Ocean Wind
An Ørsted & PSEG project

Ms. Viorica Petriman
EPA Region 2
290 Broadway
New York, NY 10007-1866
[submitted via email to Petriman.Viorica@epa.gov]

15 July 2022

RE: Ocean Wind LLC Permit Application

Ms. Petriman:

Ocean Wind LLC, an affiliate of Orsted Wind Power North America LLC, submits this revised outer continental shelf (OCS) air permit application to EPA Regional Office 2 in accordance with the requirements of 40 CFR § 55. This application is also being submitted to the New Jersey Department of Environmental Protection, the Federal Land Manager of the Edwin B. Forsythe National Wildlife Refuge, the United States Fish and Wildlife Service and to the Bureau of Ocean Energy Management.

This application package contains a revised permit application in response to comments received from EPA on the original submittal of the permit application in March 2022. Responses to EPA comment on the permit application are included in Appendix K of this application. This application package also contains updated vessel assumptions (type, number, duration of use, etc.) based on the most up-to-date plans and schedule for both the construction and commissioning phase and the operations and maintenance phase.

Appendix K of this revised permit application contains trade secrets and/or commercial or financial information that is privileged and confidential, and which is exempt from public disclosure under the Federal Freedom of Information Act (5 United States Code [U.S.C.] § 552(b)(4). This privileged and confidential information is also exempt from public disclosure under the New Jersey Open Records Act (pursuant to New Jersey Administrative Code [N.J.A.C.] 47:IA), N.J.A.C. 7: ID-3, National Historic Preservation Act (16 U.S.C. Part 470w-3) and the Archaeological Resources Protection Act of 1979 (16 U.S.C. 4702-3). Ocean Wind has marked each section of Appendix K that contains privileged and confidential material with the legend “Contains Confidential Information”, and requests that EPA (and each federal and state agency to which a copy of this permit application is provided) withhold the entirety of each designated section of Appendix K from public disclosure. The sections of Appendix K that are considered confidential have been redacted in the public copy of the permit application being provided.

Thank you in advance for your consideration of this revised permit application. Please contact Douglas Gordon, Air Permit Lead (PSE&G), at Douglas.Gordon@pseg.com or (201) 400-9039 if you have any questions or require additional information. We look forward to working with you and the appropriate delegated authority in the review of this application.

Yours sincerely,

Marc Reimer

Marc Reimer
Ocean Wind Project Development Director
Orsted North America Inc., sole member of Ocean Wind LLC

cc. Pilar Patterson, Mid-Atlantic Permitting Program Manager, Ocean Wind
Katharine Perry, Ocean Wind Permitting Manager
Meghan Albers, Environmental Manager, Ocean Wind
Bryan Stockton, Head of Regulatory Affairs, Government Affairs &Policy
David Hinchey, Major Permitting / Environmental Lead, PSE&G
John Duschang, HDR Project Manager

Francis Steitz
Division of Air Quality Director
New Jersey Department of Environmental Protection
PO Box 420
Mail Code 401-02
401 East State Street, 2nd Floor
Trenton, NJ 08625-0420
[submitted via email to: francis.steitz@dep.nj.gov]

Tim Allen
Federal Land Manager
United States Fish and Wildlife Services
Northeast Region
301 Westgate Center Drive
Hadley, MA 01035
[submitted via email to: tim_allen@fws.gov]

Will Waskes
Project Coordinator, Bureau of Ocean Energy Management Office of Renewable Energy Programs
Bureau of Ocean Energy Management
45600 Woodland Road, VAM-OREP
Sterling, VA 20166
[submitted via email to: will.waskes@boem.gov]

Ocean Wind
An Ørsted & PSEG project

Ocean Wind Offshore Wind Farm

OCS Air Permit Application

July 15, 2022

Table of Contents

1. Introduction 9
2. Project Description 10
2.1 Project Location 10
2.2 Project Infrastructure Overview 10
2.3 Project OCS Sources 12
2.3.1 Construction and Commissioning 13
2.3.2 O&M 17
2.4 Construction and Commissioning Schedule and Installation Sequencing 18
2.4.1 Offshore Export Cable Installation 18
2.4.2 Monopile Foundation Installation – WTG and OSS 18
2.4.3 Inter-array Cable Installation 20
2.4.4 WTG and OSS Topside Installation and Commissioning 21
2.4.5 Construction Support Vessels 22
2.5 Overview of Emission Units 23
2.5.1 Construction and Commissioning 23
2.5.2 O&M 26
3. Project Emissions 28
3.1 Calculation Methodology 28
3.1.1 Marine Vessel Engines 28
3.1.2 Engines of Auxiliary Equipment Onboard Vessels 33
3.1.3 Generator Engines 34
3.1.4 Fugitive Emissions 34
3.1.5 Emission Summary - Construction and Commissioning Phase 35
3.1.6 Emission Summary - O&M Phase 35
4. Applicable Regulatory Requirements 35
4.1 Federal Requirements 36
4.1.1 PSD Review 36
4.1.2 Title V Operating Permit 39
4.1.3 New Source Performance Standards (NSPS) 39
4.1.4 National Emission Standards for Hazardous Air Pollutants (NESHAP) 43

