06	570243.04, 4357818.76, 0.00	N/A
	8-Hour	H	492.5	500	98%	6/4/20 Hr: 08	570267.81, 4357824.26, 0.00	N/A
NO_2	1-Hour	H	2.3	7.5	31%	2018-2020	570192.81, 4357674.26, 0.00	N/A
PM2.5	24-Hour	H	8.2	1.2	682%	12/8/20 Hr: 24	570086.92, 4357635.61, 0.00	5.75
PM10	24-Hour	H	8.8	5	177%	7/24/18 Hr: 24	569462.87, 4358553.50, 0.00	1.125
Scour Protection								
CO	1-hour	H	711.7	2000	36%	5/23/18 Hr: 16	569181.22, 4358285.44, 0.00	N/A
	8-Hour	H	191.4	500	38%	6/4/20 Hr: 8	570252.38, 4357901.14, 0.00	N/A
NO_2	1-Hour	H	1.81	7.5	24%	2018-2020	569753.83, 4357488.39, 0.00	N/A
PM2.5	24-Hour	H	5.3	1.2	438%	4/13/19 Hr: 24	569171.28, 4357989.65, 0.00	2.25
PM10	24-Hour	H	13.3	5	265%	8/30/18 Hr: 24	570045.86, 4358561.66, 0.00	1.32
OSS Install								
CO	1-hour	H	1332.9	2000	67%	5/8/19 Hr: 3	573519.25, 4349317.00, 0.00	N/A
	8-Hour	H	620.8	500	124%	6/28/19 Hr:08	573444.25, 4349542.00, 0.00	0.83
NO_2	1-Hour	H	28.9	7.5	386%	2018-2020	572894.25, 4348592.00, 0.00	7.923
PM2.5	24-Hour	H	10.3	1.2	855%	6/5/19 Hr: 24	573319.25, 4349692.00, 0.00	5.7
PM10	24-Hour	H	10.41	5	2.083	6/5/19 Hr: 24	573319.25, 4349692.00, 0.00	1.82
Pre-Lay IAC								
CO	1-hour	H	3850.3	2000	193%	5/23/18 Hr: 17	569257.60, 4358222.68, 0.00	2.43
	8-Hour	H	628.3	500	126%	2/24/18 Hr: 16	570794.96, 4358764.93, 0.00	1.55
NO_2	1-Hour	H	4.27	7.5	57%	2018-2020	569218.80, 4358157.35, 0.00	N/A
PM2.5	24-Hour	H	8.45	1.2	704%	8/30/18 Hr: 24	570794.96, 4358764.93, 0.00	4.74
PM10	24-Hour	H	8.7	5	174%	8/30/18 Hr: 24	570794.96, 4358764.93, 0.00	1.43
IAC Install								
CO	1-hour	H	7356.8	2000	368%	5/23/18 Hr: 17	569214.03, 4358133.91, 0.00	2.53
	8-Hour	H	964.3	500	193%	6/17/19 Hr: 16	571476.22, 4358304.15, 0.00	1.5
NO_2	1-Hour	H	162.3	7.5	2164%	2018-2020	569289.63, 4357802.82, 0.00	31.5
PM2.5	24-Hour	H	5.44	1.2	453%	5/16/18 Hr: 24	569214.03, 4358133.91, 0.00	3.5
PM10	24-Hour	H	5.55	5	111%	5/16/18 Hr: 24	569214.03, 4358133.91, 0.00	1.24
Annual B02								
NO_2	Annual	H	13.8	1	1382%	2019	577276.40, 4342459.96, 0.00	14
PM2.5	Annual	H	0.36	0.2	180%	2018-2020	577278.05, 4342444.26, 0.00	0.042
PM10	Annual	H	0.51	1	51%	2019	577284.05, 4342450.9, 0.00	N/A

PSD Class II Significant Impact Level Results (µg/m^3) for Construction								
Poll.	Averaging Time	Form	Max Modeled Conc. (µg/m^3)	SIL (µg/m^3)	% of SIL	Period	Receptor Location (m)	Significant Impact Area (km)
WTG Install								
PM2.5	24-Hour	H	8.0	1.2	666%	10/19/20 Hr: 24	569173.99, 4358241.19, 0.00	4.89
PM10	24-Hour	H	8.3	5	165%	10/19/20 Hr: 24	569173.99, 4358241.19, 0.00	1.03
B02								
PM2.5	24-Hour	H	8.2	1.2	682%	12/8/20 Hr: 24	570086.92, 4357635.61, 0.00	5.75
PM10	24-Hour	H	8.82793	5	177%	7/24/18 Hr: 24	569462.87, 4358553.50, 0.00	1.125
Scour Protection								
PM2.5	24-Hour	H	5.3	1.2	438%	4/13/19 Hr: 24	569171.28, 4357989.65, 0.00	2.25
PM10	24-Hour	H	13.3	5	265%	8/30/18 Hr: 24	570045.86, 4358561.66, 0.00	1.32
OSS Install								
PM2.5	24-Hour	H	10.3	1.2	855%	6/5/19 Hr: 24	573319.25, 4349692.00, 0.00	5.7
PM10	24-Hour	H	8.7	5	174%	6/5/19 Hr: 24	573319.25, 4349692.00, 0.00	1.82
Pre-Lay IAC								
PM2.5	24-Hour	H	8.45	1.2	704%	8/30/18 Hr: 24	570794.96, 4358764.93, 0.00	4.74
PM10	24-Hour	H	8.72	5	174%	8/30/18 Hr: 24	570794.96, 4358764.93, 0.00	1.43
IAC Install								
PM2.5	24-Hour	H	5.44	1.2	453%	5/16/18 Hr: 24	569214.03, 4358133.91, 0.00	3.5
PM10	24-Hour	H	5.55	5	111%	5/16/18 Hr: 24	569214.03, 4358133.91, 0.00	1.24
Annual B02								
NO_2	Annual	H	13.8	1	1382%	2019	577276.40, 4342459.96, 0.00	14
PM2.5	Annual	H	0.36	0.2	180%	2018-2020	577278.05, 4342444.26, 0.00	0.042
PM10	Annual	H	0.51	1	51%	2019	577284.05, 4342450.9, 0.00	N/A

PSD Class II Increment Results (µg/m^3) for Construction									
Poll.	Averaging Time	Form	Max Modeled Conc. (µg/m^3)	Secondary Impact (µg/m3)	Total Concentration (µg/m3)	PSD Class II Increment (µg/m^3)	% of Increment	Period	Receptor Location (m)
WTG Install									
PM2.5	24-Hour	H2H	5.7	0.178	5.9	9	65.2%	5/30/18 Hr: 24	569177.60, 4358263.31, 0.00
PM10	24-Hour	H2H	5.9	N/A	5.9	30	19.6%	5/30/18 Hr: 24	569177.60, 4358263.31, 0.00
B02									
PM2.5	24-Hour	H2H	7.03	0.087	7.11	9	79%	1/25/18 Hr: 24	570086.92, 4357635.61, 0.00
PM10	24-Hour	H2H	7.64	N/A	7.64	30	25%	7/24/18 Hr: 24	569481.72, 4358566.87, 0.00
Scour Protection									
PM2.5	24-Hour	H2H	4.4	0.033	4.5	9	50%	4/13/19 Hr: 24	570027.12, 4358591.69, 0.00
PM10	24-Hour	H2H	11.6	N/A	11.6	30	39%	4/4/19 Hr: 24	570029.00, 4358576.41, 0.00
OSS Install									
PM2.5	24-Hour	H2H	8.72	0.016	8.73	9	97%	6/5/19 Hr: 24	573319.25, 4349692.00, 0.00
PM10	24-Hour	H2H	8.86	N/A	8.86	30	30%	2/1/18 Hr: 24	573344.25, 4349692.00, 0.00
Pre-Lay IAC									
PM2.5	24-Hour	H2H	6.35	0.017	6.37	9	71%	9/4/2018 Hr: 24	570415.59, 4358770.89, 0.00
PM10	24-Hour	H2H	6.55	N/A	6.55	30	22%	9/4/2018 Hr: 24	570415.59, 4358770.89, 0.00
IAC Install									
PM2.5	24-Hour	H2H	4.02	0.03	4.06	9	45%	5/26/20 Hr: 24	569213.43, 4358059.21, 0.00
PM10	24-Hour	H2H	4.10	N/A	4.10	30	14%	5/26/20 Hr: 24	569213.43, 4358059.21, 0.00
Annual B02									
NO_2	Annual	H	13.82	N/A	13.82	25	55%	2019	577299.21, 434244078, 0.00
PM2.5	Annual	H	0.36	0.015	0.38	4	9%	2018-2020	577278.05, 4342444.26, 0.00

Class I Significant Impact Level Results (µg/m^3) for Construction							
Poll.	**Averaging Time**	**Form**	**Max Modeled Conc. (µg/m^3)**	**SIL (µg/m^3)**	**% of SIL**	**Period**	**Receptor Location (m)**
WTG Install							
PM2.5	24-Hour	H	0.21	0.27	78%	10/9/18 Hr: 24	560540.23, 4372963.59, 1.25
PM10	24-Hour	H	0.22	0.3	73%	10/9/18 Hr: 24	560540.23, 4372963.59, 1.25
B02							
PM2.5	24-Hour	H	0.42	0.27	154%	5/31/18 Hr: 24	562667.15, 4375755.26, 0.71
PM10	24-Hour	H	0.42	0.3	141%	5/31/18 Hr: 24	562667.15, 4375755.26, 0.71
Scour Protection							
PM2.5	24-Hour	H	0.14	0.27	51%	5/31/18 Hr: 24	562667.15, 4375755.26, 0.71
PM10	24-Hour	H	0.34	0.3	114%	5/31/18 Hr: 24	562667.15, 4375755.26, 0.71
OSS Install							
PM2.5	24-Hour	H	0.26	0.27	96%	9/5/18 Hr: 24	557708.83, 4368317.47, 0.23
PM10	24-Hour	H	0.26	0.3	88%	9/5/18 Hr: 24	557708.83, 4368317.47, 0.23
Pre-Lay IAC							
PM2.5	24-Hour	H	0.19	0.27	69%	5/23/20 Hr: 24	557715.71, 4367392.63, 1.29
	24-Hour	H	0.19	0.3	64%	5/23/20 Hr: 24	557715.71, 4367392.63, 1.29
IAC Install							
PM2.5	24-Hour	H	0.097	0.27	36%	9/5/18 Hr: 24	559128.49, 4370177.97, -0.96
PM10	24-Hour	H	0.10	0.3	33%	9/5/18 Hr: 24	559128.49, 4370177.97, -0.96
B02 Annual Construction							
NO_2	Annual	H	0.26	0.1	264%	2018	562667.15, 4375755.26, 0.71
PM2.5	Annual	H	0.0076	0.05	15%	2018-2020	562667.15, 4375755.26, 0.71
PM10	Annual	H	0.0091	0.2	5%	2018	562667.15, 4375755.26, 0.71

Class I Increment Results (µg/m^3) for Construction									
Poll.	Averaging Time	Form	Max Modeled Conc. (µg/m^3)	Secondary Impact (µg/m3)	Total Concentration (µg/m3)	PSD Class I Increment (µg/m^3)	% of Increment	Period	Receptor Location (m)
B02									
PM2.5	24-Hour	H2H	0.25	0.069	0.32	2	16%	9/5/18 Hr: 24	558397.83, 4372022.23, 0.76
PM10	24-Hour	H2H	0.25	N/A	0.25	8	3%	9/5/18 Hr: 24	558397.83, 4372022.23, 0.76
Scour Protection									
PM10	24-Hour	H2H	0.21	N/A	0.21	8	3%	4/6/19 Hr: 24	558397.8, 4372022.2, 0.76
B02 Annual Construction									
NO_2	Annual	H	0.26	N/A	0.26	2.5	11%	2018	562667.15, 4375755.26, 0.71

NAAQS Results (µg/m^3) for Construction										
Poll.	Averaging Time	Form	Max Modeled Conc. (µg/m^3)	Background (µg/m3)	Secondary Impact (µg/m3)	Total Conc. (µg/m^3)	NAAQS (µg/m^3)	% of NAAQS	Period	Receptor Location (m)
WTG Install										
PM2.5	24-Hour	H8H	3.2	14.0	0.178	17.3	35	9%	2018-2020	569991.19, 4358601.28, 0.00
PM10	24-Hour	H4H	4.7	38	N/A	42.7	150	3%	9/2/18 Hr: 24	569317.78, 4358531.55, 0.00
B02										
PM2.5	24-Hour	H8H	4.7	14.0	0.087	18.8	35	54%	2018-2020	570150.14, 4358451.72, 0.00
PM10	24-Hour	H4H	6.1	38	N/A	44.1	150	29%	7/18/19 Hr: 24	570172.14, 4358428.67, 0.00
Scour Protection										
PM2.5	24-Hour	H8H	3.2	14.0	0.033	17.2	35	49%	2018-2020	570029.00, 4358576.41, 0.00
PM10	24-Hour	H4H	10.7	38	N/A	48.7	150	32%	4/13/19 Hr: 24	570012.14, 4358591.16, 0.00
OSS Install										
CO	8-Hour	H2H	500.1	2635.8	N/A	3135.9	10000	31%	8/29/18 Hr: 8	573469.25, 4349492.00, 0.00
NO_2	1-Hour	H8H	18.4	63.4	N/A	81.8	188	44%	2018-2020	573069.25, 4349892.00, 0.00
PM2.5	24-Hour	H8H	7.53	14.0	0.016	21.5	35	62%	2018-2020	537227.12, 43449591.69, 0.00
PM10	24-Hour	H4H	8.43	38	N/A	46.4	150	31%	9/11/19 Hr: 24	573344.25, 4349692.00, 0.00
Pre-Lay IAC										
CO	1-hour	H2H	2249.1	2865	N/A	5114.1	40000	13%	5/23/18 Hr: 16	570224.91, 4357626.81, 0.00
	8-Hour	H2H	471.0	2635.8	N/A	3106.8	10000	31%	2/24/18 Hr: 16	570794.96, 4358764.93, 0.00
PM2.5	24-Hour	H8H	2.92	14.0	0.017	16.9	35	48%	2018-2020	570794.96, 4358764.93, 0.00
PM10	24-Hour	H4H	5.13	38	N/A	43.1	150	29%	5/23/20 Hr: 24	570246.75, 4358745.07, 0.00
IAC Install										
CO	1-hour	H2H	4270.7	2865	N/A	7135.7	40000	18%	5/23/18 Hr: 14	571450.43, 4358349.80, 0.00
	8-Hour	H2H	779.7	2635.8	N/A	3415.5	10000	34%	5/26/20 Hr: 16	569253.10, 4357867.93, 0.00
NO_2	1-Hour	H8H	124.2	63.4	N/A	187.6	188	99.8%	2018-2020	569889.23, 4358623.91, 0.00
PM2.5	24-Hour	H8H	2.00	14.0	0.034	16.0	35	46%	2018-2020	570741.33, 4358788.77, 0.00
PM10	24-Hour	H4H	3.73	38	N/A	41.7	150	28%	9/11/18 Hr: 24	570336.14, 4358729.18, 0.00
Annual B02 Case										
NO_2	Annual	H	13.82	11.87	N/A	25.69	100	26%	2019	577276.40, 4342459.96, 0.00
PM2.5	Annual	H	0.36	5.66	0.015	6.04	12	50%	2018-2020	577278.05, 4342444.26, 0.00

Appendix E

WRF Performance Evaluation

Exponent®

WRF Performance Evaluation for Atlantic Shores Offshore Wind

WRF Performance Evaluation for Atlantic Shores Offshore Wind

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August 2022

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Acronyms and Abbreviations

BART	Best Available Retrofit Technology
DAT	deposition analysis threshold
FLAG	Federal Land Managers' Air Quality Related Values Work Group
FLM	Federal Land Managers
IOA	Index of Agreement
ISD	Integrated Surface Database
K	Kelvin
kg	kilogram
km	kilometers
LCC	Lambert Conformal Conic
m	meters
m/s	meters per second
MMIF	Mesoscale Model Interface Program
NO_x	Nitrogen oxides
NO_2	Nitrogen dioxide
NPS	National Park Service
NWR	National Wildlife Refuge
RMSE	Root Mean Square Error
UTM	Universal Transverse Mercator
U.S. EPA	U.S. Environmental Protection Agency
WRF	Weather Research and Forecast Model

WRF Performance Evaluation

Performance Criteria

CALPUFF is a three-dimensional air dispersion model that requires representative meteorological data for grid points across the modeling domain. Twelve-km resolution WRF prognostic model simulations produced by EPA were provided by FLM after being converted to CALMET format using the MMIF processor. To evaluate this prognostic meteorological data set, modeled meteorological fields have been compared with observed data collected at stations within the modeling domain and farther north, covering the broader Northeast region. This evaluation uses measures of statistical agreement between observations and model-simulated values based on the approach of Willmont (1981) and the benchmarks developed by Emery et al. (2001) and Tesche et al. (2001) for their mesoscale modeling studies, consistent with the metrics and benchmarks included in the MMIFStat program and described in the accompanying User Guide (McNally 2010).

Four statistical measures were computed: Index of Agreement (IOA), Mean Bias, Root Mean Square Error (RMSE), and Gross Error. IOA is computed using the equations from the study of Willmont (1981):

$$IOA = 1 - \left[\frac{IJ.RMSE^2}{\sum_{j=1}^{J} \sum_{i=1}^{I} \left| P_j^i - M_o \right| + \left| O_j^i - M_o \right|} \right] \tag{1}$$

where RMSE is calculated using the equation

$$RMSE = \left[\frac{i}{IJ} \sum_{j=1}^{J} \sum_{i=1}^{I} (P_j^i - O_j^i)^2 \right]^{1/2} \tag{2}$$

P_j^i and O_j^i are the prediction and the observation at Station *j* and time *i*. M_o is the Mean Observation and equal to

$$M_o = \frac{1}{IJ}\sum_{j=1}^{J}\sum_{i=1}^{I} O_j^i \tag{3}$$

The other two qualities used in the evaluation are Mean Bias (B) and Gross Error (E). Mean Bias is calculated using:

$$B = \frac{1}{IJ}\sum_{j=1}^{J}\sum_{i=1}^{I}\left(P_j^i - O_j^i\right) \tag{4}$$

Gross Error equals to:

$$E = \frac{1}{IJ}\sum_{j=1}^{J}\sum_{i=1}^{I}\left|P_j^i - O_j^i\right| \tag{5}$$

Benchmarks using these statistical measures have been developed by Emery et al. (2001) and Tesche et al. (2001) for meteorological parameters including wind speed, wind direction, temperature and specific humidity. The benchmark values were developed based on an analysis of a collection of prognostic meteorological model runs available at the time. They are intended to represent typical performance for prognostic modeling simulations and serve as guidelines for good model performance. The benchmarks should not be considered as strict pass/fail criteria and serve as part of a holistic evaluation of model performance.

The evaluation analysis also compares wind roses and meteorological time series to assess time-matched model performance and reproducibility of diurnal and seasonal cycles.

Additional visual representations are made using “soccer” plots which use two performance metrics as x-axis and y-axis values. For example, wind direction bias presented on the x-axis versus wind direction error presented on the y-axis. The performance benchmarks are framing the “soccer” field as a simple way of visualizing the comparison of these two metrices for each individual station.

Observed Meteorological Data

For this evaluation, surface meteorological observations have been taken from the Integrated Surface Database (ISD) (https://www.ncdc.noaa.gov/isd). This database includes hourly observations for approximately 3,000 active stations across the United States. Stations within the modeling domain and broader Northeast region were identified from the ISD dataset and used in the evaluation. All stations within the broader Northeast region and with a 10-meter anemometer height were selected in order to allow for a direct comparison between the observations and the meteorological data included in the first layer of the MMIF generated CALMET data files. Additionally, stations located near the project site and identified by FLM/EPA were included. This resulted in a total of 56 surface stations. The stations have further been divided into two categories, coastal and inland, where coastal stations are those sites located within 15 km of the coastline. The stations included in the analysis are summarized in Table 1 (Inland) and Table 2 (Coastal) and shown in Figure 1.

To further evaluate WRF model performance at overwater locations, nine stations have been extracted from the National Data Buoy Center archive (www.ndbc.noaa.gov). These stations are summarized in Table 3 and are also shown in Figure 1. Because overwater data are not routinely collected at 10 meters, the wind data needed to be profiled to 10-meter height for comparison with the 10-meter modeled layer. Wind speed will be vertically profiled up or down using a log-based boundary layer profile with a wind speed-dependent calculation of roughness length as described by Hosker (1974). Since the roughness length calculation itself requires a measurement of 10-meter wind speed, an iterative approach was used.

Table 1. Inland Surface Stations for the Statistical Analysis

USAF	WBAN	STATION NAME	STATE	ICAO	LAT	LON	ELEV(M)
722247	54785	Somerset Airport	NJ	KSMQ	40.624	-74.669	32
724074	93780	South Jersey Regional Arpt	NJ	KVAY	39.941	-74.841	14.9
724075	13735	Millville Municipal Arpt	NJ	KMIV	39.366	-75.078	18.3
724077	54779	Aeroflex-Andover Airport	NJ	K12N	41.009	-74.736	176.8
725015	4789	Orange County Airport	NY	KMGJ	41.509	-74.265	111.3
725027	54788	Meriden Markham Muni Arpt	CT	KMMK	41.51	-72.828	31.4
725029	64707	Waterbury-Oxford Airport	CT	KOXC	41.483	-73.133	221.3
725059	14702	Laurence G Hanscom Fld Apt	MA	KBED	42.47	-71.289	40.5
725068	54777	Taunton Municipal Airport	MA	KTAN	41.876	-71.021	13.1
725075	54768	Harriman-and-West Airport	MA	KAQW	42.697	-73.17	195.1
725080	14740	Bradley International Airport	CT	KBDL	41.938	-72.682	53.3
725085	54756	Orange Municipal Airport	MA	KORE	42.57	-72.291	169.2
725087	14752	Hartford-Brainard Airport	CT	KHFD	41.736	-72.651	5.8
725100	94746	Worcester Regional Airport	MA	KORH	42.271	-71.873	304.8
725107	4780	Fitchburg Municipal Arp	MA	KFIT	42.552	-71.756	106.1
725145	54746	Sullivan County Intl Arpt	NY	KMSV	41.701	-74.795	427.6
725165	94737	Rutland State Airport	VT	KRUT	43.533	-72.95	239
725180	14735	Albany International Airport	NY	KALB	42.747	-73.799	85.3
725220	14750	Floyd Bennett Memo Airport	NY	KGFL	43.338	-73.61	97.8
726116	94765	Lebanon Municipal Airport	NH	KLEB	43.626	-72.305	182.3
726140	54742	St. Johnsbury(Amos)	VT	K1V4	44.42	-72.019	212.4
726155	54736	Laconia Municipal Airport	NH	KLCI	43.567	-71.433	166.1
726160	94700	Berlin Municipal Airport	NH	KBML	44.576	-71.179	353
726163	54770	Jaffrey Mini-Slvr Rnch Apt	NH	KAFN	42.805	-72.004	317
726166	54781	W. H. Morse State Airport	VT	KDDH	42.891	-73.247	251.8
726183	54772	Eastern Slopes Rgnl Arpt	ME	KIZG	43.991	-70.948	135.6
726184	94709	Auburn/Lewiston Muni Arpt	ME	KLEW	44.05	-70.283	87.8
740001	54793	Sussex Airport	NJ	KFWN	41.199	-74.626	125
743945	14710	Manchester Airport	NH	KMHT	42.933	-71.436	67.4
744104	14763	Pittsfield Municipal Arpt	MA	KPSF	42.427	-73.289	363.9
744904	94723	Lawrence Municipal Airport	MA	KLWM	42.717	-71.124	45.4
744915	14775	Barnes Municipal Airport	MA	KBAF	42.158	-72.716	82.6
724095	14792	Trenton Mercer Airport	NJ	KTTN	40.277	-74.816	57.9
724094	54743	Essex County Airport	NJ	KCDW	40.876	-74.283	52.7
724093	13764	Sussex County Airport	DE	KGED	38.69	-75.363	14
724180	13781	New Castle County Airport	DE	KILG	39.674	-75.606	24.1
724085	94732	Ne Philadelphia Airport	PA	KPNE	40.079	-75.013	32

Table 2. Coastal Surface Stations for the Statistical Analysis

USAF	WBAN	STATION NAME	STATE	ICAO	LAT	LON	ELEV(M)
725016	54790	Brookhaven Airport	NY	KHWV	40.822	-72.869	25
725020	14734	Newark Liberty International Ap	NJ	KEWR	40.683	-74.169	2.1
725030	14732	La Guardia Airport	NY	KLGA	40.779	-73.88	3.4
725037	94745	Westchester County Airport	NY	KHPN	41.067	-73.708	115.5
725046	14707	Groton-New London Airport	CT	KGON	41.328	-72.049	3.1
725058	94793	Block Island State Airport	RI	KBID	41.168	-71.578	32
725060	14756	Nantucket Memorial Airport	MA	KACK	41.253	-70.061	14.6
725064	54769	Plymouth Municipal Airport	MA	KPYM	41.91	-70.729	45.4
725066	94724	Martha's Vineyard Airport	MA	KMVY	41.393	-70.615	20.7
725069	94624	Chatham Municipal Airport	MA	KCQX	41.688	-69.993	20.7
725070	14765	Theodore F Green State Airport	RI	KPVD	41.723	-71.433	16.8
725073	64708	Provincetown Muni Airport	MA	KPVC	42.072	-70.221	2.4
725088	54733	Beverly Municipal Airport	MA	KBVY	42.584	-70.918	32.9
727135	94623	Wiscasset Airport	ME	KIWI	43.964	-69.712	20.7
744860	94789	John F Kennedy Int.Airport	NY	KJFK	40.639	-73.762	3.4
744864	54787	Republic Airport	NY	KFRG	40.734	-73.417	24.7
744865	14719	Francis S Gabreski Ap	NY	KFOK	40.844	-72.632	20.4
724070	93730	Atlantic City International Airport	NJ	KACY	39.452	-74.567	18.3
725025	94741	Teterboro Airport	NJ	KTEB	40.85	-74.061	2.7

Table 3. Overwater Stations for the Statistical Analysis

ID	Type	Anemometer Height (m)	Lat	Lon
BUZM3	C-MAN	24.8	41.397	-71.033
44020	NDBC	4.1	41.493	-70.279
44017	NDBC	4.1	40.693	-72.049
44018	NDBC	4.1	42.206	-70.143
44025	NDBC	4.1	40.251	-73.164
ACYN4	WLON	- *	39.357	-74.418
44009	NDBC	3.8	38.46	-74.692
44065	NDBC	4.1	40.369	-73.703
LWSD1	WLON	9.5	38.783	-75.119

* Wind data is not collected at this site. Only temperature will be evaluated.

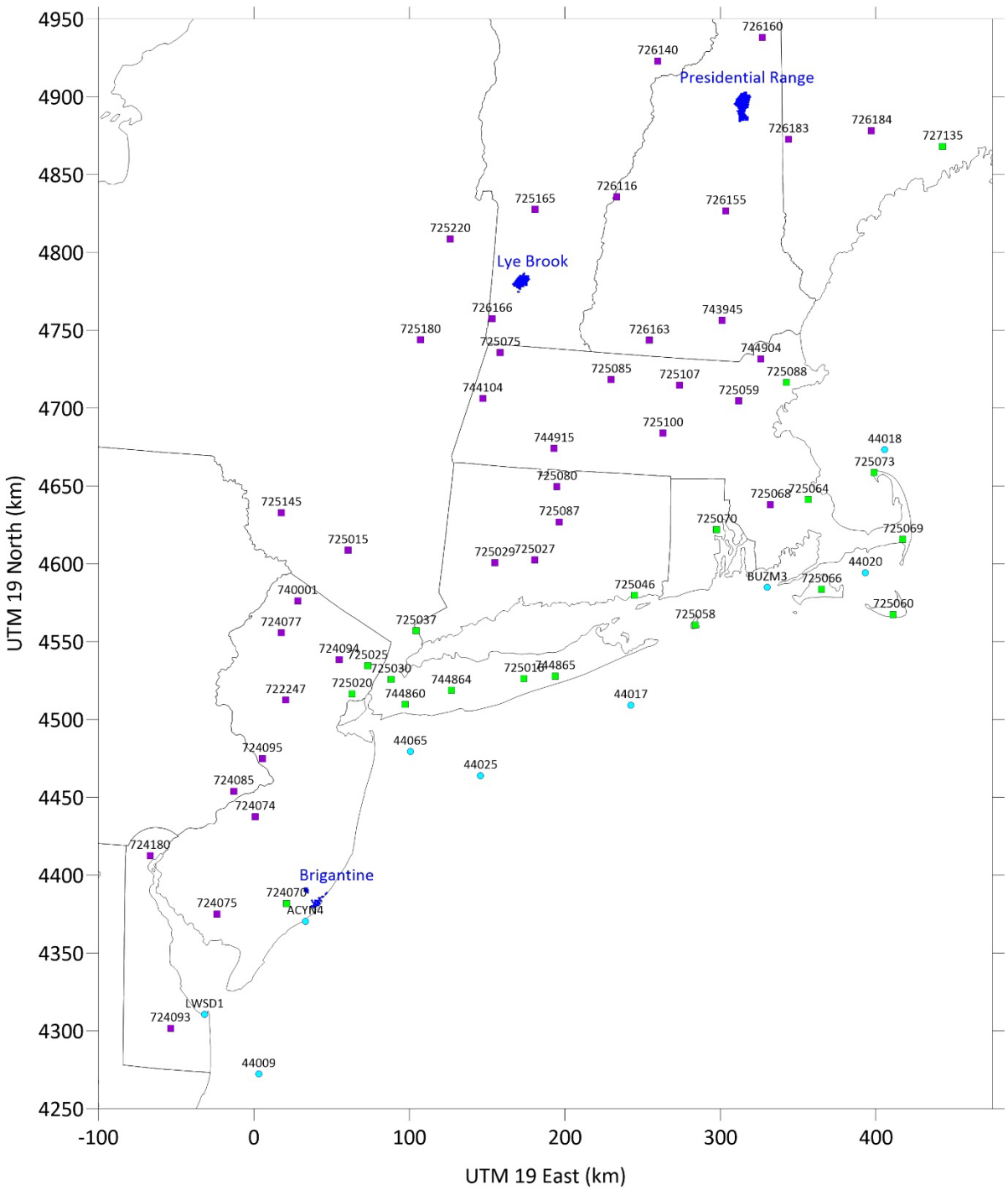

Figure 1 Observational stations to be included in the evaluation, including surface inland stations (purple), surface coastal stations (green) and overwater stations/buoys (turquoise).

Model Performance

Wind Speed and Direction

The results of the statistical assessment for wind speed and direction are presented in Table 4. Evaluation across all 56 surface stations (both coastal and inland) shows mean values which fall within the associated benchmarks. The bias for wind speed is positive which indicates WRF generated wind speeds that are slightly higher than observed. Bias for wind direction is relatively small, which indicates that the distribution of wind directions seen over the year should provide a reliable representation of actual conditions.

Inland stations show slightly higher gross error in wind direction as compared with coastal locations. This may be attributable to greater terrain influences on inland locations which are not completely resolved by the 12 km WRF grid cells. Bias values are lower for coastal stations than for inland stations. Low bias values for both subgroups indicate that the annual distribution of wind speeds and directions should be representative.

The overwater analysis is based on nine identified buoy stations in the region around the project site (eight for wind, nine for temperature). These stations show a higher wind direction bias and gross error which are near or slightly above the benchmark values. Wind speed RMSE is also slightly above the benchmark. The measurement height at these stations and the need to profile wind speed contributes to higher uncertainty for the observed values.

Figure 2 through Figure 7 show modeled and observed wind roses for 11 stations across the modeling domain. Separate comparisons are provided for each modeled year (2018-2020). The predominant wind directions are well correlated between the two datasets. Coastal sites, both on land and overwater, show a predominant northeast and southwest flow which is apparent in both the observation and the WRF dataset. The overwater stations show higher wind speeds than the surface stations. This is the case for both the modeled and observed datasets. For inland stations, individual peaks, such as the more prominent westerly sector at Worcester, may not exactly match or may be slightly rotated. However, the predominant wind directions are generally well captured. Stations located in complex terrain including Rutland VT and Laconia NH show more

significant difference between the modeled and observed wind direction distributions. This may be influenced by the grid resolution of the WRF model runs. 12 km resolution may not be sufficient to capture all localized terrain influences, especially in regions of complex terrain. While local winds in regions of complex terrain my not be fully resolved, the regional flow patterns between the source regions and the Class I areas are reasonably well captured.

Table 4. Statistical Model Performance for Wind Speed and Direction

		Wind Speed			Wind Direction	
	Year	IOA -	Mean Bias m/s	RMSE m/s	Mean Bias deg	Gross Error deg
Benchmark		≥ 0.6	≤ ±0.5	≤ 2	≤ ±10	≤ 30
All Surface	2018	0.73	0.20	1.87	7.56	23.45
	2019	0.74	0.37	1.94	7.77	23.67
	2020	0.75	0.35	1.90	8.37	23.36
Coastal Surface	2018	0.72	-0.16	2.00	4.56	18.40
	2019	0.70	0.24	2.16	5.36	18.93
	2020	0.72	0.23	2.11	5.58	18.63
Inland Surface	2018	0.70	0.39	1.78	9.68	27.09
	2019	0.71	0.45	1.79	9.48	27.14
	2020	0.72	0.42	1.76	10.37	26.94
Overwater	2018	0.85	-0.07	1.66	4.73	17.51
	2019	0.86	-0.04	1.58	5.54	17.69
	2020	0.86	-0.06	1.59	6.76	18.14