4.1.5 Other Federal Regulations for Marine Compression-Ignition Engines and Non-Road Compression-Ignition Engines 44
4.1.6 Coastal Zone Management Act Requirements 47
4.2 State Requirements 47
4.2.1 Chapter 27 Subchapter 2 - Control and Prohibition of Open Burning (Effective 6/20/1994) 47
4.2.2 Chapter 27 Subchapter 3 - Control and Prohibition of Smoke From Combustion of Fuel (Effective 2/4/2002) 47
4.2.3 Chapter 27 Subchapter 4 - Control and Prohibition of Particles From Combustion of Fuel (Effective 4/20/2009) 48
4.2.4 Chapter 27 Subchapter 5 - Prohibition of Air Pollution (Effective 10/12/1977) 48
4.2.5 Chapter 27 Subchapter 6 - Control and Prohibition of Particles From Manufacturing Processes (Effective 6/12/1998) 48
4.2.6 Chapter 27 Subchapter 7 - Sulfur (Effective 11/6/2017) 48
4.2.7 Chapter 27 Subchapter 8 - Permits and Certificates for Minor Facilities (and Major Facilities Without an Operating Permit) (Effective 1/16/2018) 48
4.2.8 Chapter 27 Subchapter 9 - Sulfur in Fuels (Effective 9/20/2010) 49
4.2.9 Chapter 27 Subchapter 10 - Sulfur in Solid Fuels (Effective 9/6/2011) 49
4.2.10 Chapter 27 Subchapter 11 - Incinerators (Effective 5/4/1998) 49
4.2.11 Chapter 27 Subchapter 12 - Prevention and Control of Air Pollution Emergencies (Effective 5/20/1974) 49
4.2.12 Chapter 27 Subchapter 16 - Control and Prohibition of Air Pollution by VOCs (Effective 1/16/2018) 49
4.2.13 Chapter 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) 49
4.2.14 Chapter 27 Subchapter 19 - Control and Prohibition of Air Pollution From Oxides of Nitrogen (Effective 1/16/2018) 50
4.2.15 Chapter 27 Subchapter 21 - Emission Statements (Effective 1/16/2018) 50
4.2.16 Chapter 27 Subchapter 22 - Operating Permits (Effective 1/16/2018) 51
4.2.17 Chapter 27B Subchapter 1 - Sampling and Analytical Procedures for Determining Emissions of Particles From Manufacturing Processes and From Combustion of Fuels (Effective 6/21/1976) 51
4.2.18 Chapter 27B Subchapter 2 - Procedures for Visual Determination of the Opacity (Percent) and Shade or Appearance (Ringelmann Number) of Emissions From Sources (Effective 6/21/1976) 52
4.2.19 Chapter 27B Subchapter 3 - Air Test Method 3: Sampling and Analytical Procedures for the Determination of VOCs From Source Operations (Effective 12/1/2008) 52

5. Analysis of Alternative Sites, Sizes, Production Processes, Pollution Prevention Measures, and Environmental Control Techniques....52
5.1 Analysis of Alternative Sites, Sizes, and Production Processes....52
5.2 Pollution Prevention Measures and Environmental Control Techniques....52
5.3 Minimizing Environmental Costs....53
5.4 Minimizing Social Costs....53
6. Air Pollution Control Technology Review – LAER/BACT/SOTA....53
6.1 Technology Review....53
6.1.1 Design and Retrofit Technologies....53
6.1.2 Fuel Alternatives....56
6.1.3 Add-On Controls....58
6.2 LAER Determination....60
6.2.1 Engines Powering Vessels Meeting the Definition of an OCS Source – NO_x....61
6.2.2 Engines Powering Vessels Meeting the Definition of an OCS Source – VOC....74
6.2.3 Engines Powering Electric Generators on WTG and OSS and Engines Powering Auxiliary Equipment Onboard Vessels Considered OCS Sources – NO_x and VOC....76
6.3 BACT Determination....102
6.3.1 Engines Powering Vessels Meeting the Definition of an OCS Source – NO_x....102
6.3.2 Engines Powering Vessels Meeting the Definition of an OCS Source – CO....103
6.3.3 Engines Powering Vessels Meeting the Definition of an OCS Source – PM, PM_{10}, and $PM_{2.5}$....103
6.3.4 Engines Powering Vessels Meeting the Definition of an OCS Source – GHG....104
6.3.5 Engines Powering Electric Generators on WTG and OSS and Engines Powering Auxiliary Equipment Onboard Vessels Considered OCS Sources – NO_x....105
6.3.6 Engines Powering Electric Generators on WTGs and OSSs and Engines Powering Auxiliary Equipment Onboard Vessels Considered OCS Sources – CO105
6.3.7 Engines Powering Electric Generators on WTG and OSS and Engines Powering Auxiliary Equipment Onboard Vessels Considered OCS Sources – PM, PM_{10}, and $PM_{2.5}$....105
6.3.8 Engines Powering Electric Generators on WTG and OSS and Engines Powering Auxiliary Equipment Onboard Vessels Considered OCS Sources – GHG....106
6.4 SOTA Determination....106
6.4.1 Construction and Commissioning Phase....106
6.4.2 O&M Phase....107
7. Proposed Permit Conditions....107

7.1 Construction and Commissioning Phase....107
7.2 O&M Phase....107
8. Emissions Offsets....107
9. Additional Impact Analysis....108
10. Source Impact Analysis....108
11. AQRV Analysis....108
12. Environmental Justice....108
12.1 New Jersey's Environmental Justice Law....108
12.2 EPA Executive Orders on Environmental Justice....109
12.2.1 EJSCREEN 2.0 Analysis....111

Appendices

Appendix A O&M OCS Source Determination Supporting Documentation
Appendix B O&M OCS Source – Alternate Approach
Appendix C Emissions Calculations
Appendix D Air Dispersion Modeling Protocol – Revised July 15, 2022
Appendix E PSD and AQRV Modeling Report
Appendix F Coastal Zone Consistency Assessment and Documentation of Submittal to NJDEP
Appendix G RBLC Database Search Results from South Fork, LLC OCS Permit Application
Appendix H SCAQMD and CARB BACT Database Search Results from South Fork, LLC OCS Permit Application
Appendix I AQRV Modeling Protocol
Appendix J EJSCREEN 2.0 Report
Appendix K EPA Region 2 Comment on March 2022 Permit Application and Responses

(Contains Confidential Information – Not for Public Disclosure)

List of Tables

Table 2-1. Vessel List – Construction and Commissioning Phase....23
Table 2-2. Auxiliary Equipment List – Construction and Commissioning Phase....25
Table 2-3. Generator List – Construction and Commissioning Phase....26
Table 2-4. Marine Vessel List – O&M Phase....26
Table 2-5. Auxiliary Equipment List – O&M Phase....27
Table 2-6. Generator List – O&M Phase....27
Table 3-1. Vessel Equivalency Assumptions....30
Table 3-2. Ports During Construction....31
Table 3-3. Emission Estimates – Construction and Commissioning Phase....35

Table 3-4. Annual Emission Estimates – O&M Phase. 35
Table 4-1. Applicability of Federal Regulations per 40 CFR § 55.13. 36
Table 4-2. WTA Potential-to-Emit During Construction and Commissioning and PSD SER Thresholds..... 37
Table 4-3. Potential-to-Emit During O&M and PSD Major Source Thresholds. 38
Table 4-4. NSPS Subpart IIII Emission Standards for Non-Emergency CI ICE with a Displacement of Less Than 30 Liters Per Cylinder. 40
Table 4-5. NSPS Subpart IIII Emission Standards for Non-Emergency CI ICE with a Displacement of 30 Liters or More Per Cylinder. 41
Table 4-6. NSPS Subpart IIII Emission Standards for Emergency CI ICE with a Displacement of Less Than 10 Liters Per Cylinder..... 41
Table 4-7. NSPS Subpart IIII Emission Standards for Emergency CI ICE with a Displacement of 10 Liters per Cylinder or More and Less Than 30 Liters Per Cylinder. 42
Table 4-8. NSPS Subpart IIII Emission Standards for Emergency CI ICE with a Displacement of 30 Liters or More Per Cylinder. 43
Table 4-9. MARPOL Annex VI NO_x Emission Limits..... 45
Table 4-10. Operating Permit Facility Thresholds. 51
Table 6-1. NJDEP Major Facility Thresholds. 60
Table 6-2. NJDEP Significant Net Emission Increases. 61
Table 6-3. Rules Related to Marine Vessel Engines Identified in SIPs..... 62
Table 6-4. RBLC Database Updated Review for Large (>500 HP) Engines. 78
Table 6-5. RBLC Database Updated Review for Small (<500 HP) Engines. 92
Table 6-6. Tier Standards for 209 hp (150 kW) Diesel-Fired Electric Generator on the OSS..... 99
Table 6-7. Tier Standards for 102 hp (75 kW) Diesel-Fired Electric Generator on the OSS..... 100
Table 6-8. Tier Standards for 50 hp (40 kW) Diesel-Fired Electric Generator on the WTG. 100
Table 6-9. Tier Standards for 800 hp (600 kW) Diesel-Fired Electric Generator on the OSS..... 100
Table 6-10. Tier Standards for 5 hp (4 kW) Diesel-Fired Electric Generator on the Jack-up Vessel. 100
Table 6-11. Tier Standards for 90 hp (70 kW) Diesel-Fired Cherry Picker on the Jack-up Vessel. 101