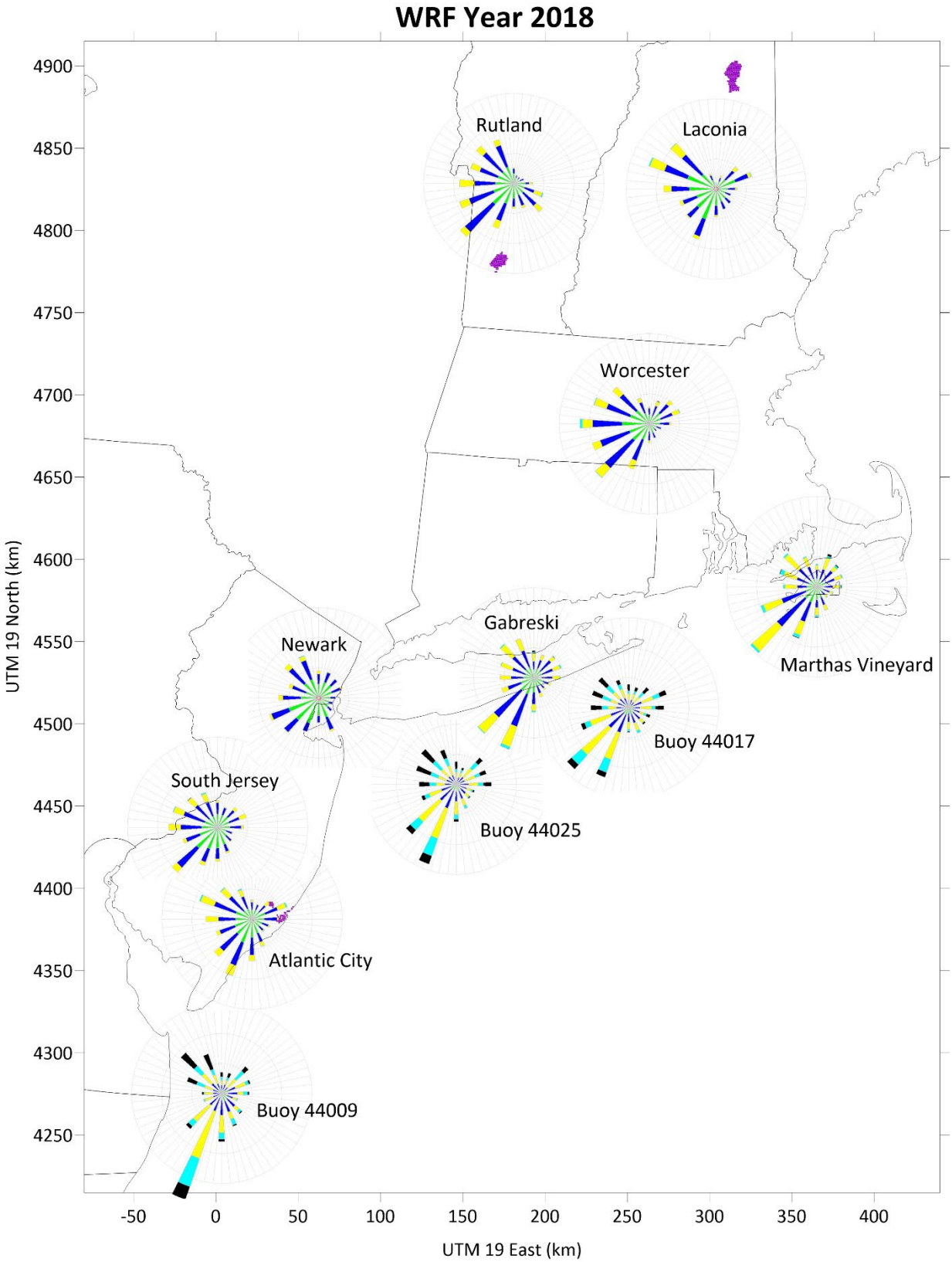

Figure 2 WRF predicted wind fields for year 2018

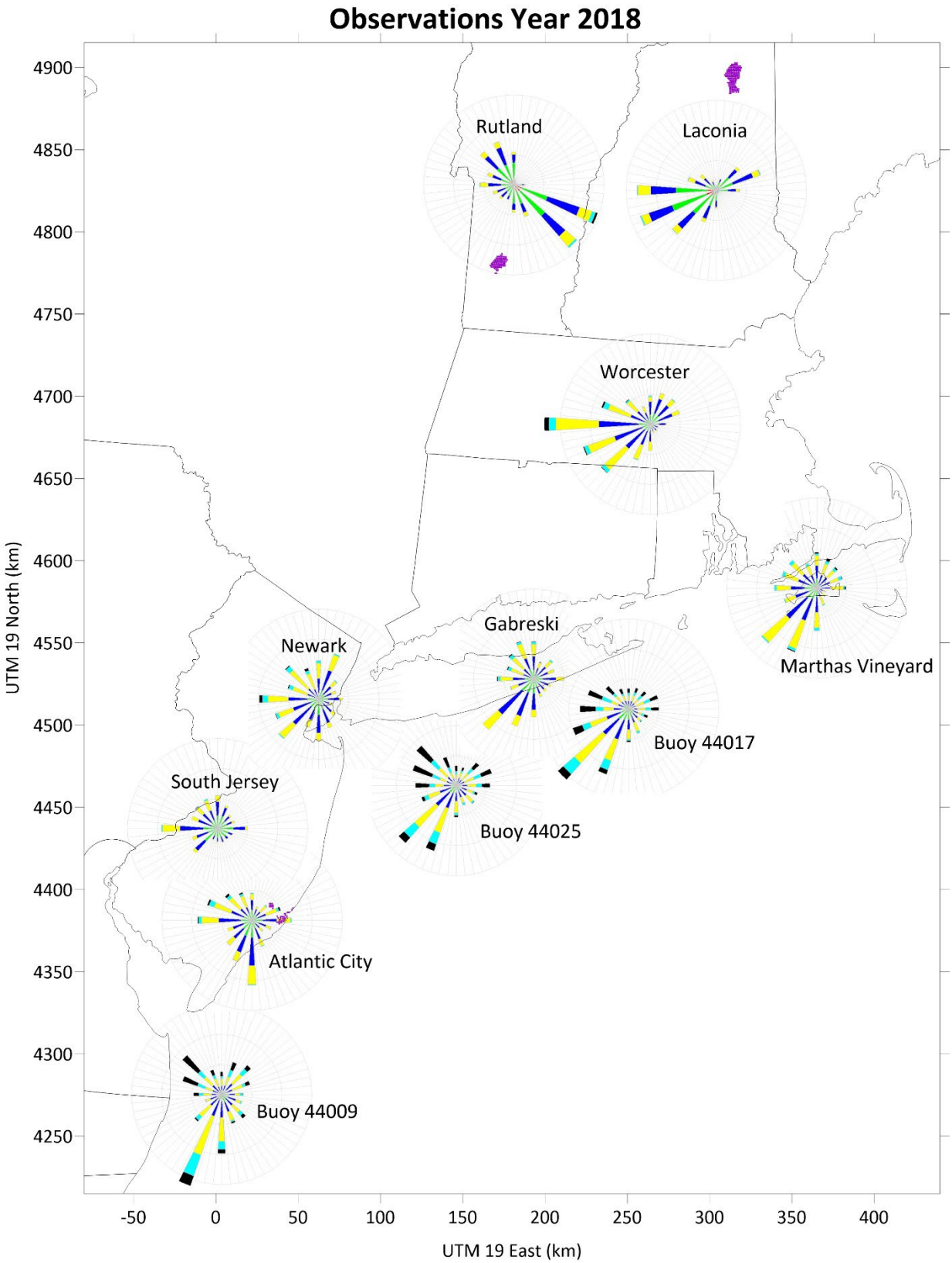

Figure 3 Observed wind fields for year 2018

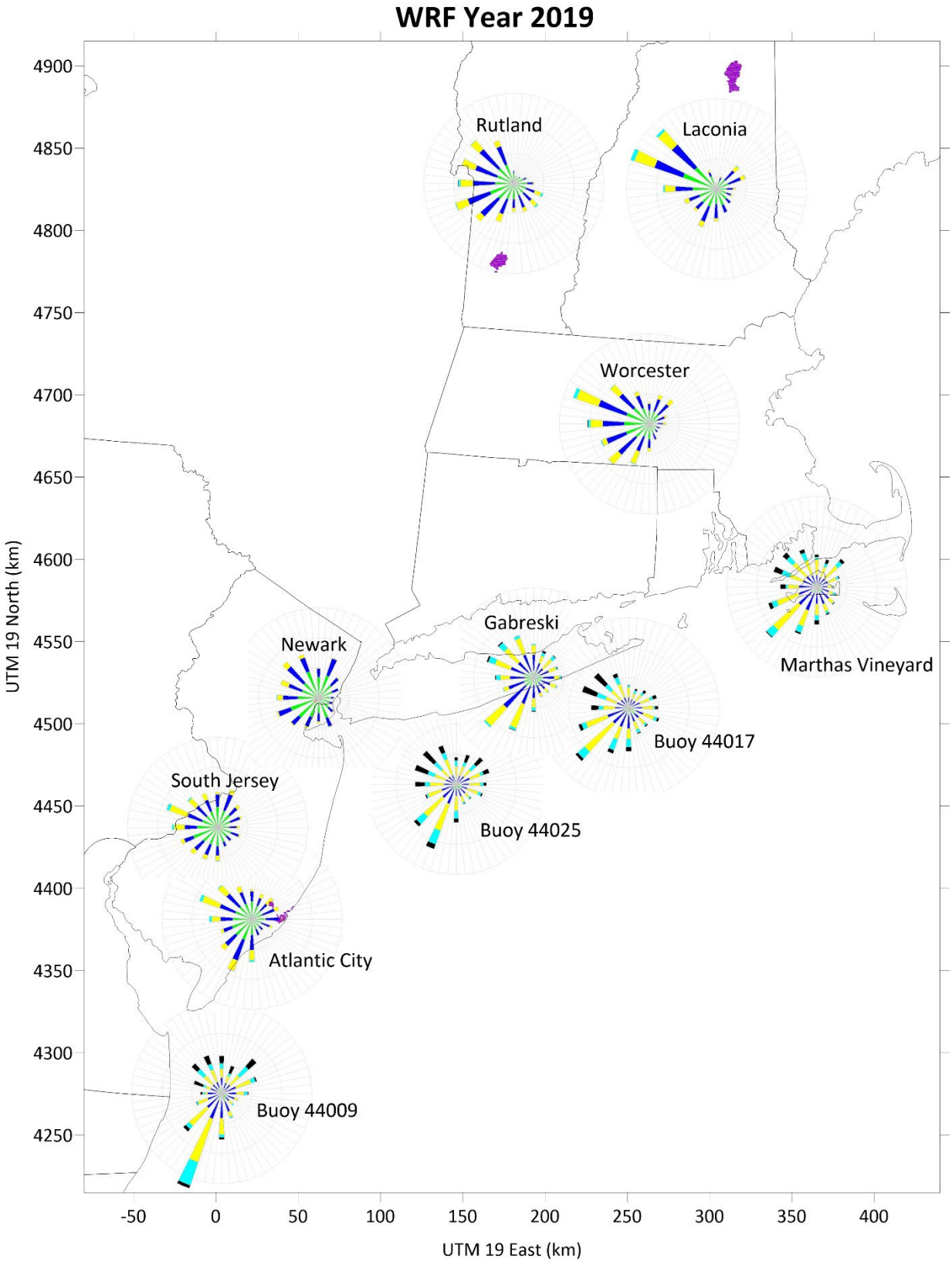

Figure 4 WRF predicted wind fields for year 2019

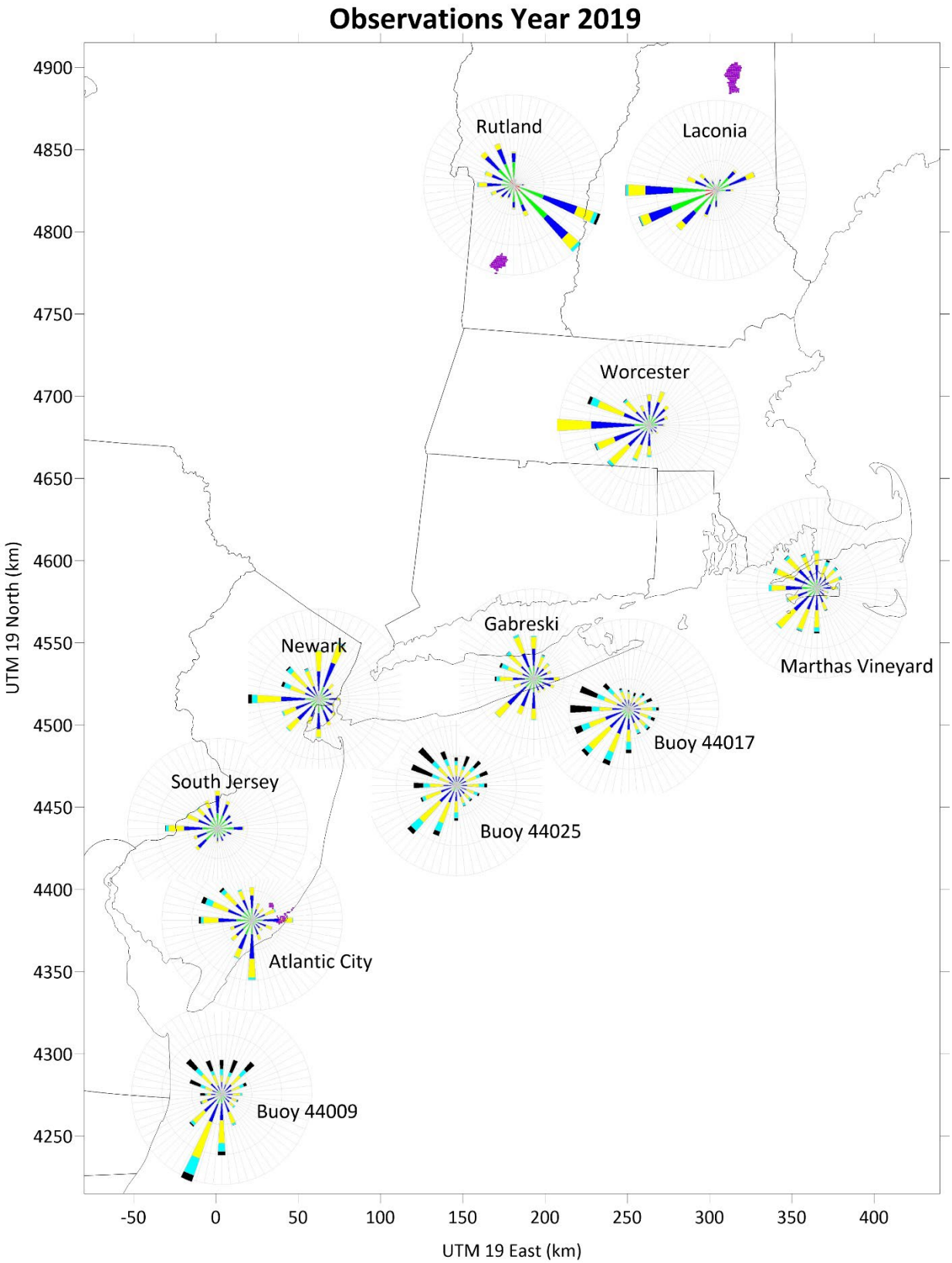

Figure 5 Observed wind fields for year 2019

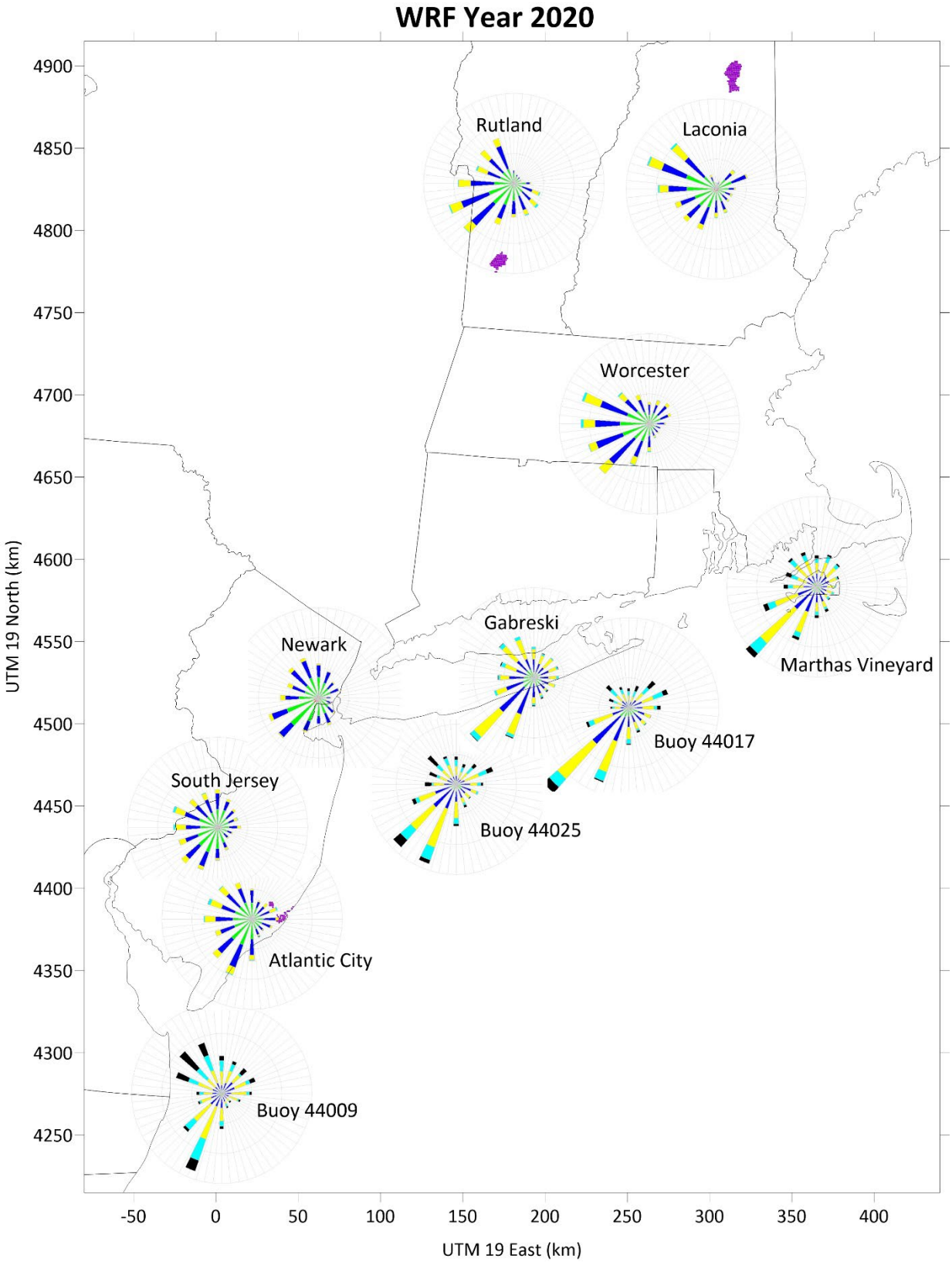

Figure 6 WRF predicted wind fields for year 2020

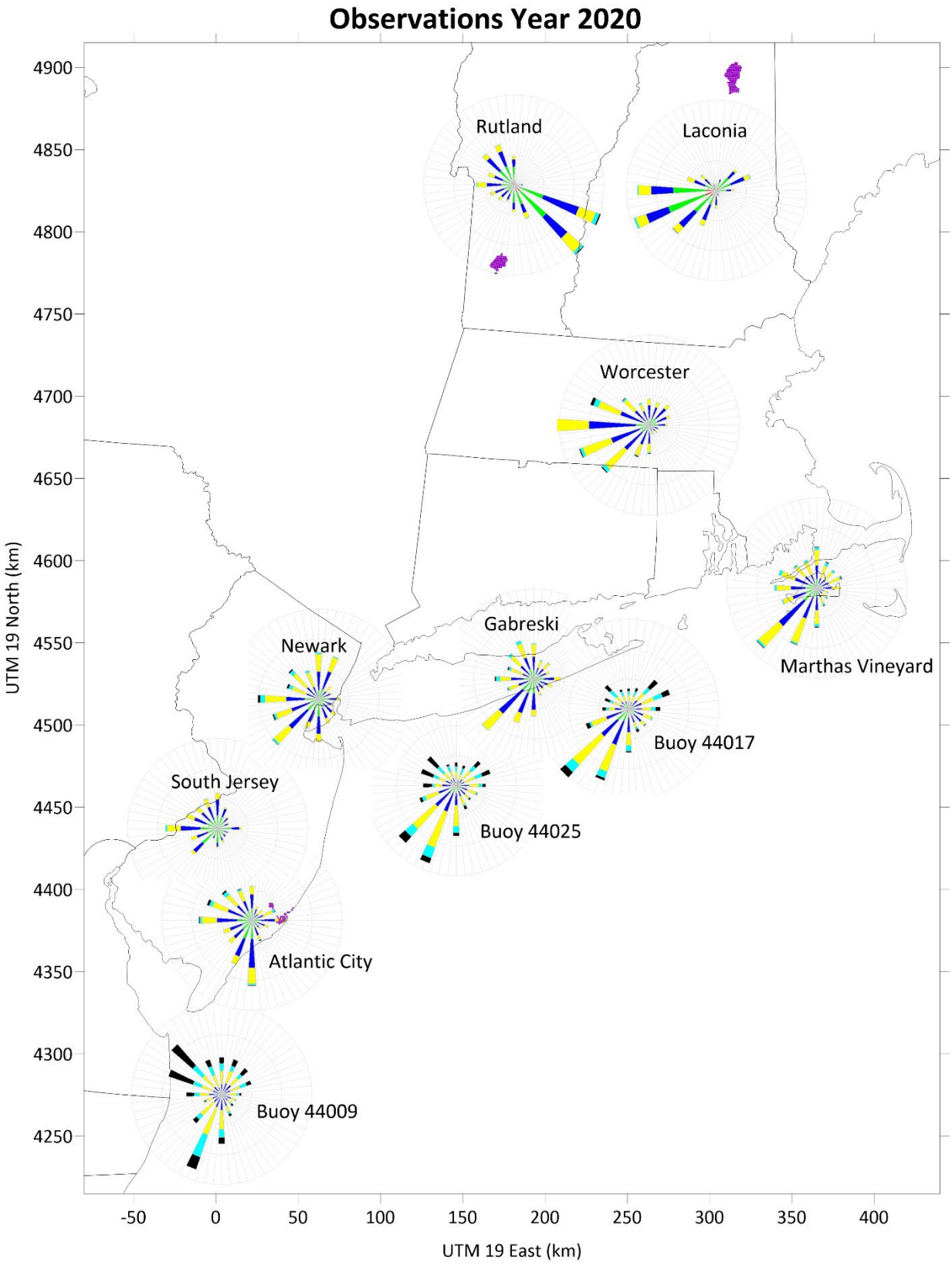

Figure 7 Observed wind fields for year 2020

Some locations, such as the South Jersey station, show a large fraction of calm winds in the observed database. This is partially due to the 3 knot minimum wind speed recorded for these ASOS stations in the ISD database. The WRF generated winds show a greater fraction of non-calm hours for these stations with light winds. The light winds (less than 3 knots, but larger than 0 knots) in the WRF data set correspond to calm observed winds at these stations.

A more refined analysis is conducted using the soccer plots Figure 8 through Figure 15. In each plot, bias is plotted against error and results are included on a monthly basis for all three years. Plots are presented for all stations combined, coastal stations, inland stations and overwater stations. In most cases, the monthly values are tightly grouped and show consistent levels of error and bias. Data points often fall near the boundary of the simple conditions benchmark values. In some cases, such as wind direction bias for the inland stations, some values fall outside the benchmark. The model performance in these regions is likely impacted by the low horizontal grid resolution of 12 km.

Additional refined analysis is conducted using time series profiles to better quantify the time history of wind speeds and directions and also to examine diurnal profiles found in the two datasets in both winter (January) and summer (July). For this analysis, 3 stations were selected which spanned the distance from the project site to the Class I areas: Martha's Vineyard, Worcester and Rutland VT. Martha's Vineyard is located very close to the project site, while Rutland VT is located in a region and at a distance similar to the closest two Class I areas. Worcester represents regions in between, which would be transited by pollutants transported from the project site.

Figure 16 and Figure 17 show modeled and observed wind speeds for the months of January and July 2020 at Atlantic City. The peak winds are well represented in the WRF dataset for both periods. Observed wind speeds that drop to zero indicate calm records in the ISD database and typically are matched with light winds in the WRF simulations. During the summer months, these light winds are most common at nighttime and early morning hours. Figure 18 and Figure 19 show the corresponding comparison for wind direction. The wind directions match well during both periods. Note that some records of zero for the observed wind direction represent hours of calm winds.

Figure 20 through Figure 31 show the same analysis for Martha's Vineyard, Worcester and Rutland. At these stations, there are more frequent calm wind records in the observational database, which are generally well paired with WRF wind speeds of 2 m/s or less. At these stations, WRF under predicts some of the peak wind speeds and over predicts some light winds. The inland stations show a greater degree of wind direction variability which is reasonably well matched by WRF. The higher frequency of calm winds at Rutland, VT results in many hours with zero wind direction. During non-calm hours, the observed wind directions are matched well by WRF.

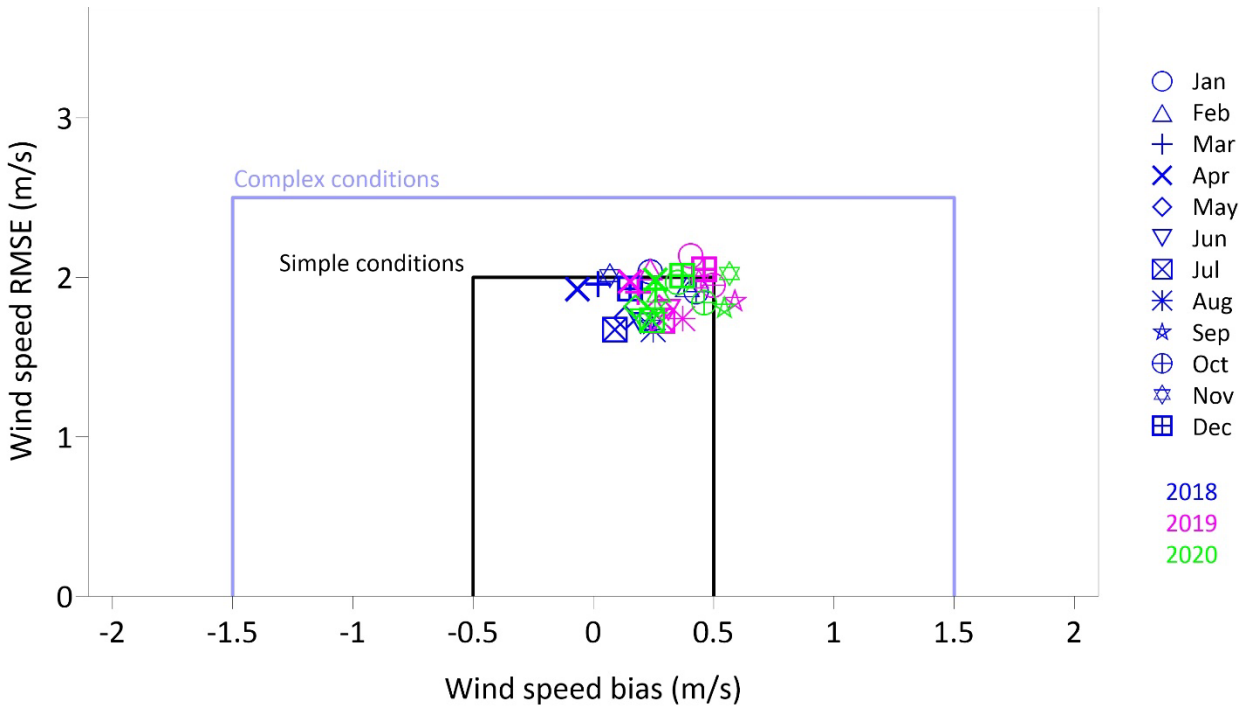

Figure 8 Soccer plot of the wind speed bias and RMSE for a 3-year period, by month, for all stations.

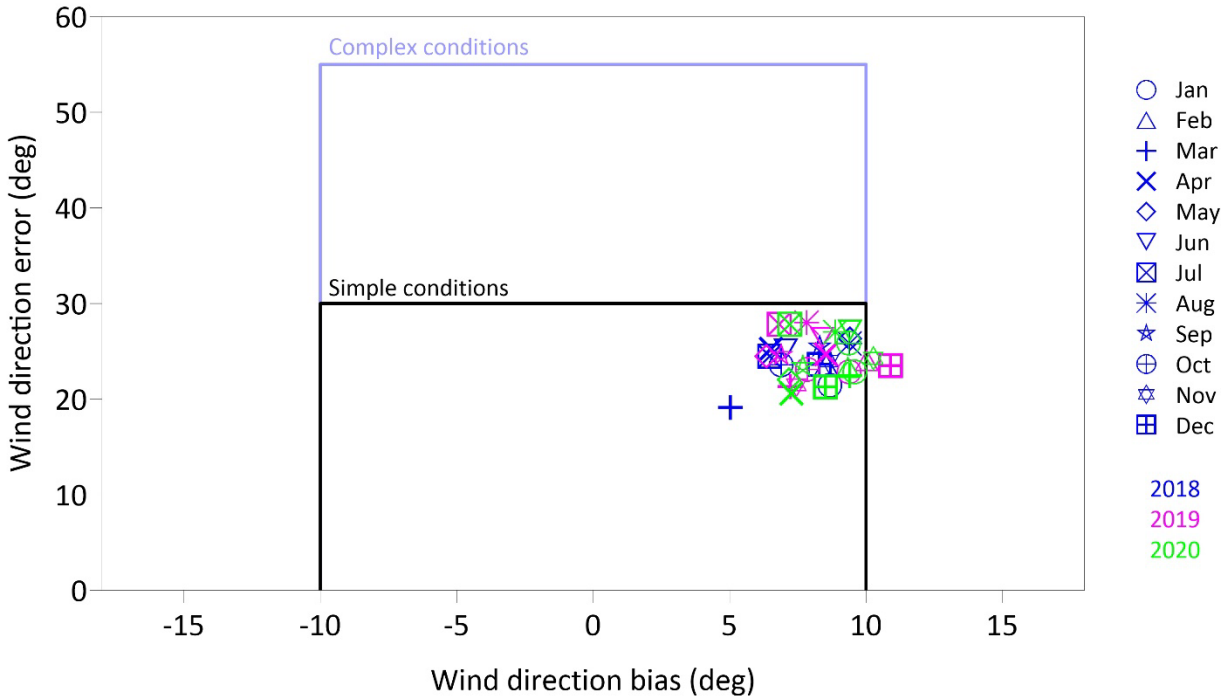

Figure 9 Soccer plot of the wind direction bias and error for a 3-year period, by month, for all stations.

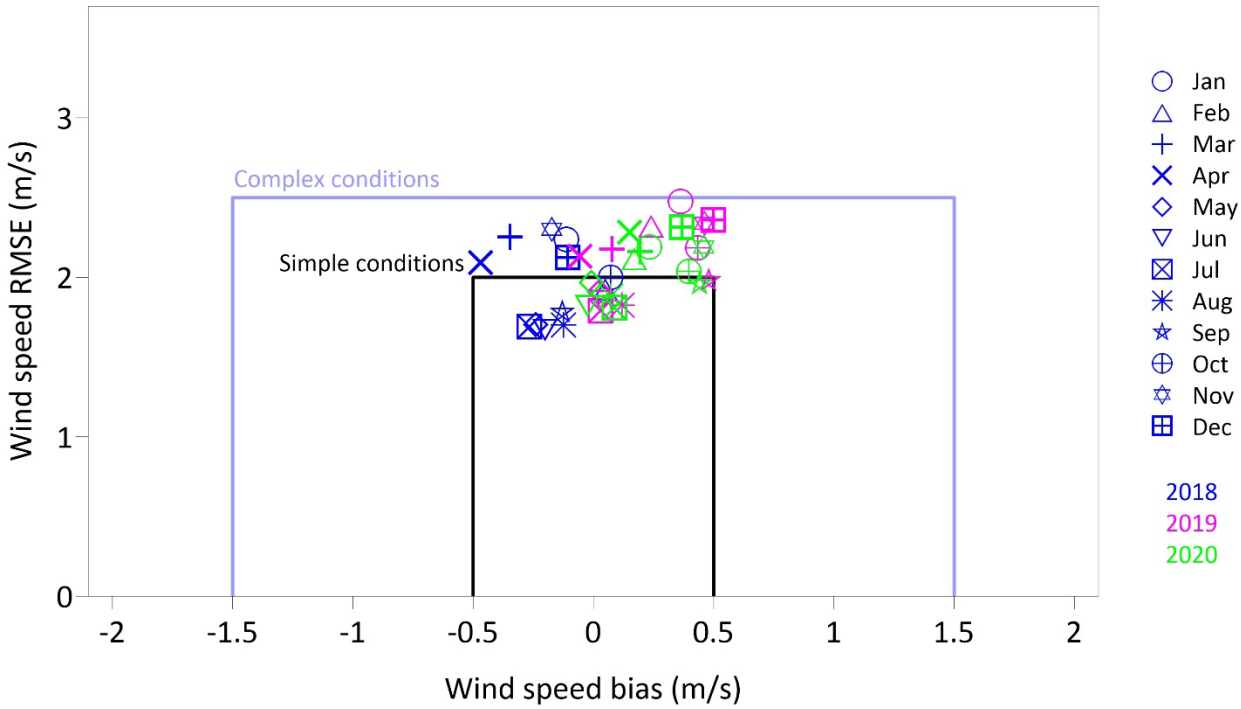

Figure 10 Soccer plot of the wind speed bias and RMSE for a 3-year period, by month, for coastal stations.

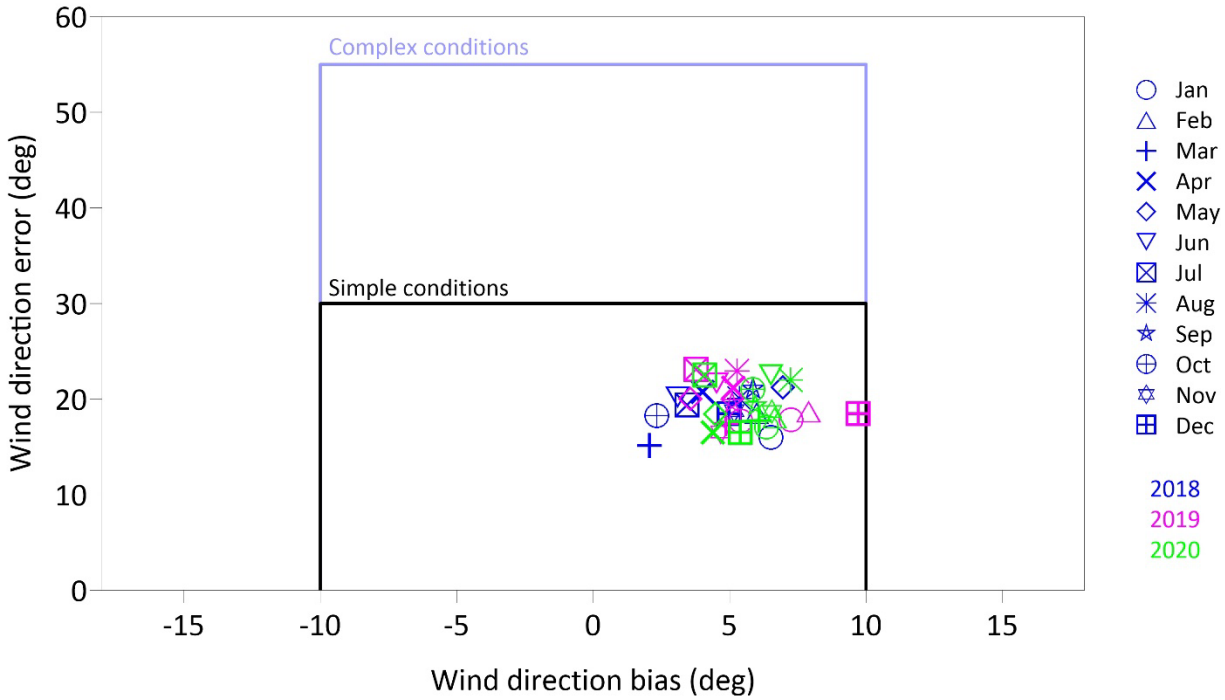

Figure 11 Soccer plot of the wind direction bias and error for a 3-year period, by month, for coastal stations.

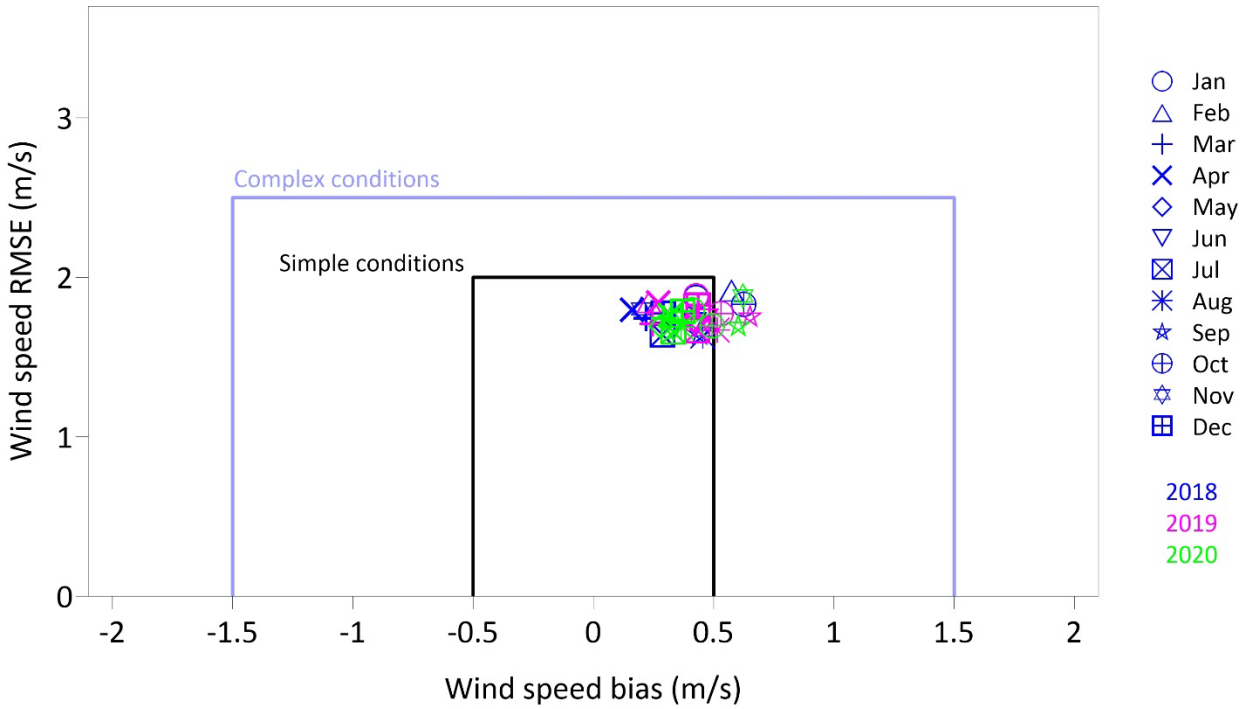

Figure 12 Soccer plot of the wind speed bias and RMSE for a 3-year period, by month, for inland stations.