List of Figures

Figure 2-1. Project Location and Layout. 11
Figure 2-2. Key Project Components. 12
Figure 2-3. OCS Air Permit Circle with a 25-nm Radius. 15
Figure 2-4. Indicative Construction Schedule. 19
Figure 2-5. First-end Pull..... 21
Figure 2-6. Second-end Pull. 21

Table of Abbreviations

AQRV	Air Quality Related Values
BACT	Best Available Control Technology
BOEM	Bureau of Ocean Energy Management
CAA	Clean Air Act
CARB	California Air Resources Board
CCR	California Code of Regulation
CFR	Code of Federal Regulation
CH_4	Methane
CI	Compression Ignition
CO	Carbon Monoxide
CO_2e	Carbon Dioxide Equivalent
COA	Corresponding Onshore Area
COP	Construction and Operations Plan
CTV	Crew Transfer Vessel

DPF	Diesel Particulate Filter
EAB	Environmental Appeals Board
ECA	Emission Control Area
EIAPP	Engine International Air Pollution Prevention
EPA	Environmental Protection Agency
FLM	Federal Land Manager
FTF	Flow-Through Filter
GHG	Greenhouse Gas
HAP	Hazardous Air Pollutant
H_2SO_4	Sulfuric Acid
HDD	Horizontal Directional Drilling
HC	Hydrocarbons
ICE	Internal Combustion Engine
IFO	Intermediate Fuel Oil
IMO	International Marine Organization
kW	Kilowatt
LAER	Lowest Achievable Emission Rate
LNC	Lean NOx Catalyst
LNT	Lean NOx Trap
LPG	Liquified Petroleum Gas
MACT	Maximum Achievable Control Technology
MARPOL	International Convention for the Prevention of Pollution from Ships
MDO	Marine Diesel Oil
MGO	Marine Gas Oil
MMBtu	Million British Thermal Units
MOVES	Motor Vehicle Emission Simulator
MW	Megawatt
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emission Standards for Hazardous Air Pollutants
NH_3	Ammonia
NJAAQS	New Jersey Ambient Air Quality Standards
N.J.A.C.	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NM	Nautical Mile
NMHC	Non-Methane Hydrocarbon
NNSR	Nonattainment New Source Review
N_2O	Nitrous Oxide
NO_x	Nitrogen Oxides
NSPS	New Source Performance Standards
NSR	New Source Review
O_3	Ozone
OCS	Outer Continental Shelf
O&M	Operations and Maintenance
OSCLA	Outer Continental Shelf Lands Act
OSS	Offshore Substations
Pb	Lead

PLGR	Pre-lay Grapnel Run
PM	Particulate Matter
PM_{10}	Particulate Matter with Diameter 10 Micrometer or Less
$PM_{2.5}$	Particulate Matter with Diameter 2.5 Micrometer or Less
PPM	Parts Per Million
PSD	Prevention of Significant Deterioration
PSEG	Public Service Enterprise Group Renewable Generation LLC
PTE	Potential to Emit
RACT	Reasonably Available Control Technology
RBLC	RACT/BACT/LAER Clearinghouse
RICE	Reciprocating Internal Combustion Engine
RSZ	Reduced Speed Zone
SAP	Site Assessment Plan
SCAQMD	South Coast Air Quality Management District
SCR	Selective Catalytic Reduction
SER	Significant Emission Rate
SF_6	Sulfur Hexafluoride
SIP	State Implementation Plan
SNCR	Selective Non-Catalytic Reduction
SO_2	Sulfur Dioxide
SOTA	State of the Art
TCEQ	Texas Commission on Environmental Quality
TPY	Tons per Year
TSP	Total Suspended Particles
ULSD	Ultra Low Sulfur Diesel
USFWS	United States Fish and Wildlife Service
VOC	Volatile Organic Compounds
WTA	Wind Turbine Array
WTG	Wind Turbine Generator

1. Introduction

In accordance with 40 Code of Federal Regulation (CFR) Part 55, Ocean Wind LLC (Ocean Wind), a joint venture between Orsted Wind Power North America, LLC (Orsted) and Public Service Enterprise Group Renewable Generation LLC (PSEG) submits this Outer Continental Shelf (OCS) air permit application to support the construction and operation of the Ocean Wind Offshore Wind Farm Project (Ocean Wind or Project). This air permit application has been prepared by Ocean Wind in accordance with OCS air permit regulations promulgated by the Environmental Protection Agency (EPA) in 40 CFR Part 55.

Ocean Wind is proposing to install wind turbine generators (WTGs) and offshore infrastructure required to transmit power generated by the WTGs to onshore interconnection point(s). The offshore components of the Project include WTGs, three offshore substations installed on platforms (OSSs), array cabling connecting WTGs, interconnection cabling connecting two of the OSSs together, up to three offshore export cables connecting OSSs to land, and emergency generators installed on a portion of the WTGs. The Project will install up to 98 WTGs. WTGs and OSSs will be constructed on monopile support structures anchored to the ocean floor. The Project will be located approximately 13 nautical miles (nm) southeast of the Atlantic City, New Jersey shoreline. The offshore export cables will be buried below the seabed surface within Federal and State waters. Construction will begin contingent upon required regulatory approvals; it is anticipated the Project will be constructed from 2023 through 2024 and is scheduled to have first power in 2024.

The purpose of the Project is to develop an offshore wind generation project within the Bureau of Ocean and Energy Management (BOEM) Lease Area (OCS-A 0498, Lease Area) to deliver competitively priced renewable energy and additional capacity to meet State and regional renewable energy demands and goals. The Project meets New Jersey's need to fulfil New Jersey's Offshore Wind Economic Development Act, which mandates the development of a minimum of 1,100 megawatts (MW) of offshore wind resources. The Project also contributes to meeting the need established by both NJ Executive Order 8, which set a goal for 3,500 MW of renewable energy by 2030, and Executive Order 92, which in November 2019 increased the goal to 7,500 MW by 2035.

As required by 40 CFR §55.4, Ocean Wind submitted Notice of Intent (NOI) to EPA Region 2 and New Jersey Department of Environmental Protection (NJDEP) as the Nearest Onshore Authority (NOA) on September 14, 2021. In addition, the NOI was provided to the Delaware Department of Natural Resources and Environmental Control (DNREC) and the New York State Department of Environmental Conservation (NYSDEC). The EPA's rule promulgation in response to the submittal of the NOI is discussed in Section 4.2.

This Project includes a construction and commissioning phase, an operations and maintenance (O&M) phase, and a decommissioning phase. This application addresses the construction and commissioning phase and the O&M phase. Because it is expected that marine vessel technology and construction technologies will substantially change over the next 35 years, the decommissioning phase is not addressed in the OCS air permit application. If the decommissioning phase of the Project is subject to 40 CFR Part 55, a separate permit will be applied for at that time.

Federal regulations promulgated in 40 CFR Part 55 regulate air emissions from OCS sources. The Project is subject to 40 CFR Part 55 and must obtain a preconstruction air permit prior to commencing construction of the Project.

This revised application is being submitted to EPA Region 2 in response to comments received on April 29, 2022 on the initial air permit application submitted on March 29, 2022 and to apply for the OCS air permit required pursuant to 40 CFR § 55.6. EPA comments and Ocean Wind responses to comment are included in **Appendix K** to this revised permit application. This application includes the following sections:

- Section 2 – Project Description
- Section 3 – Project Emissions
- Section 4 – Applicable Regulatory Requirements
- Section 5 – Analysis of Alternative Sites, Sizes, Production Processes, Pollution Prevention Measures, and Environmental Control Techniques
- Section 6 – Air Pollution Control Technology Review – Lowest Achievable Emission Rate (LAER)/Best Available Control Technology (BACT)/State of the Art (SOTA)
- Section 7 – Proposed Permit Conditions
- Section 8 – Emission Offsets
- Section 9 – Additional Impact Analysis
- Section 10 – Source Impact Analysis
- Section 11 – Air Quality Related Values (AQRV) Analysis

2. Project Description

2.1 Project Location

The Project will be located on the OCS approximately 13 nm southeast of the Atlantic City, New Jersey shoreline. The Lease Area is approximately 75,525 acres and is depicted in **Figure 2-1**. The WTGs will occupy the portion labeled Wind Farm Area on the figure; this area is referred to as the Wind Turbine Array (WTA) area in this air permit application. Except for the offshore export cabling, all offshore components of the Project will be located within the WTA. Offshore export cabling will run from the OSSs to two onshore interconnection points, also shown on **Figure 2-1**.

2.2 Project Infrastructure Overview

The Project will include turbines and all infrastructure required to transmit power generated by the WTGs to two interconnection points with the PJM electric transmission system or power pool. Grid connections will be made at Oyster Creek and BL England.