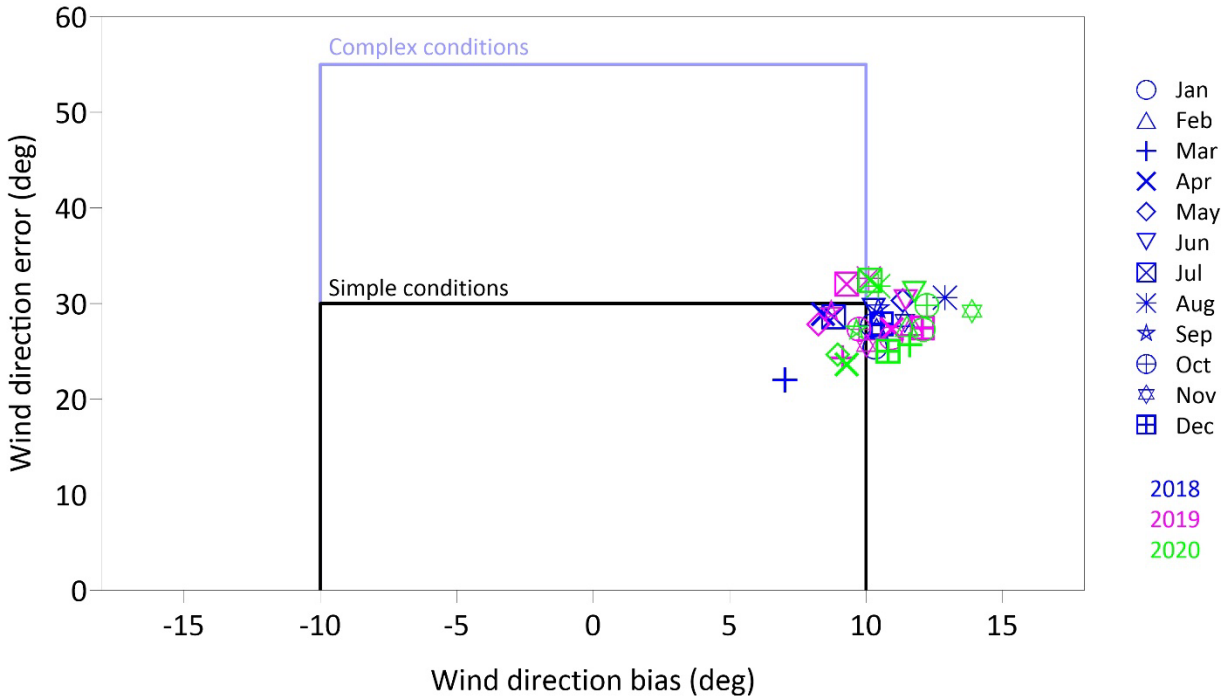

Figure 13 Soccer plot of the wind direction bias and error for a 3-year period, by month, for inland stations.

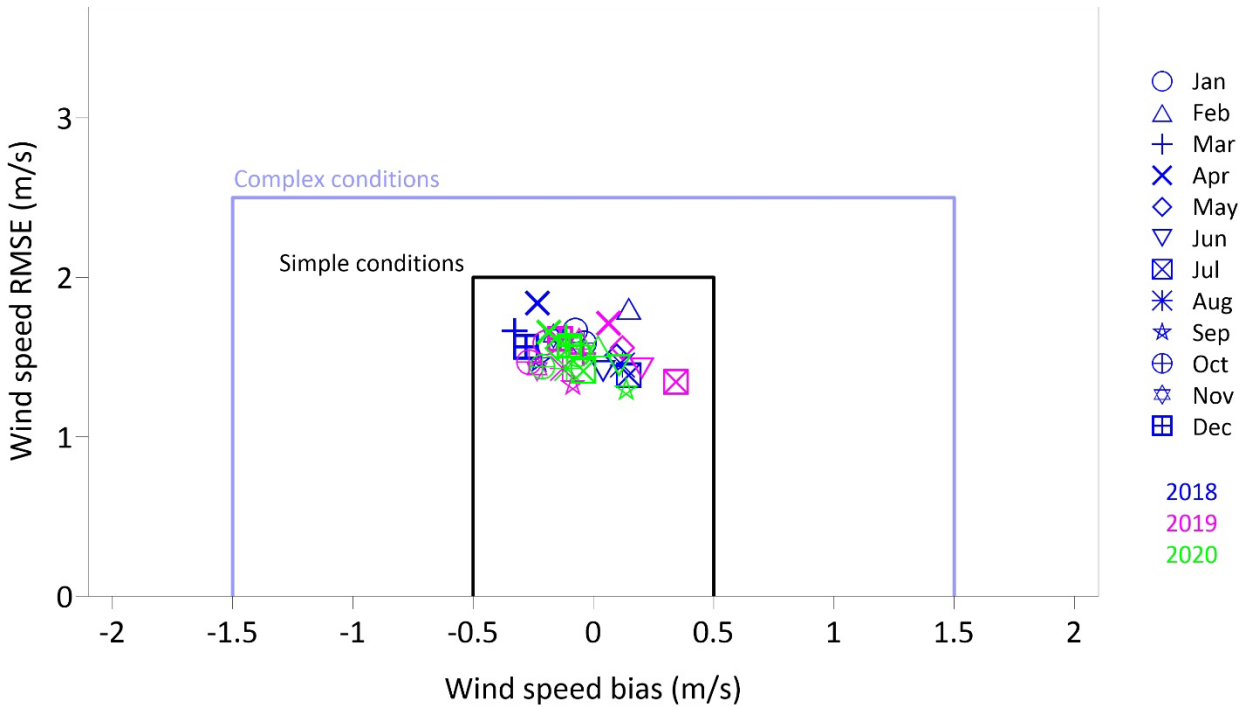

Figure 14 Soccer plot of the wind speed bias and RMSE for a 3-year period, by month, for overwater stations.

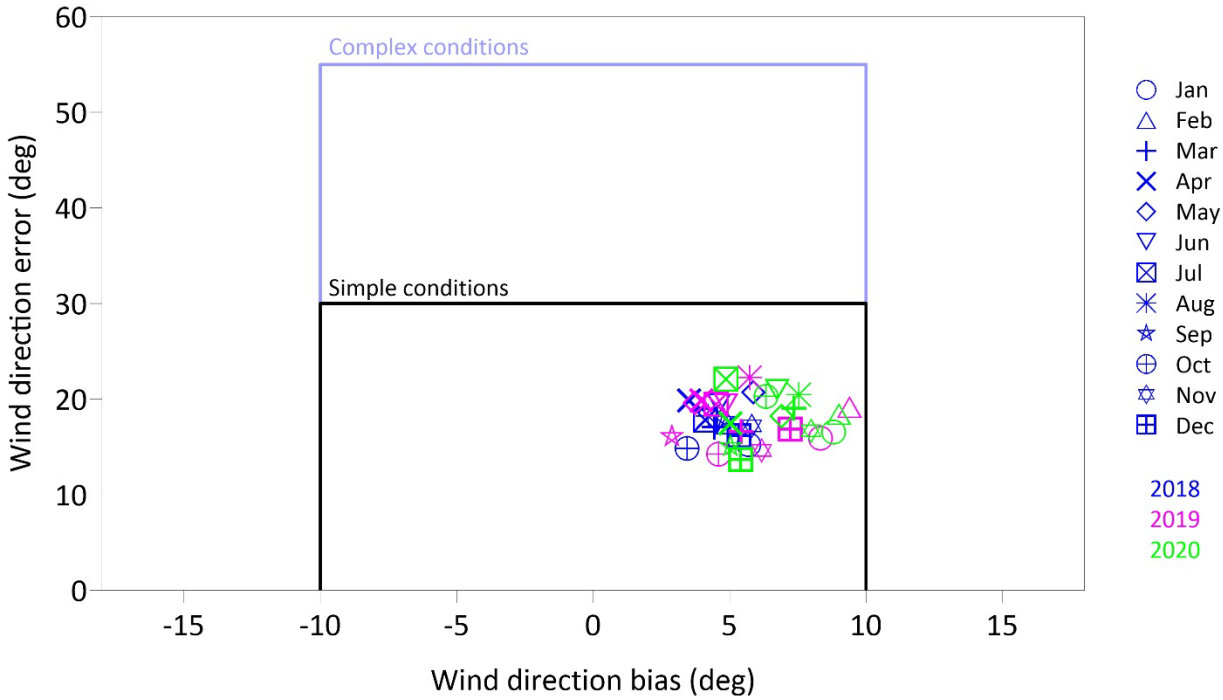

Figure 15 Soccer plot of the wind direction bias and error for a 3-year period, by month, for overwater stations.

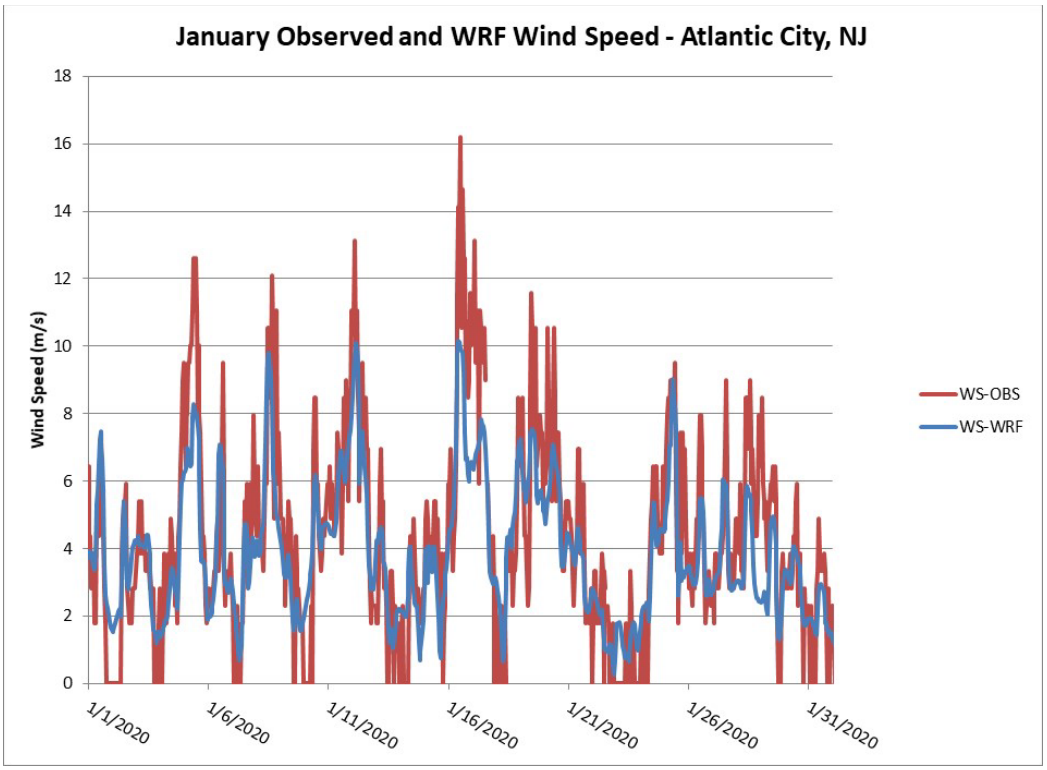

Figure 16 Observed and modeled wind speeds for Atlantic City January 2020.

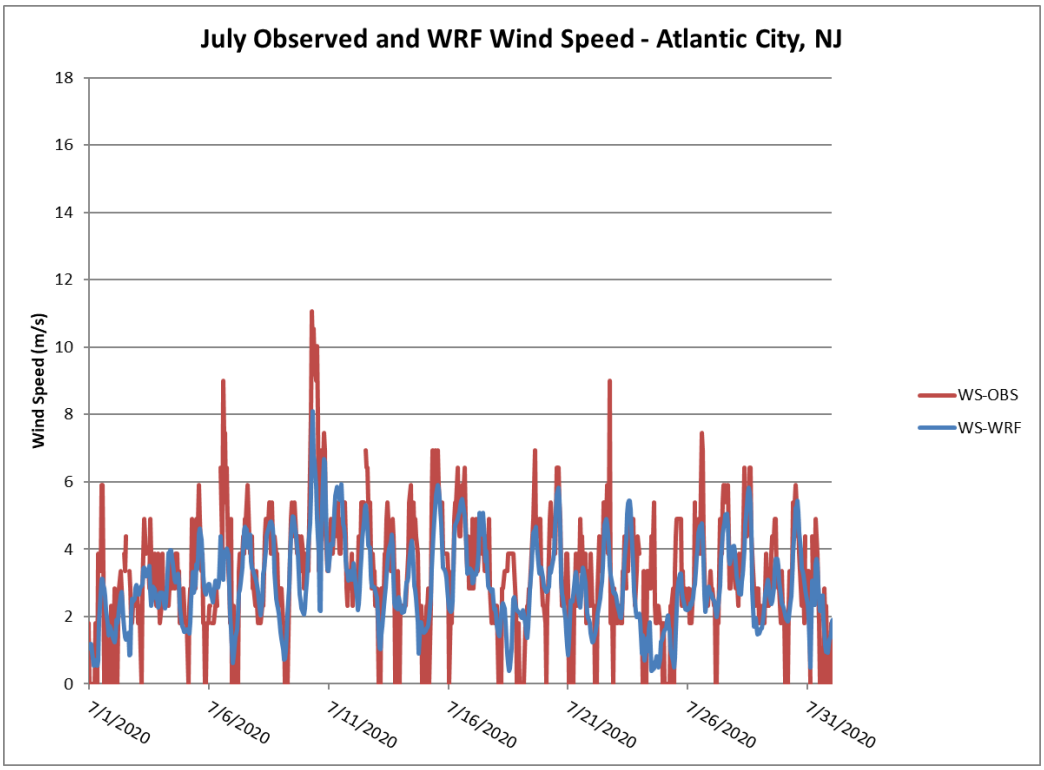

Figure 17 Observed and modeled wind speeds for Atlantic City July 2020.

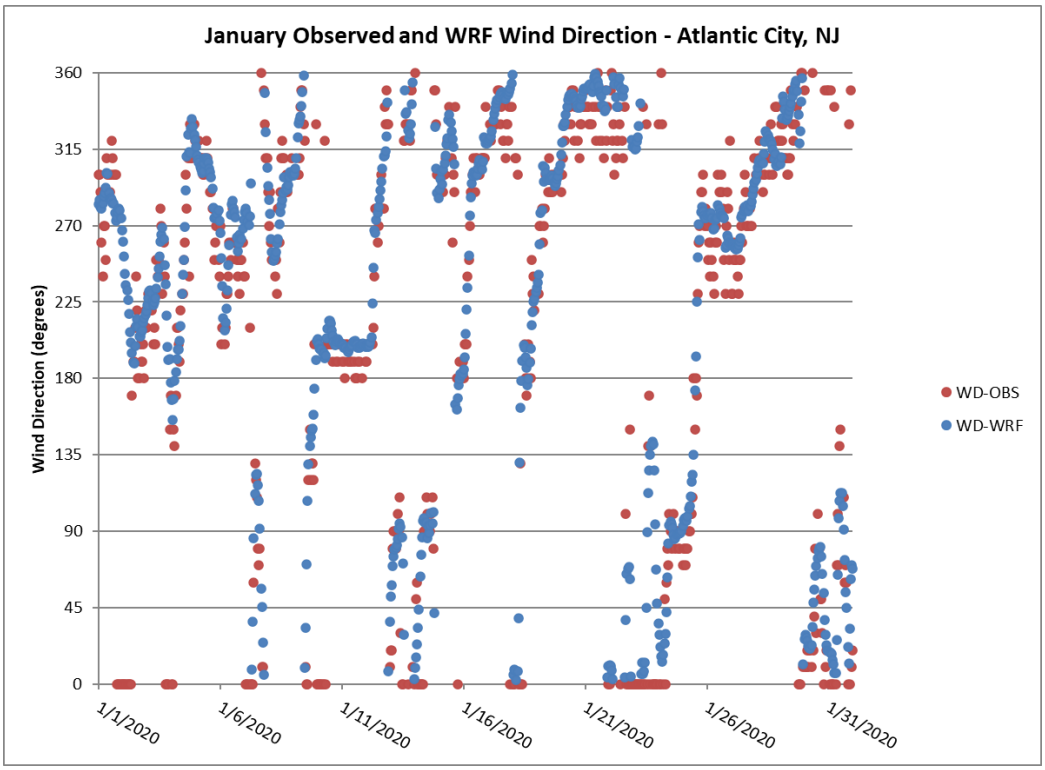

Figure 18 Observed and modeled wind direction for Atlantic City January 2020.

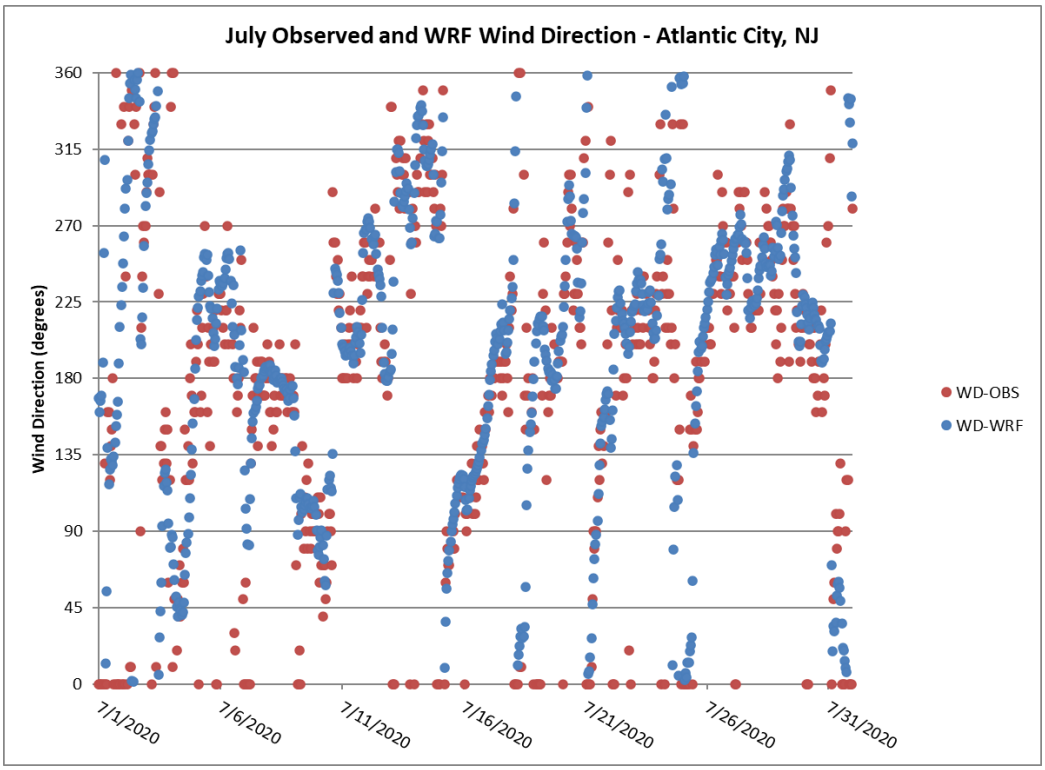

Figure 19 Observed and modeled wind direction for Atlantic City July 2020.

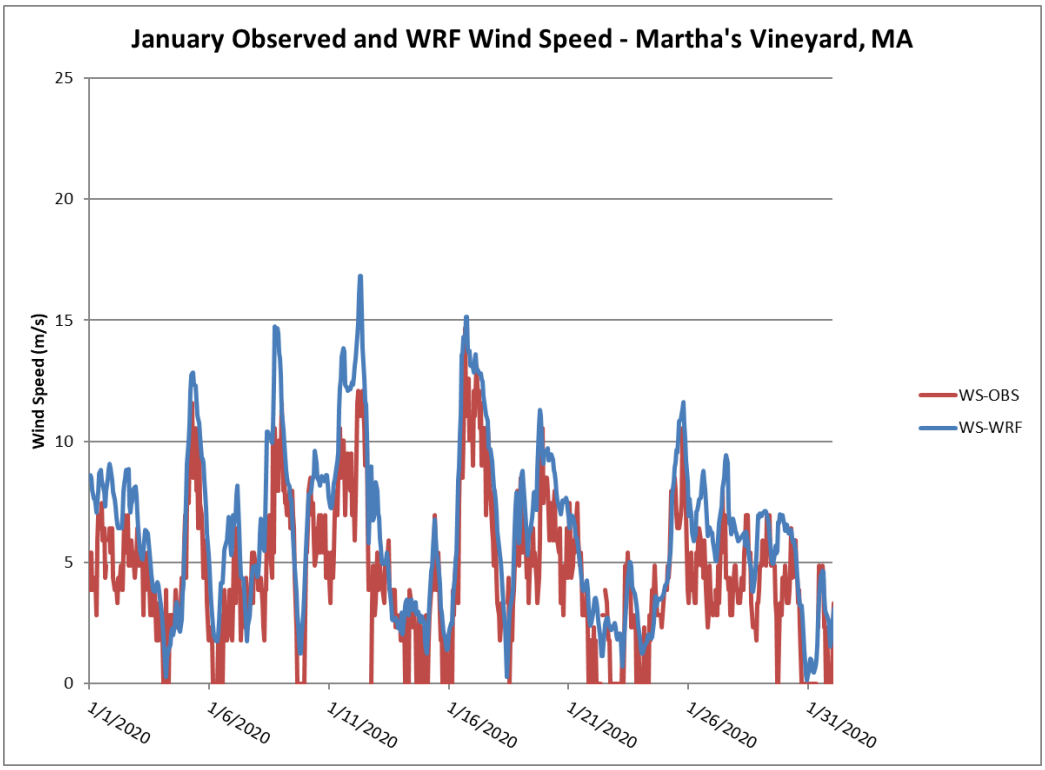

Figure 20 Observed and modeled wind speeds for Martha's Vineyard January 2020.

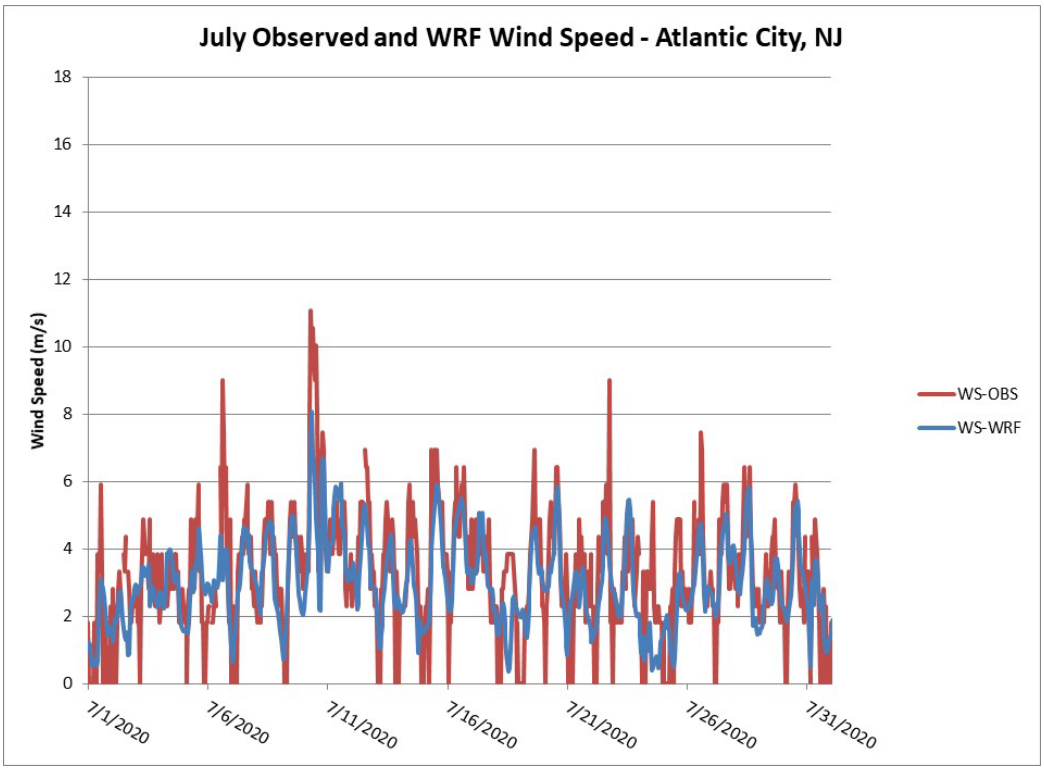

Figure 21 Observed and modeled wind speeds for Martha's Vineyard July 2020.