Power will be generated at the offshore wind turbines. The Project will have a maximum of 98 turbines. Array cables will carry that power to OSSs where the power will be collected and 'stepped up' to a higher voltage by transformers within the substation. The OSSs will be connected to each other by substation interconnection cables to provide redundancy, providing the voltage is the same across the wind farm. Each OSS will collect the power transmitted from the WTGs and transform the voltage for transmission through the offshore export cable to the onshore substations

The Project will include the following components (**Figure 2-2**):

Offshore Components

- Offshore wind turbines, foundations, and scour protection;
- OSSs with supporting substructure foundation, including scour protection where required;
- Array cable systems – linking the individual turbines together to OSSs and including cable protection;
- Substation interconnector cables – linking two substations to each other; and
- Offshore export cable systems (includes offshore export cables and cable protection).

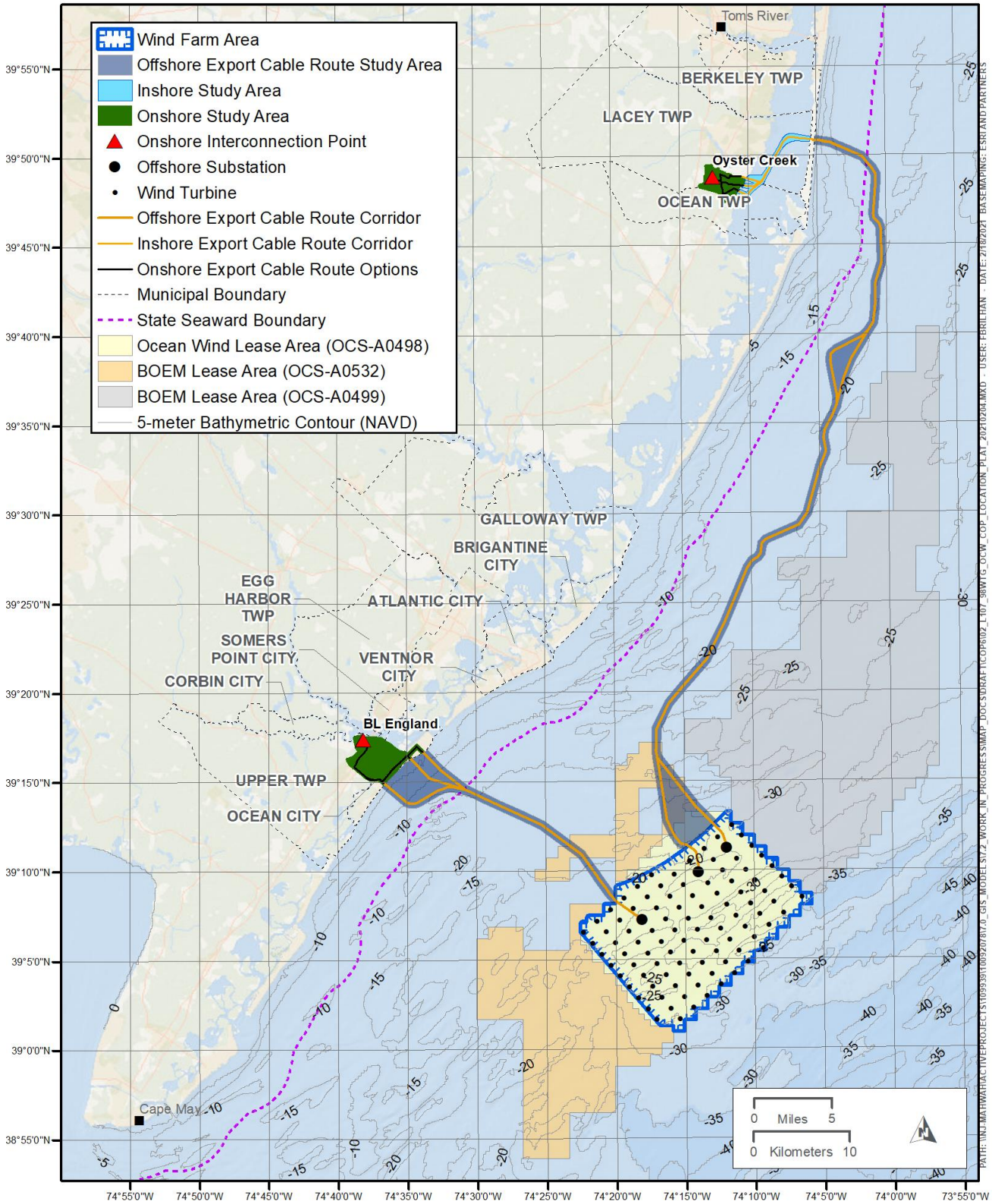


Figure 2-1. Project Location and Layout.

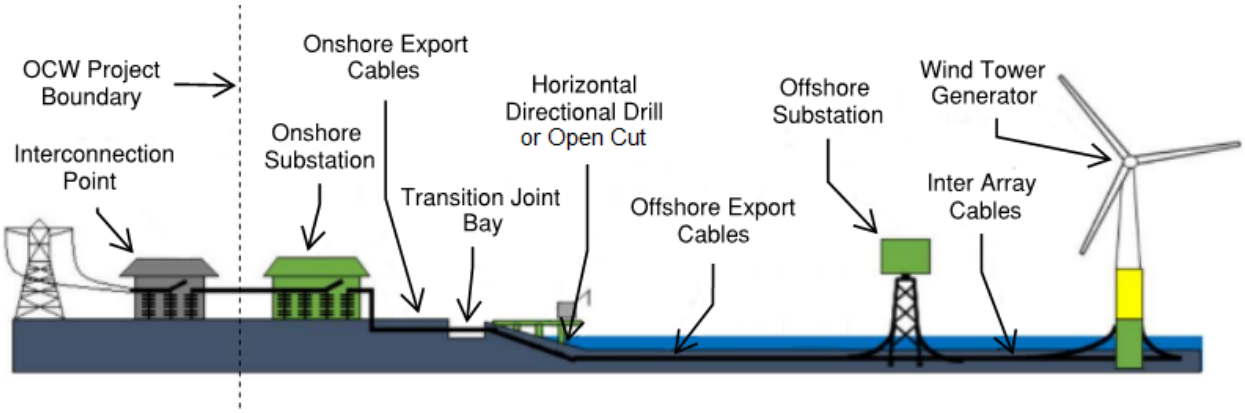


Figure 2-2. Key Project Components.

Onshore Components

- Onshore export cable system – including transition joint bays, splice vaults/grounding link boxes, and fiber optic system, including manholes;
- Onshore substation(s); and
- Connection to the existing grid.

Other Supporting Components

- Supervisory Control and Data Acquisition (SCADA) system;
- Temporary construction staging areas, including storage areas; and
- Permanent and temporary access roads.

The Project is being permitted with a 'design envelope' approach which allows the permitting authority to review and analyze the maximum impacts that could occur from a range of designs. This allows meaningful assessment of the Project to proceed while still allowing reasonable flexibility for future Project design decisions. During the permitting process the Project design may be refined further to minimize potential environmental impacts within the design envelope. A detailed description of all offshore components of the Project is presented in Volume I Section 6.1 of the Construction and Operations Plan (COP)[1].

2.3 Project OCS Sources

Determining how 40 CFR Part 55 applies to the Project requires defining which aspects of the Project are considered an OCS source. An OCS source is defined in 40 CFR § 55.2 as:

> "any equipment, activity, or facility which:
>
> (1) emits or has the potential to emit any air pollutant;
>
> (2) is regulated or authorized under the Outer Continental Shelf Lands Act (OCSLA); and
>
> (3) is located on the OCS or in or on waters above the OCS."

[1] Ocean Wind Construction and Operations Plan (COP) most recently updated and submitted to BOEM March 24, 2021. The most recently submitted COP can be accessed at https://www.boem.gov/ocean-wind-construction-and-operations-plan.

Aspects of the Project meet the definition of an OCS source by emitting or having the potential to emit air pollutants, being regulated or authorized under the OSCLA and being located on or above the OCS.

Per 40 CFR § 55.2, an "OCS source" shall include vessels only 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; or
>
> (2) Physically attached to an OCS facility, in which case only the stationary source aspects of the vessels will be regulated."

The definition of potential emissions in § 55.2 includes emissions from vessels servicing or associated with an OCS source. Although not considered OCS sources themselves, emissions from such vessels are considered direct emissions from the OCS source while the vessels are on-site and while enroute to or from the OCS source when within 25 nm of the source.

In accordance with Environmental Appeals Board (EAB) decision *In re Shell Gulf of Mex., Inc.,* 15 EAD 193, 220 (EAB 2011), the potential emissions of an OCS source must only include equipment in use and within 25 nautical miles of the OCS source during the time it is considered an OCS source. For instance, emissions from vessels servicing or associated with a jack-up vessel must be included in the potential emissions of the jack-up vessel only while the jack-up vessel has at least three legs attached to the seafloor[2].

Potential emissions resulting from the Project fall into two broad categories: 1) direct emissions from the OCS source(s) when regulated as a stationary source and 2) emissions included in the potential emissions of the OCS source.

Emissions in the first category occur only during the time when a piece of equipment, an activity, or facility (which may include a vessel) meets the definition of an OCS source. Emissions in this category will be subject to specific emission limits of the OCS permit and to federal regulations governing stationary sources including New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAP).