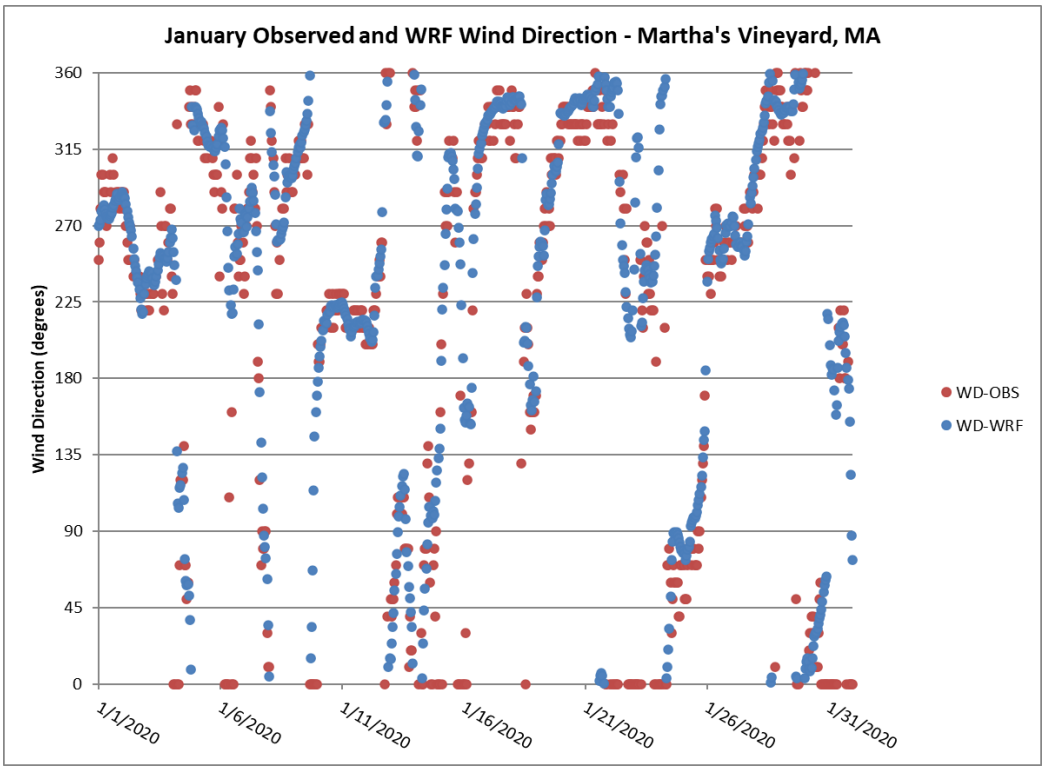

Figure 22 Observed and modeled wind direction for Martha's Vineyard January 2020.

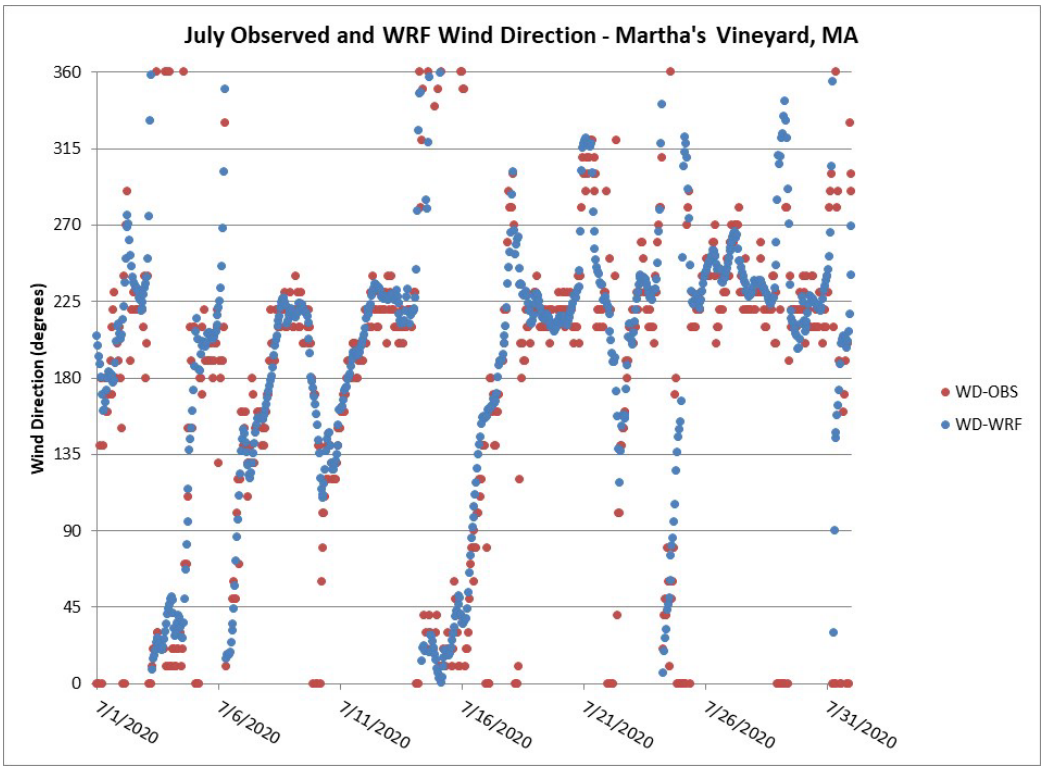

Figure 23 Observed and modeled wind direction for Martha's Vineyard July 2020.

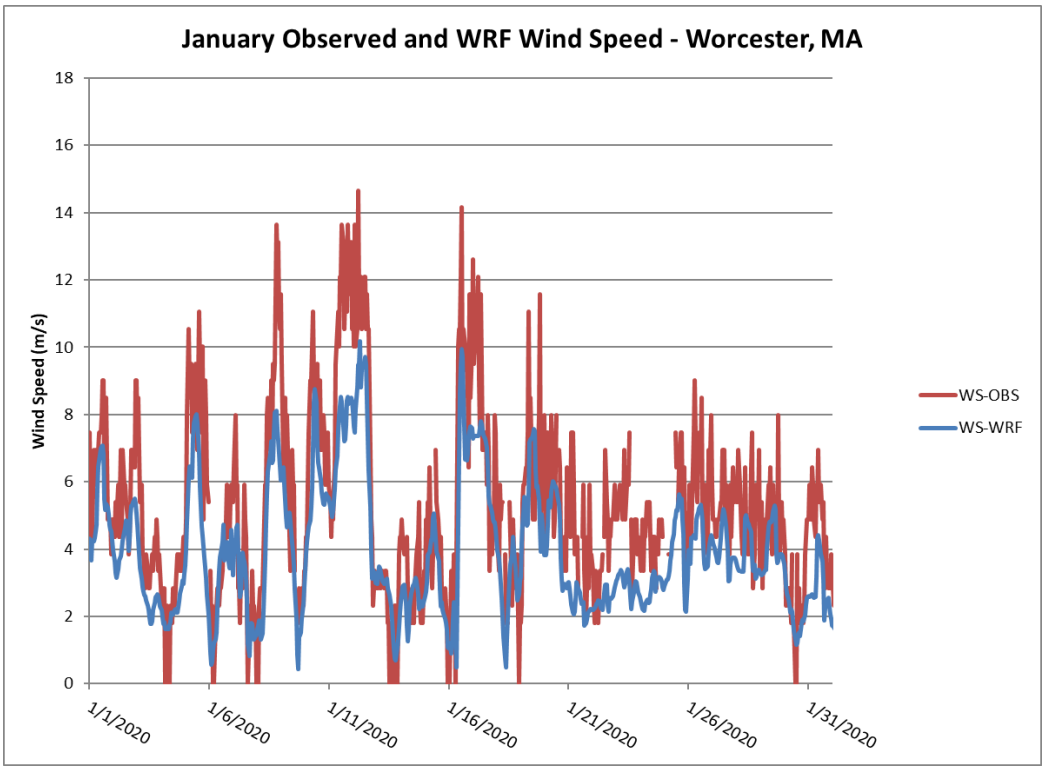

Figure 24 Observed and modeled wind speeds for Worcester January 2020.

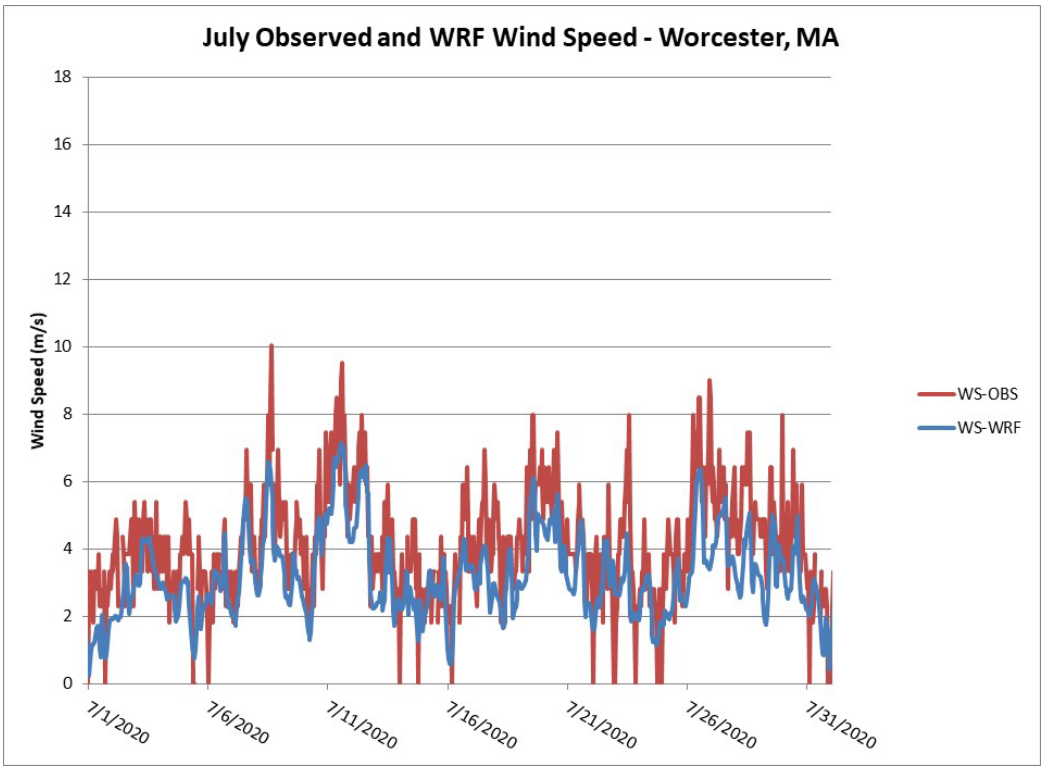

Figure 25 Observed and modeled wind speeds for Worcester July 2020.

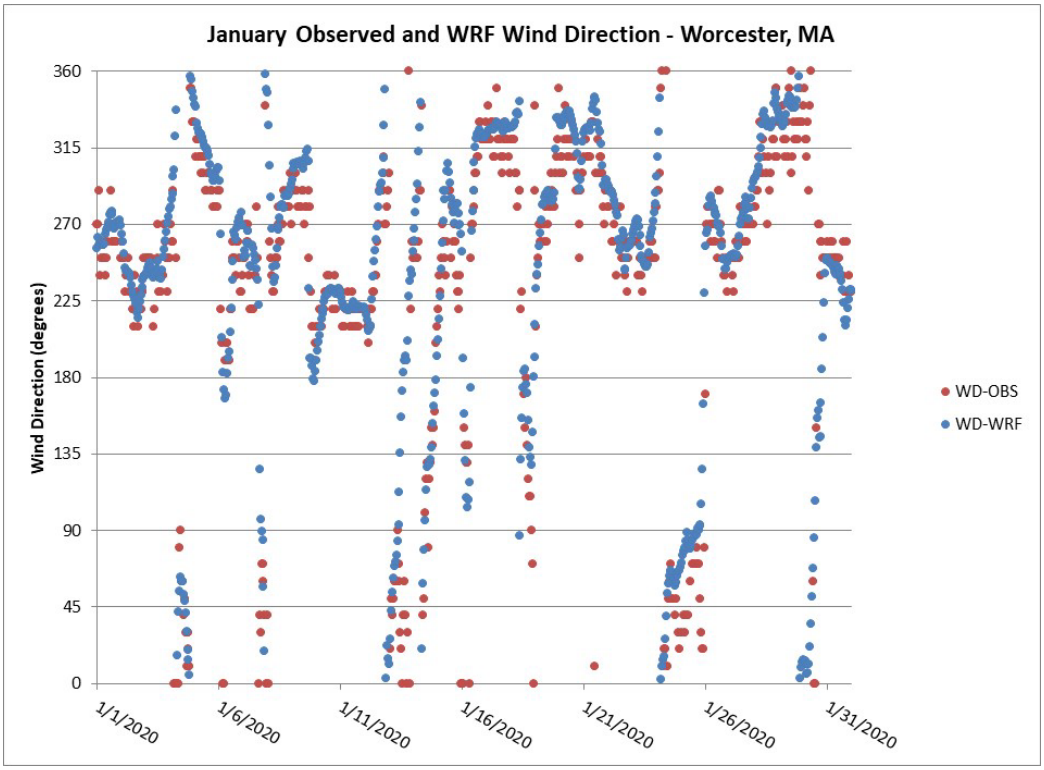

Figure 26 Observed and modeled wind direction for Worcester January 2020.

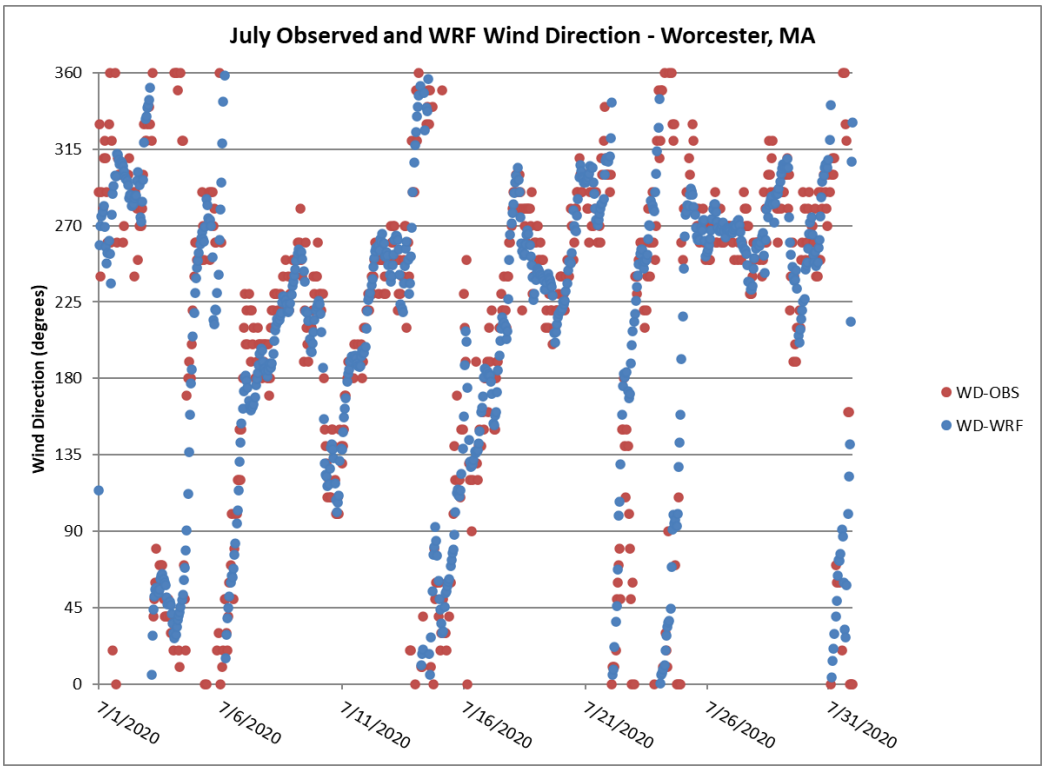

Figure 27 Observed and modeled wind direction for Worcester July 2020.

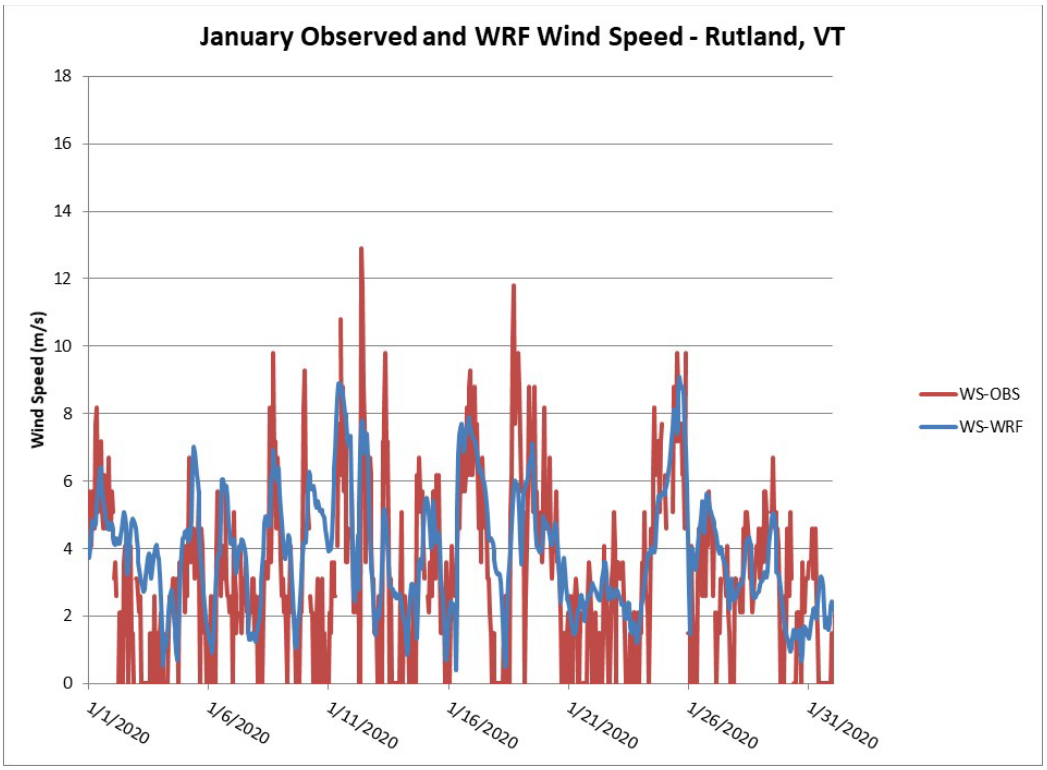

Figure 28 Observed and modeled wind speeds for Rutland, VT January 2020.

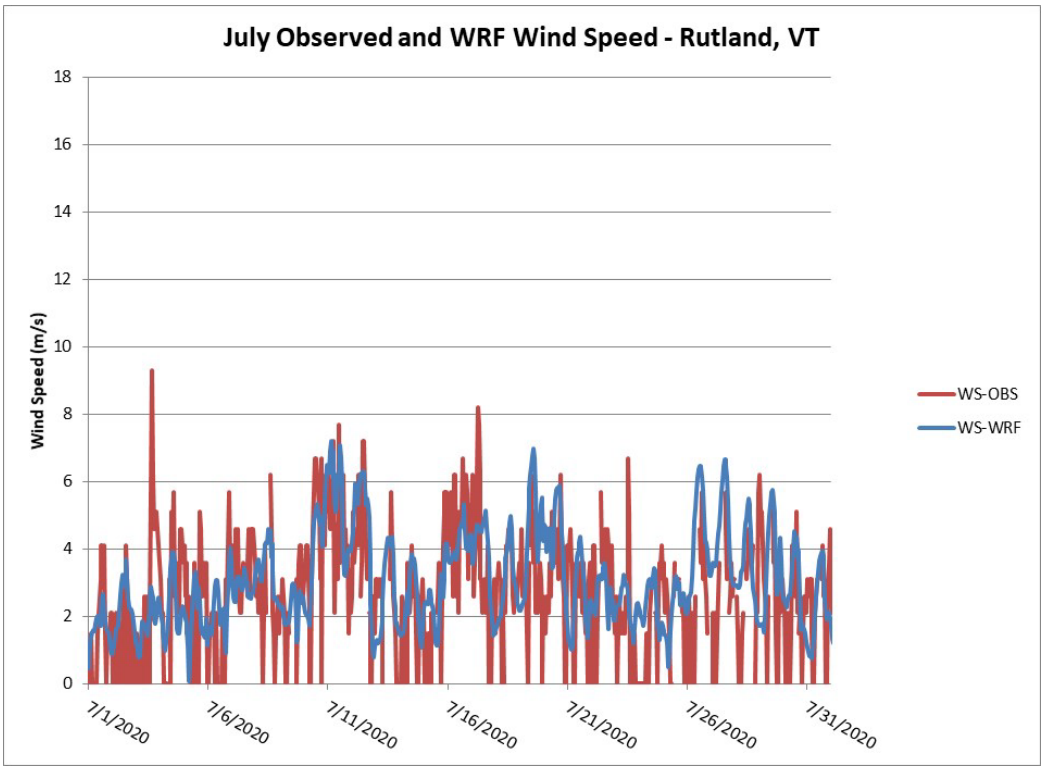

Figure 29 Observed and modeled wind speeds for Rutland, VT July 2020.

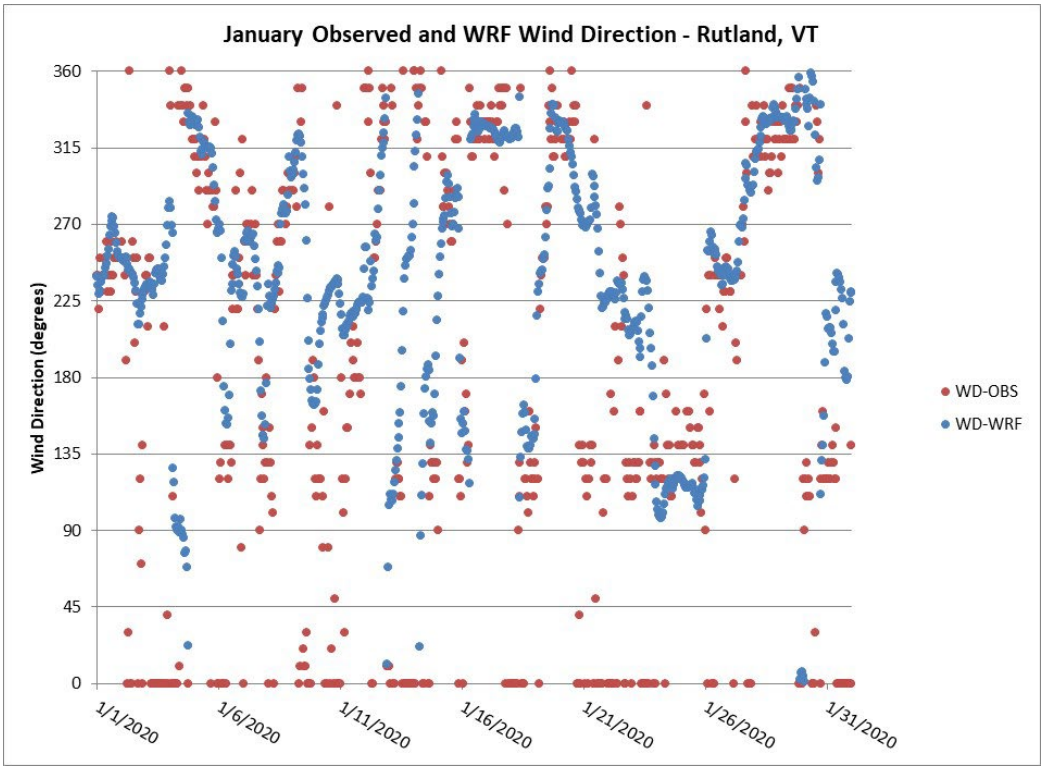

Figure 30 Observed and modeled wind direction for Rutland, VT January 2020.

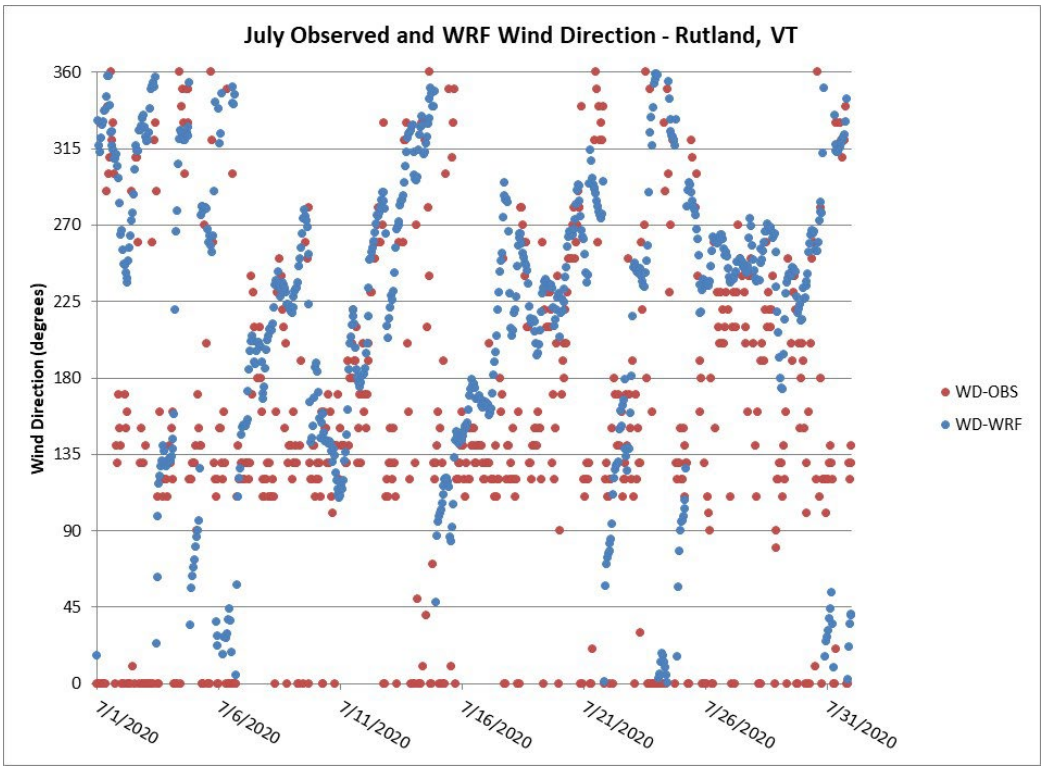

Figure 31 Observed and modeled wind direction for Rutland, VT July 2020.

Temperature

A summary of the evaluation statistics for temperature are presented in Table 5. Bias values are low across all subgroups, which indicate no tendency to over or under predict temperatures. Gross errors are all within the benchmarks. The soccer plots in Figure 34 through Figure 37 show the performance statistics on a monthly basis. Results are generally within the ranges expected for simple conditions.

Figure 36 and Figure 37 show time series of temperature for January and July 2020 at Atlantic City, and Figure 38 and Figure 39 show time series of temperature for January and July 2020 at Martha's Vineyard. During the winter months, the temperature variation is well captured. Summer months show a more regular diurnal profile. The WRF model has a tendency to under predict the daytime high and over predict the nighttime low. This may be partially related to the 12 km grid size of the model. While these stations are located over land, the model will include a certain amount of overwater land use in the grid cell. The water land use included in the grid cell may tend to modulate the modeled temperature swings.

Figure 40 through Figure 43 show the time series of temperature for January and July 2020 at Worcester and Rutland VT. The winter month performance is well captured. In July at Worcester, the diurnal profile of temperatures is well captured. However at Rutland, VT, the model accurately predicts the daytime high, but sometimes slightly over predicts nighttime low temperatures.

Table 5. Statistical Model Performance for Temperature

		Temperature		
	Year	IOA -	Mean Bias K	Gross Error K
Benchmark		≥ 0.8	≤ ±0.5	≤ 2
All Surface	2018	0.92	-0.25	1.62
	2019	0.93	-0.21	1.58
	2020	0.93	-0.18	1.56
Coastal Surface	2018	0.89	-0.22	1.43
	2019	0.9	-0.10	1.42
	2020	0.90	-0.09	1.38
Inland Surface	2018	0.91	-0.26	1.72
	2019	0.93	-0.26	1.66
	2020	0.93	-0.23	1.65
Overwater	2018	0.91	0.1	0.88
	2019	0.92	0.09	0.87
	2020	0.91	0.17	0.92

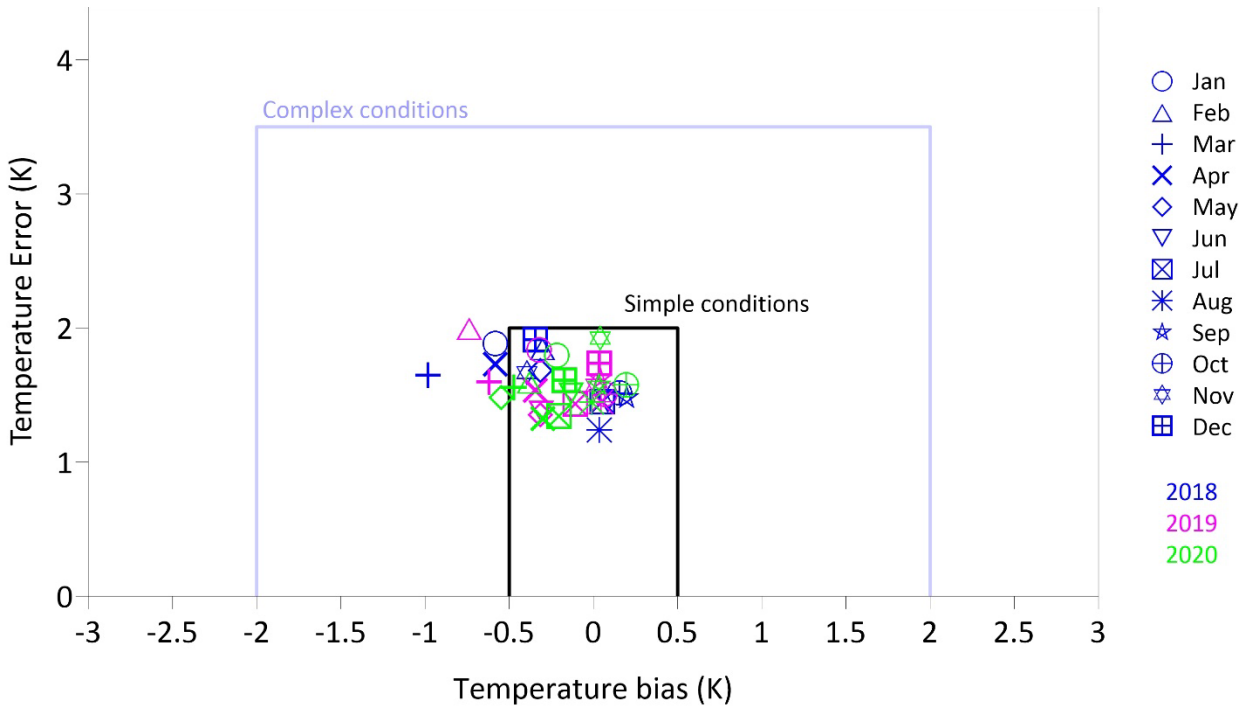

Figure 32 Soccer plot of the temperature bias and error for a 3-year period, by month, for all stations.

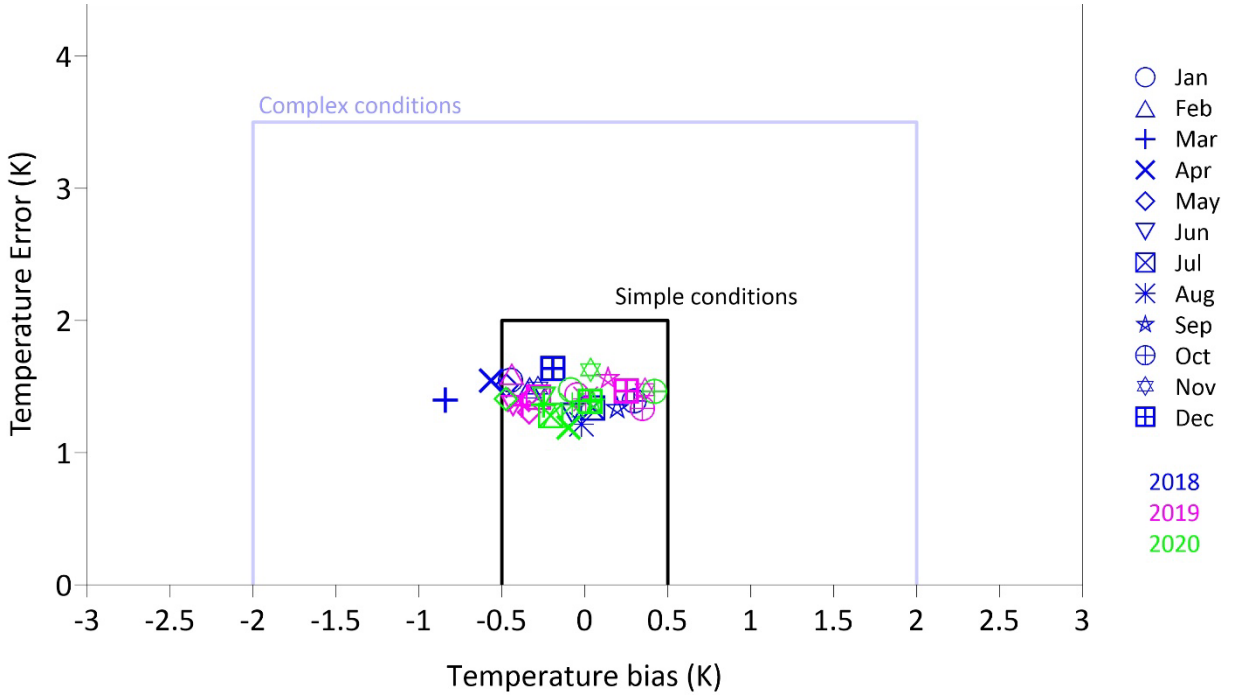

Figure 33 Soccer plot of the temperature bias and error for a 3-year period, by month, for coastal stations.

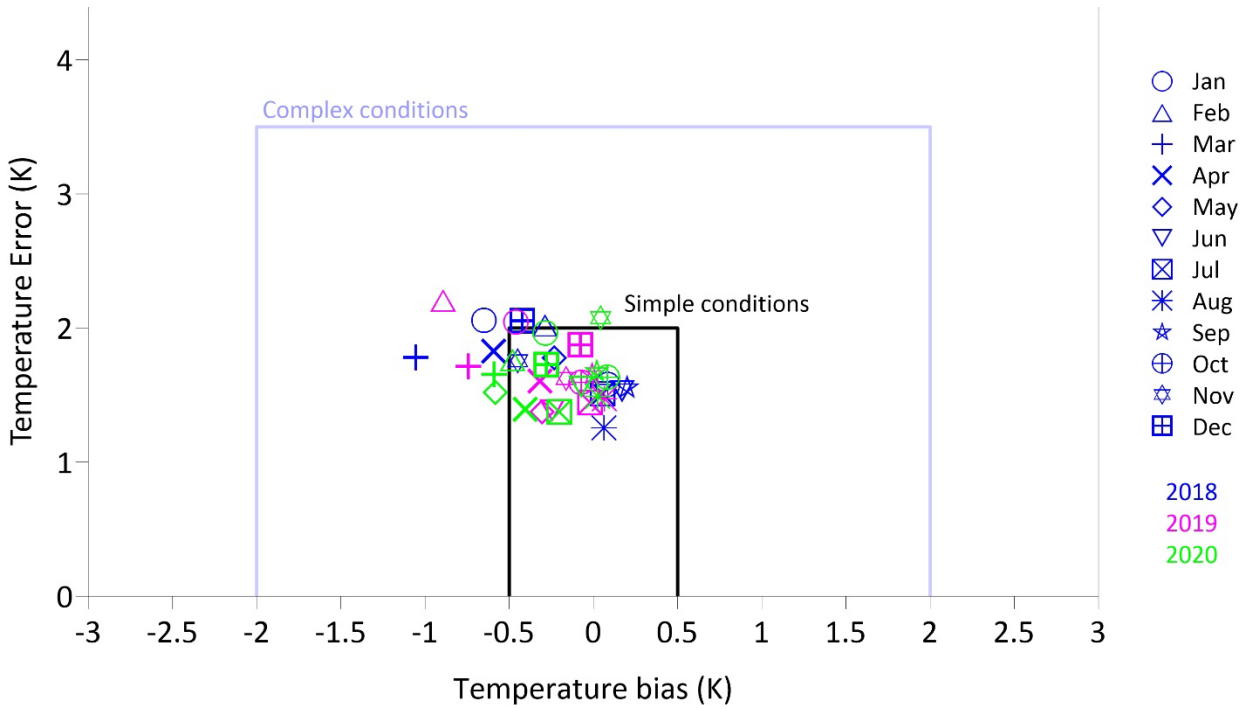

Figure 34 Soccer plot of the temperature bias and error for a 3-year period, by month, for inland stations.

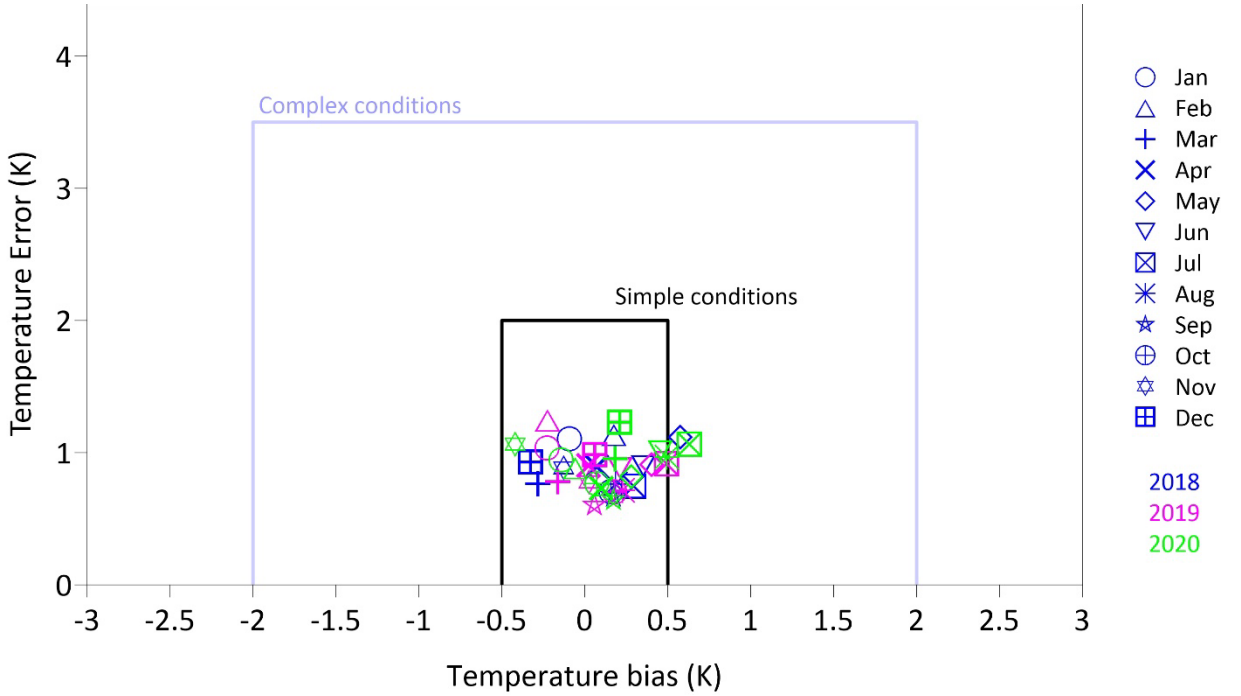

Figure 35 Soccer plot of the temperature bias and error for a 3-year period, by month, for overwater stations.

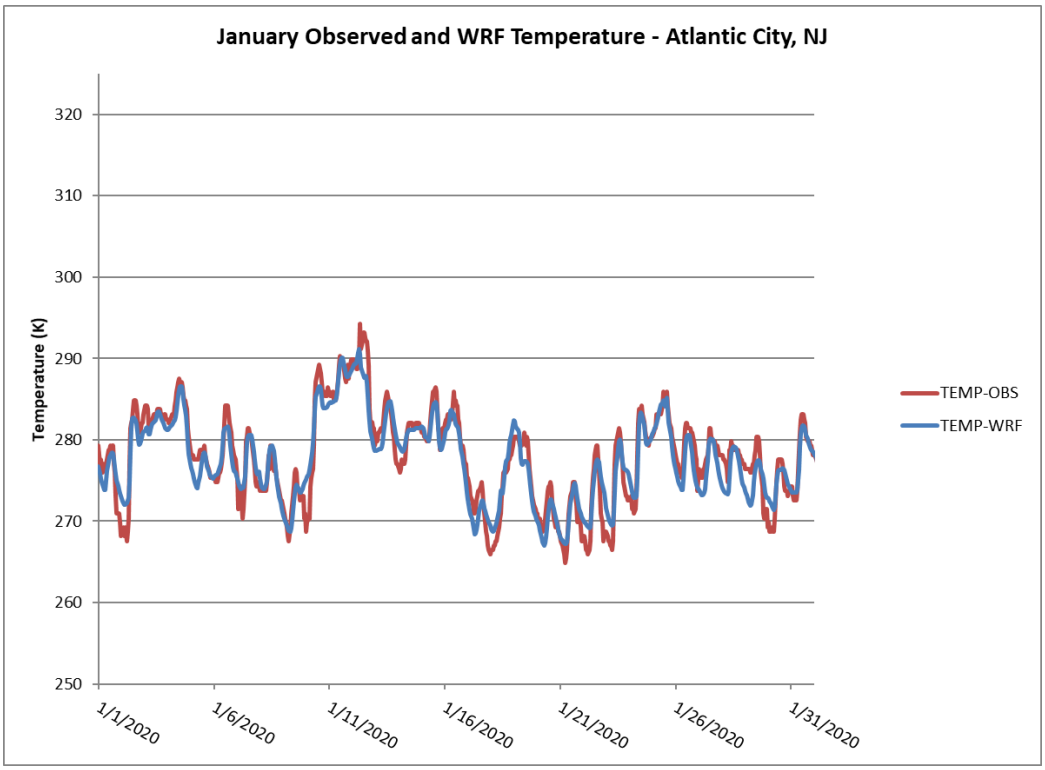

Figure 36 Observed and modeled temperature for Atlantic City January 2020.

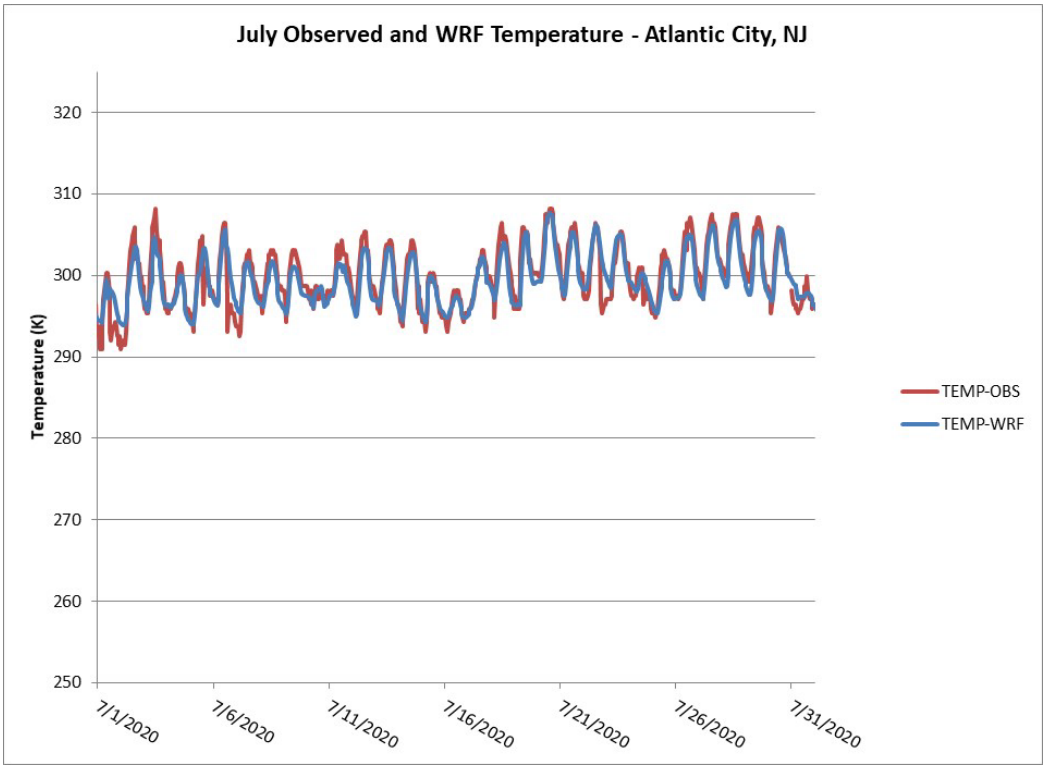

Figure 37 Observed and modeled temperature for Atlantic City July 2020.

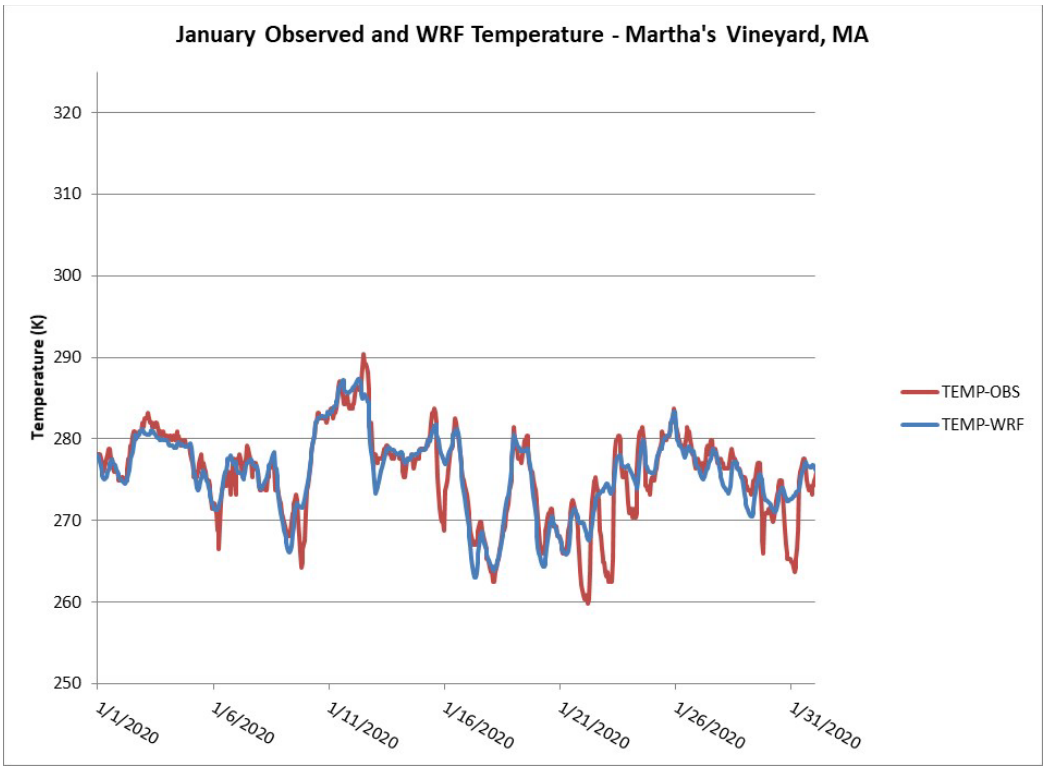

Figure 38 Observed and modeled temperature for Martha's Vineyard January 2020.

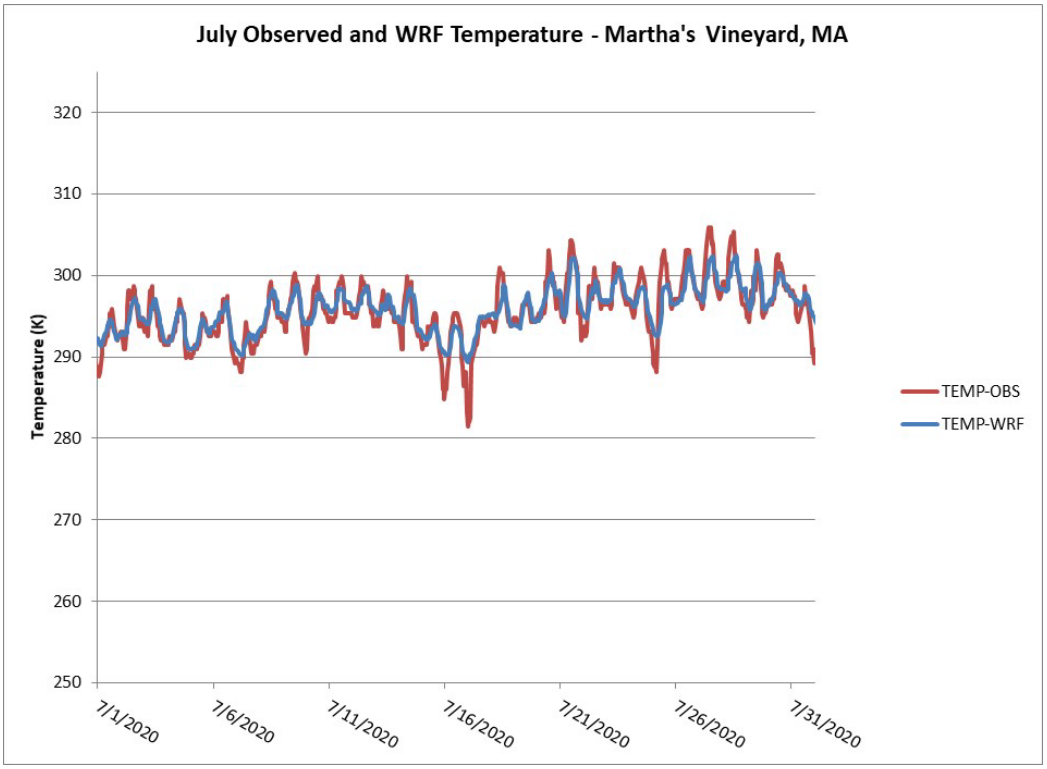

Figure 39 Observed and modeled temperature for Martha's Vineyard July 2020.

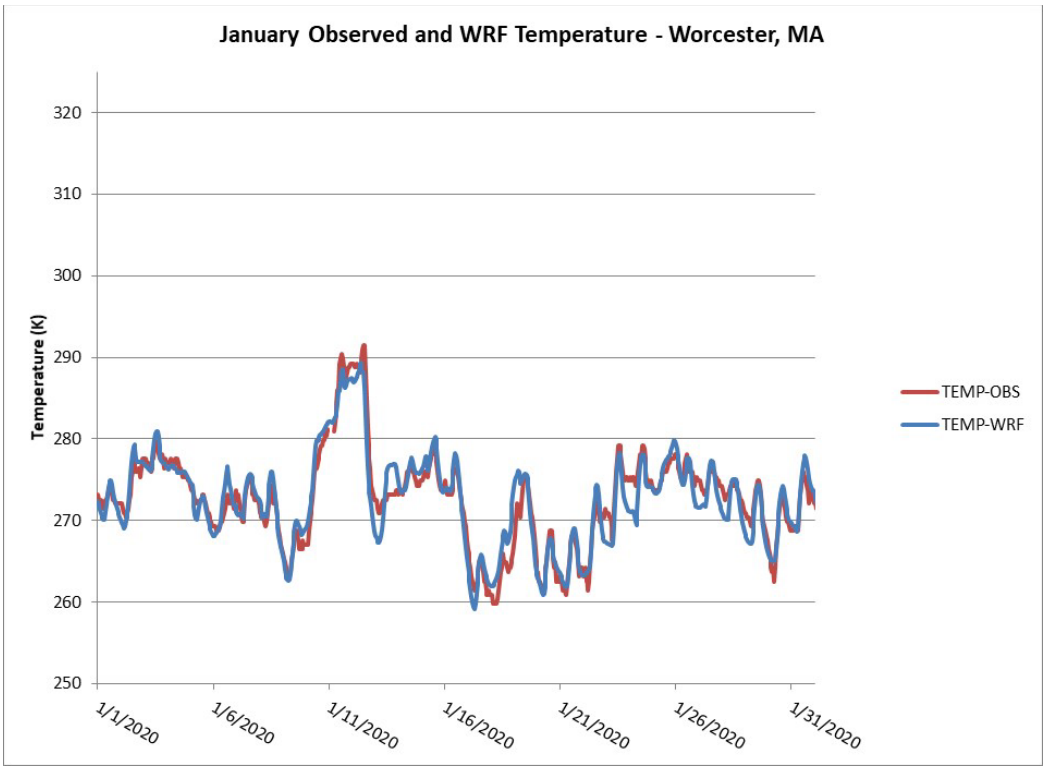

Figure 40 Observed and modeled temperature for Worcester January 2020.

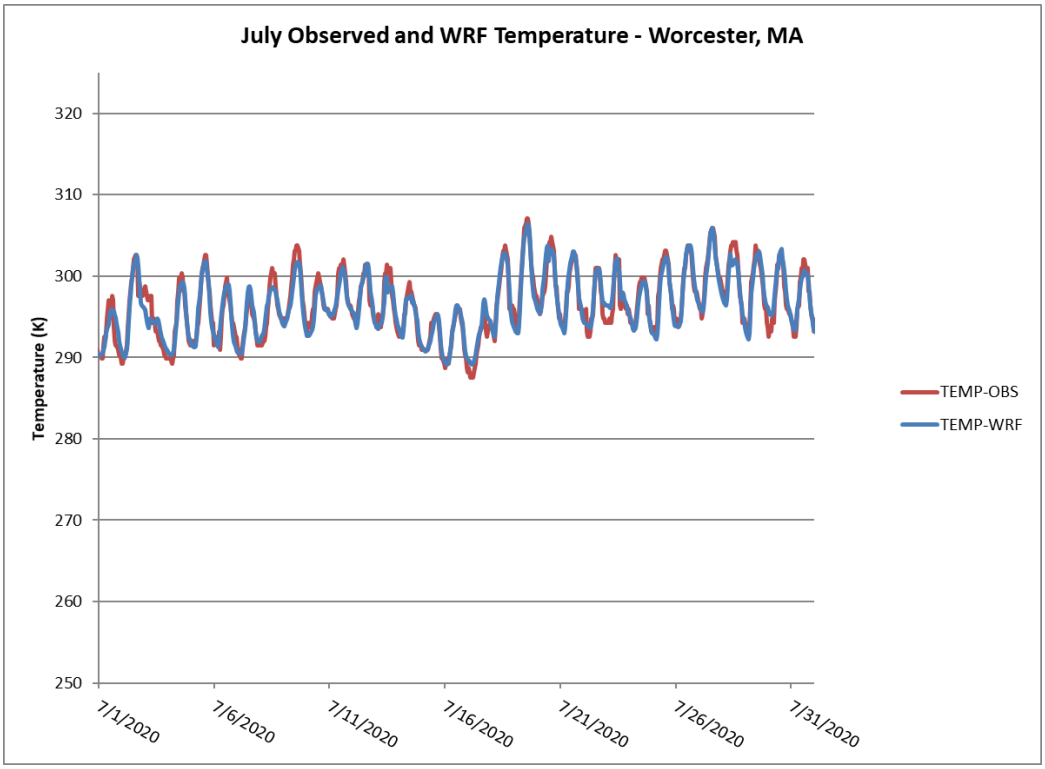

Figure 41 Observed and modeled temperature for Worcester July 2020.

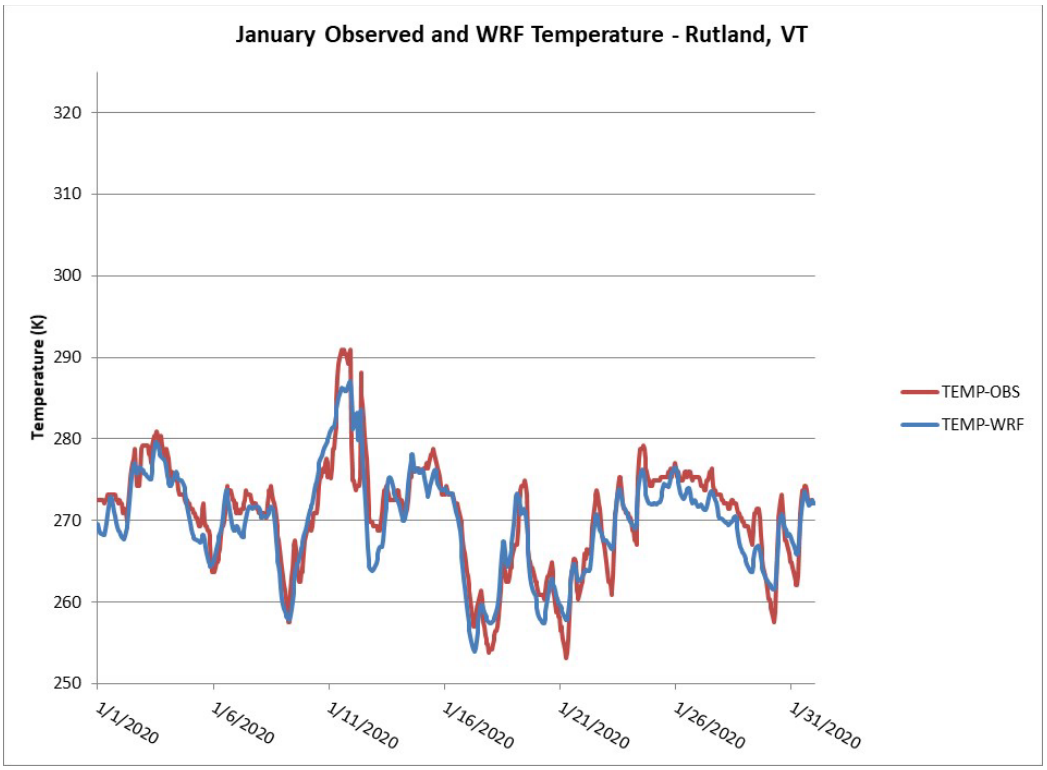

Figure 42 Observed and modeled temperature for Rutland, VT January 2020.

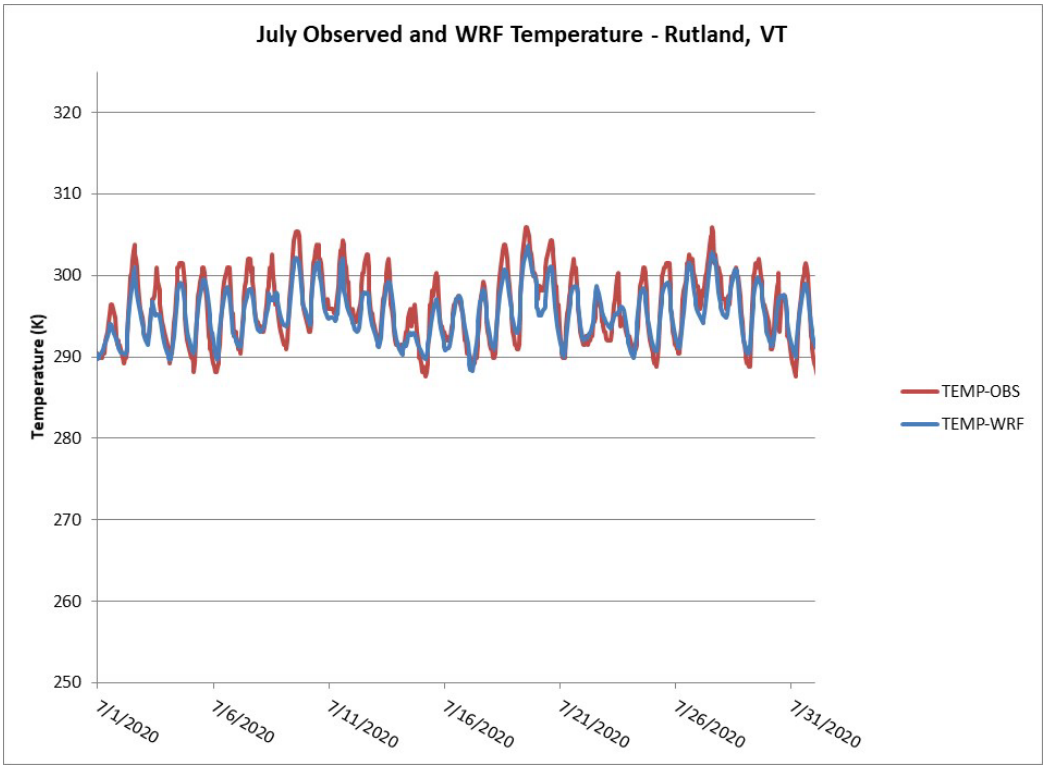

Figure 43 Observed and modeled temperature for Rutland, VT July 2020.

Specific Humidity

The final analysis considers model performance for specific humidity. A summary of the evaluation statistics for specific humidity are presented in Table 6. IOA, Bias values and Gross Errors are within the performance benchmarks. While all of the results show good performance, overwater stations receive slightly lower scores when compared to inland or coastal stations. The soccer plots in Figure 44 through Figure 37 show the performance statistics of specific humidity on a monthly basis for a 3-year period (2018-2020). Results are generally within the expected ranges, except for the overwater stations that show high bias for certain months.

Time series of specific humidity for January and July 2020 are shown in Figure 48 through Figure 55. Winter model predictions match well with observations. During the summer there is a tendency for the model to over predict daytime humidity levels. This behavior is most pronounced for Martha's Vineyard, much less so for Atlantic City and Worcester, and not there for Rutland.

Humidity in the CALPUFF model is used in the chemical transformation modules and as part of visibility calculations. Humidity is also used when calculating the overwater mixing height in CALMET, but that calculation is bypassed through direct use of WRF data in this application.

Conclusions

The WRF simulations provide reliable representations of meteorological parameters important for air dispersion modeling. Wind speeds, wind directions, temperature and specific humidity are well within the range of the benchmarks for good model performance. Further analysis demonstrates that the distribution of winds reliably reproduces the regional conditions and diurnal profiles of modeled parameters and are well matched during sampled winter and summer months. The simulations will provide an accurate distribution of meteorological conditions which will be important when calculating the visibility and deposition impacts in Class I areas.

Table 6. Statistical Model Performance for Specific Humidity

		Specific Humidity		
	Year	IOA -	Mean Bias g/kg	Gross Error g/kg
Benchmark		≥ 0.6	≤ ±1	≤ 2
All Surface	2018	0.79	0.54	0.89
	2019	0.85	0.40	0.73
	2020	0.84	0.46	0.79
Coastal Surface	2018	0.73	0.63	0.95
	2019	0.78	0.50	0.84
	2020	0.76	0.66	0.92
Inland Surface	2018	0.80	0.50	0.86
	2019	0.87	0.35	0.68
	2020	0.86	0.36	0.72
Overwater	2018	0.61	0.70	1.14
	2019	0.67	0.62	1.05
	2020	0.60	0.63	0.94

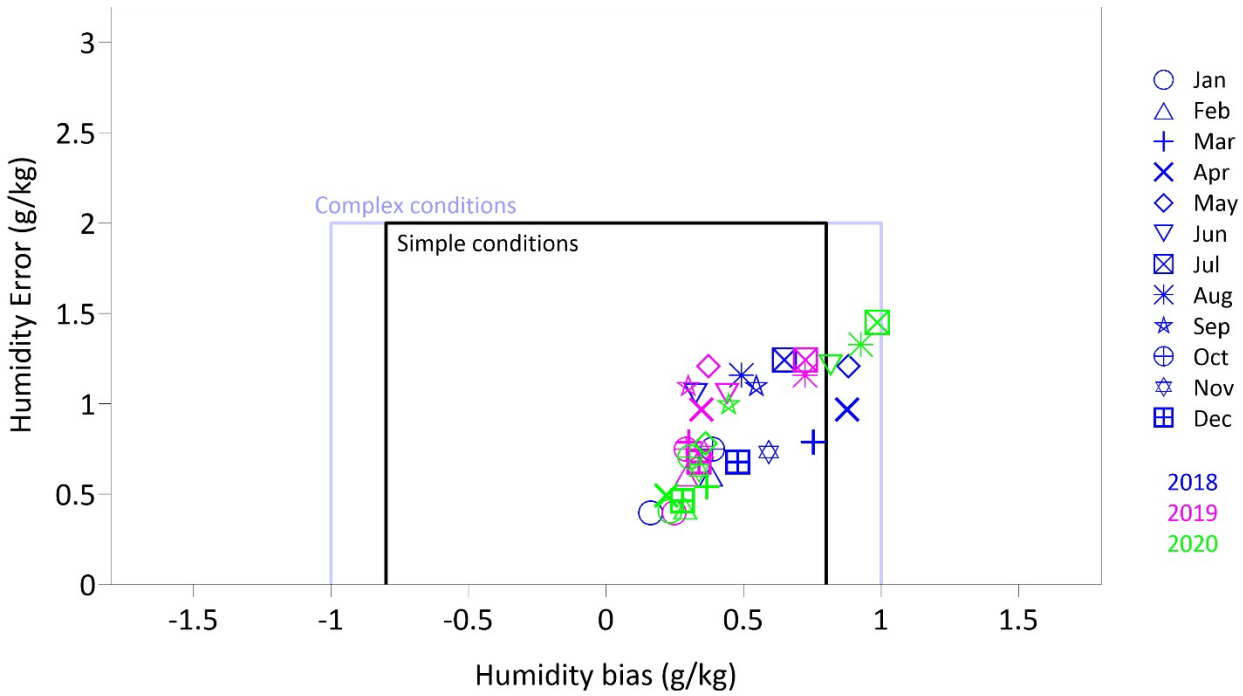

Figure 44 Soccer plot of the specific humidity bias and error for a 3-year period, by month, for all stations.

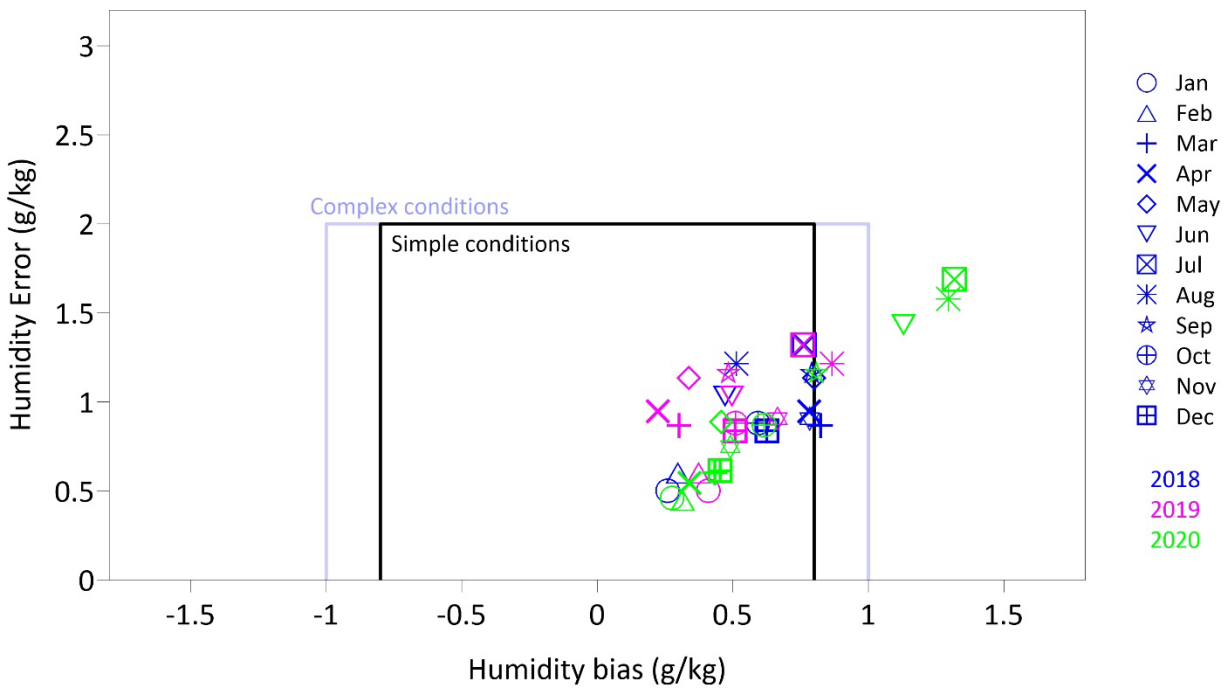

Figure 45 Soccer plot of the specific humidity bias and error for a 3-year period, by month, for coastal stations.

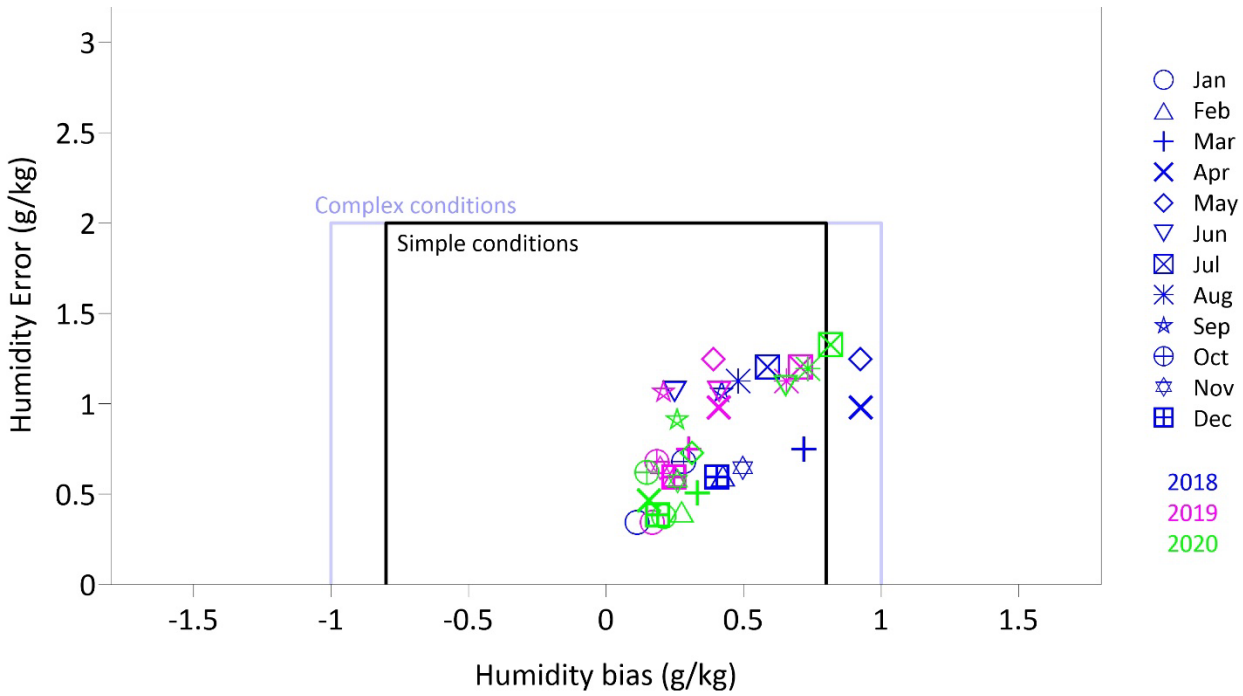

Figure 46 Soccer plot of the specific humidity bias and error for a 3-year period, by month, for inland stations.

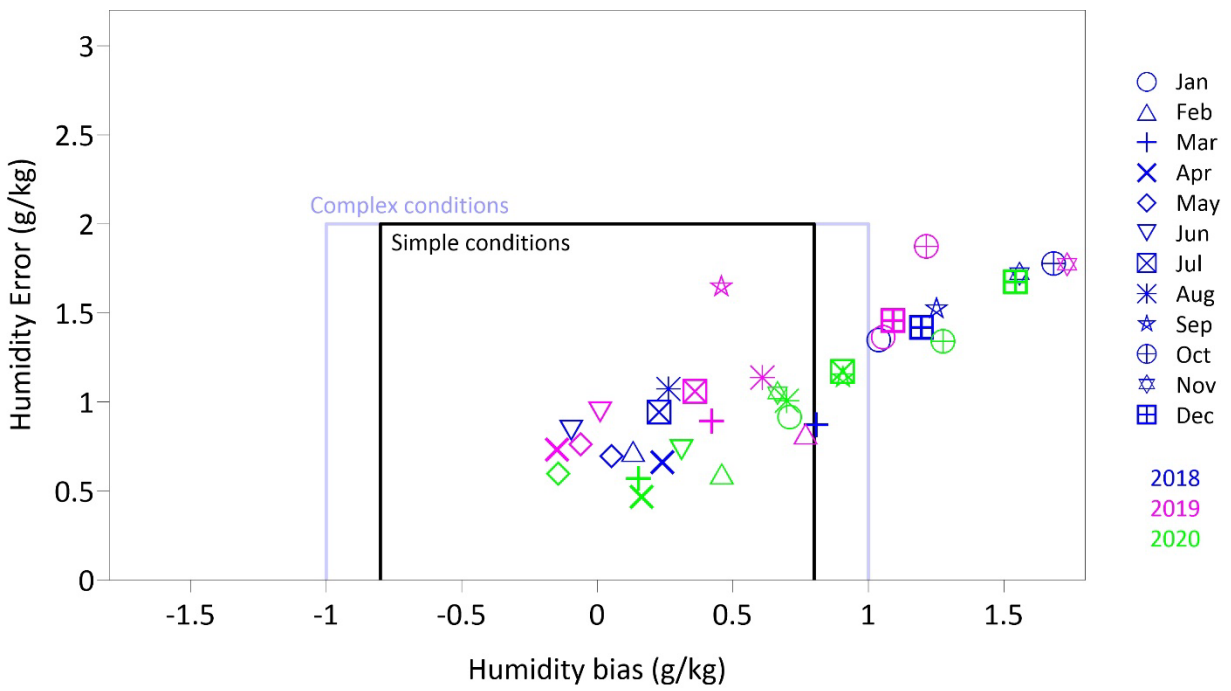

Figure 47 Soccer plot of the specific humidity bias and error for a 3-year period, by month, for overwater stations.

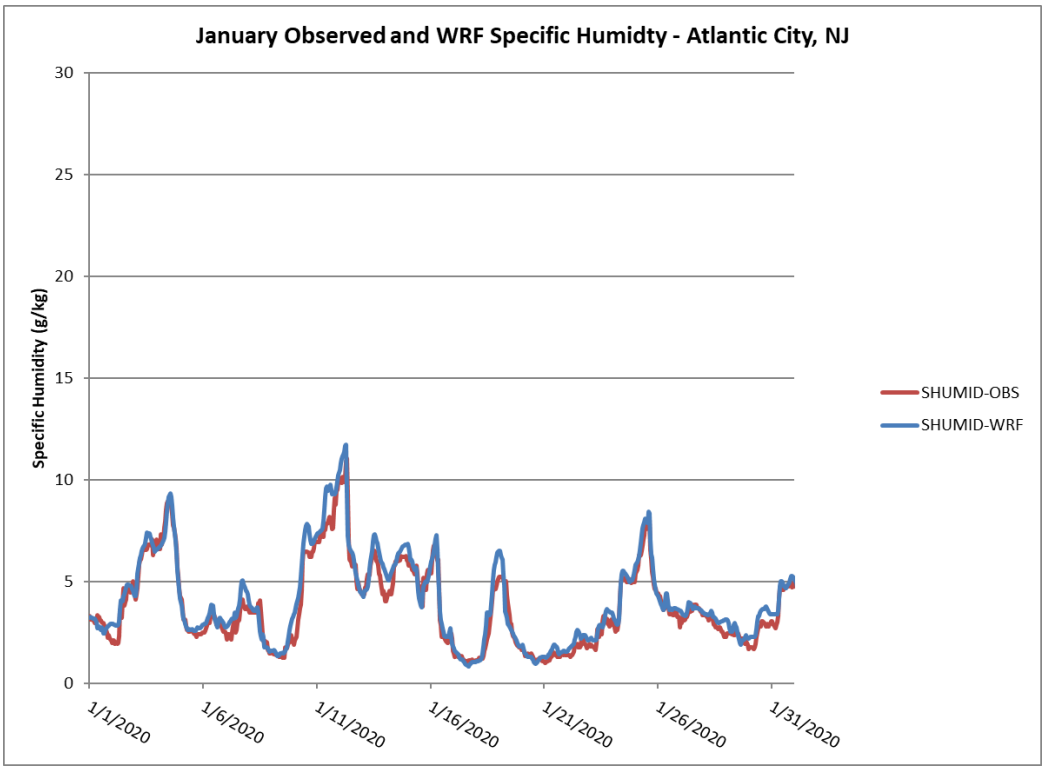

Figure 48 Observed and modeled humidity for Atlantic City January 2020.

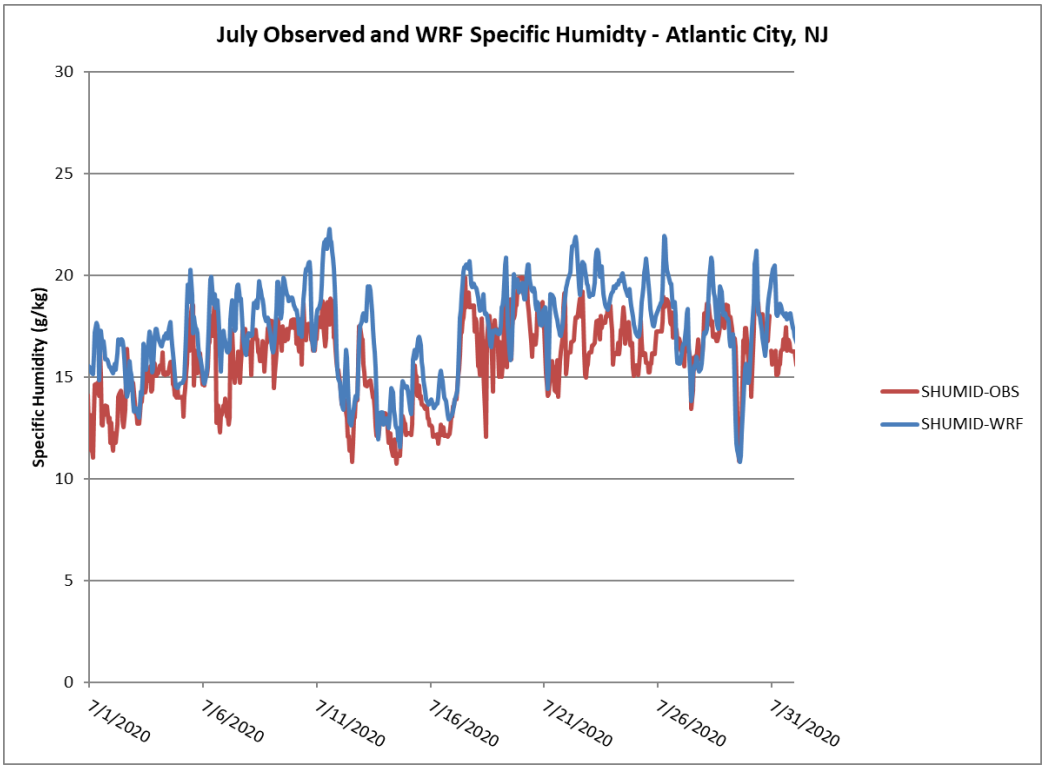

Figure 49 Observed and modeled humidity for Atlantic City July 2020.

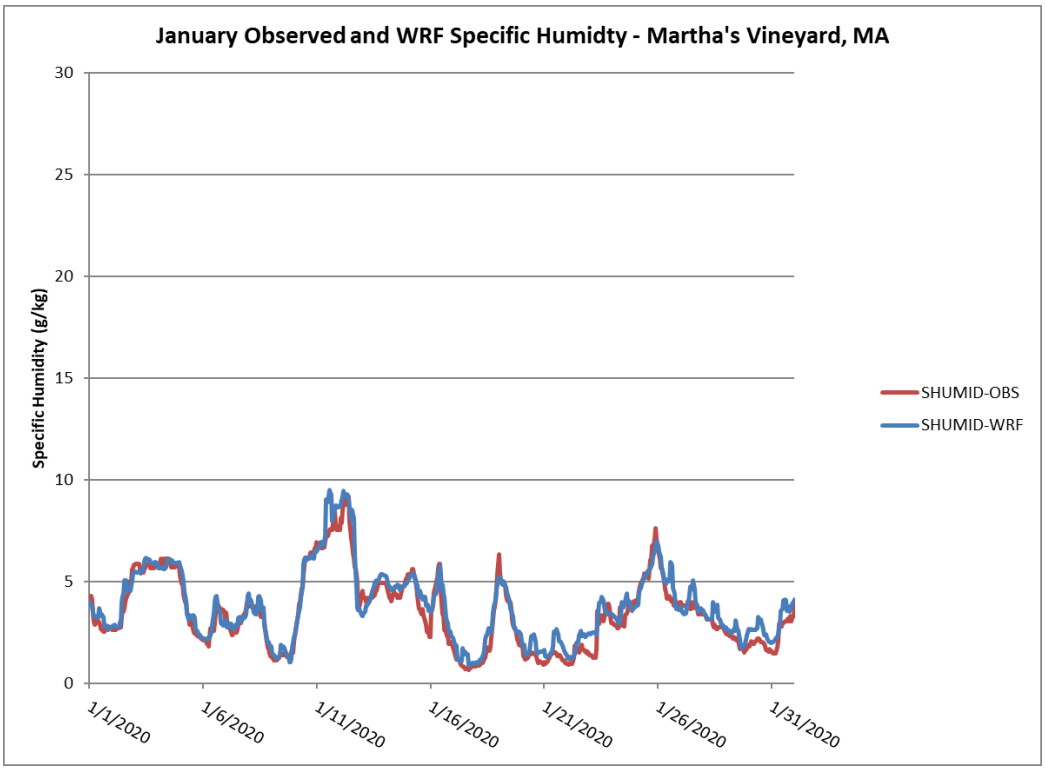

Figure 50 Observed and modeled humidity for Martha's Vineyard January 2020.

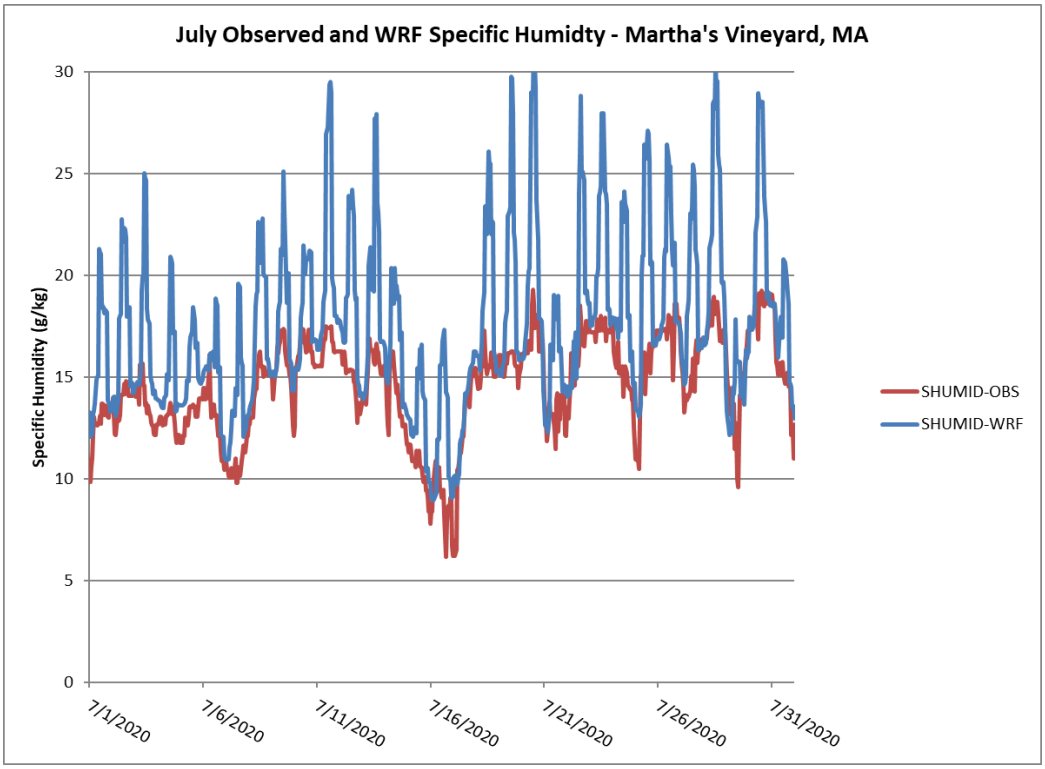

Figure 51 Observed and modeled humidity for Martha's Vineyard July 2020.

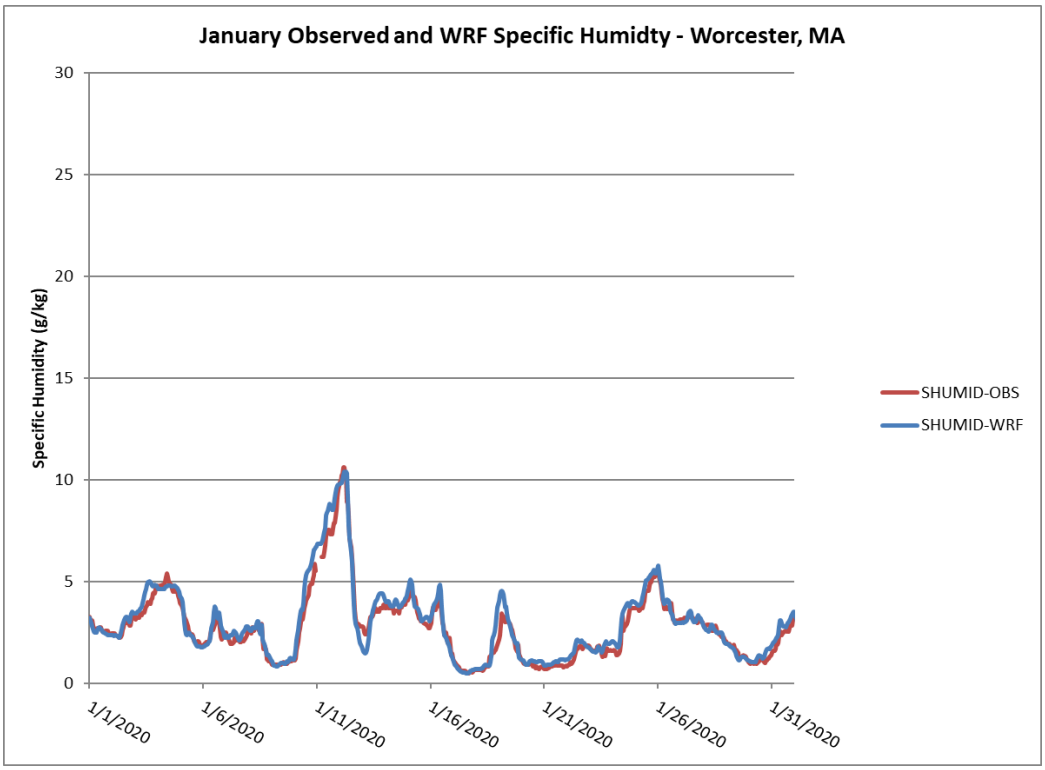

Figure 52 Observed and modeled humidity for Worcester January 2020.

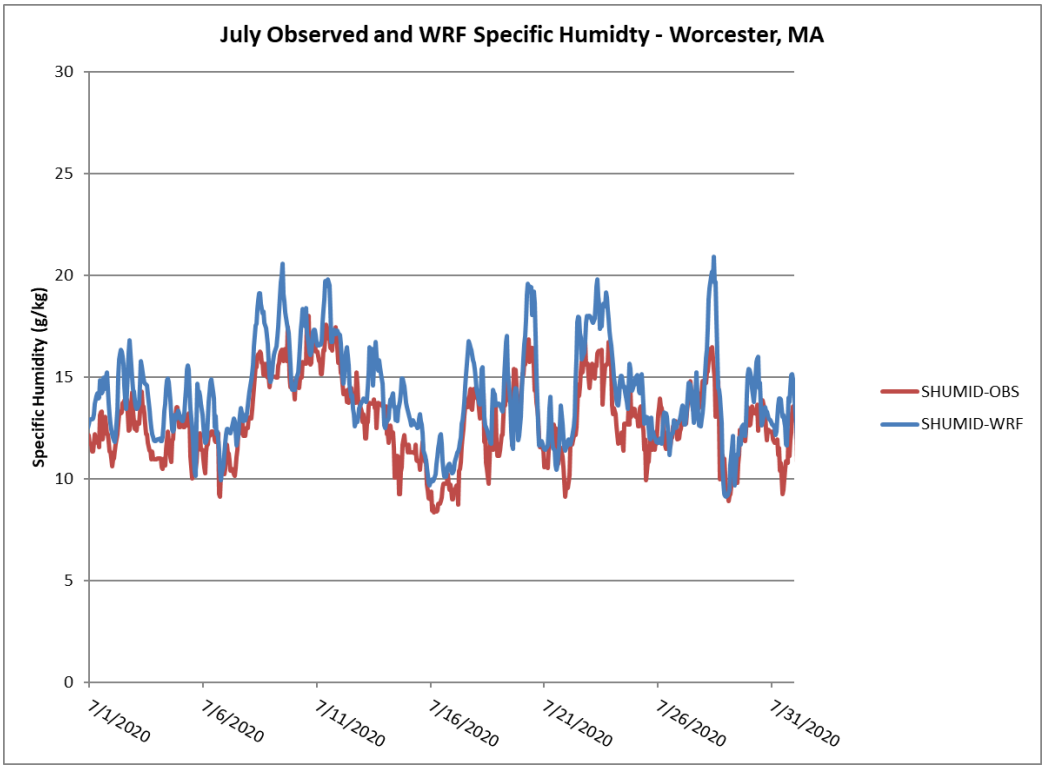

Figure 53 Observed and modeled humidity for Worcester July 2020.

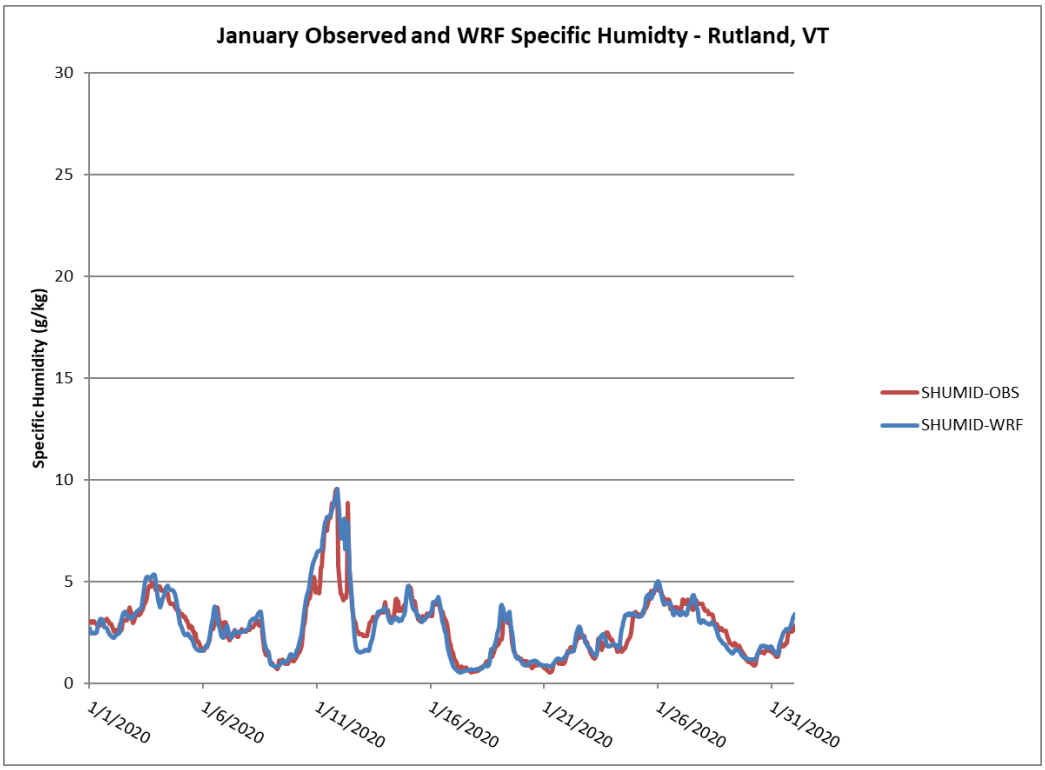

Figure 54 Observed and modeled humidity for Rutland, VT January 2020.

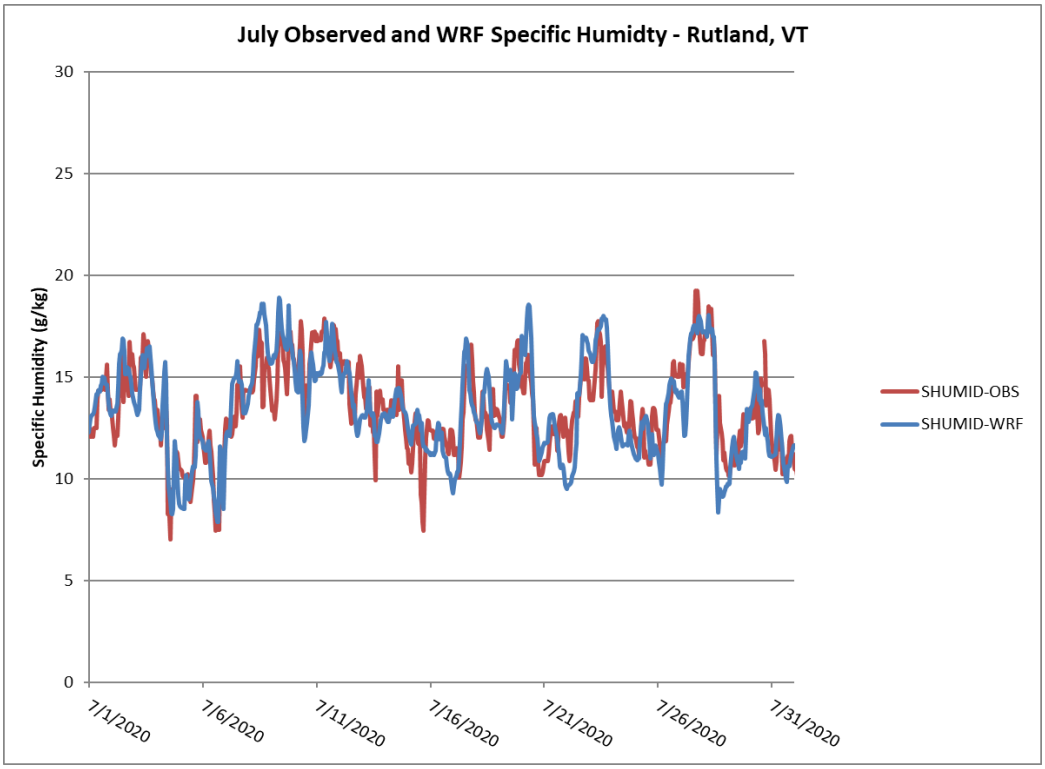

Figure 55 Observed and modeled humidity for Rutland, VT July 2020.

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