Emissions in the second category include all potential emissions associated with the Project, including emissions from vessels while enroute to and from an OCS source when within 25 nm of the OCS source[3]. Emissions in this category are utilized when:

1. Determining applicability of Clean Air Act (CAA) permit programs (Non-Attainment New Source Review [NNSR], Prevention of Significant Deterioration [PSD], and CAA Title V operating permits);
2. Calculating number of nitrogen oxides (NO_x) and volatile organic compounds (VOC) offsets required due to emissions if the Project is subject to NNSR permitting for one or both pollutants;
3. Modeling potential impact of Project on Class I areas and ambient air, as applicable.

2.3.1 Construction and Commissioning

During the construction and commissioning phase, it is anticipated that the first aspect of the Project to meet the definition of an OCS source will be a jack-up vessel for the OSS and WTG installation activity. The jack-up vessel will be temporarily attached to and erected on the seabed and used for the purpose of developing or

[2] See supporting discussion in the Fact Sheet to South Fork Wind, LLC OCS Air Permit (OCS-R1-04) at pages 21-22.
[3] See *Source Determination Analysis for Vineyard Wind OCS Windfarm* authored by Eric Wortman, Air Permit Specialist, EPA Region 1 Air & Radiation Division dated June 26, 2019.

producing resources (i.e., wind power) from the OCS. Then the jack-up vessel will detach from the seabed and move to the next installation location. The jack-up vessels will only be in a specific location for less than a week on average before moving to the next installation location. Similarly, following the installation of the monopile foundations, towers, and nacelles, temporary portable diesel generators will be transported to WTG locations for commissioning as a prelude to grid connection. After commissioning at a WTG location is complete, the generators will be moved to the next WTGs to be commissioned. While the temporal duration of the OCS sources (the jack-up activity and commissioning use of generators) will be short and intermittent, the project has conservatively aggregated these activities together within the WTA during the construction period, consistent with U.S. EPA's source determination for the South Fork Wind Farm, even though the EAB has rejected the notion that a single vessel attaching to the seabed at multiple locations within 25 nm of each other must be treated as a single OCS source.[4]

As a further conservative assumption for purposes of the OCS air permit, and because the exact travel and work schedule of each vessel is difficult to predict, it is assumed that all vessels within 25 nm of the centroid of the WTA area are included in the potential emissions of the construction and commissioning phase of the Project, including those which are anticipated to be utilized prior to the first instance of an OCS source. Based on the source determination analysis for a similar project[5], the construction and commissioning activities within the WTA area are considered a single OCS source, with the centroid of the WTA area serving as the centroid of the 25 nm radius circle as shown in **Figure 2-3**.

None of the vessels associated with horizontal directional drilling (HDD) installation at landfall or offshore export cable installation outside of the 25 nm radius circle around the centroid of the WTA area meet the definition of an OCS source. The HDD vessels are excluded because they are not located on the OCS or in or on waters above the OCS. The vessels associated with offshore export cable installation are excluded because either they are not located on the OCS or in or on waters above the OCS or because they are not considered permanently or temporarily attached to the seabed and erected on the seabed.

The term OCS is defined in 43 CFR § 1331(a) as *all submerged lands lying seaward and outside of the area of lands beneath navigable waters as defined in section 1301 of this title, and of which the subsoil and seabed appertain to the United States and are subject to its jurisdiction and control*. The definition of "lands beneath navigable waters" in 43 CFR §1301(a) includes *all lands permanently or periodically covered by tidal waters up to but not above the line of mean high tide and seaward to a line three geographical miles distant from the coastline of each State....* Vessels used for HDD installation and a portion of vessels used for the offshore export cable installation will operate solely within three geographical miles of the coastline of New Jersey and so the vessels will not be considered OCS sources. Additionally, these vessels will not travel to or from the WTA (the OCS source during construction), and so they will not be included in potential emission estimates of the Project.

For a vessel to be considered an OCS source, it must both be permanently or temporarily attached to the seabed and erected on the seabed. The anchor-pulling vessels associated with the offshore export cable installation (on waters above the OCS) are temporarily attached to the seabed. However, the anchors attached

[4] *See Shell Offshore*, 13 E.A.D. at 378-380 ("However, we reject NSB's contention that this provision therefore requires emissions from multiple OCS sources that are formed as a result of a single vessel attaching to the seabed at multiple locations to be 'treated as a single OCS Source' when within 25 miles of each other. The plain language of the statutory provision covers 'vessels servicing or associated with an OCS source' – it does not speak to emissions from two separate OCS sources.").

[5] Vineyard Wind OCS Permit (EPA Permit Number OCS-R1-03). Retrieved from https://www.epa.gov/caa-permitting/permit-documents-vineyard-wind-1-llcs-wind-energy-development-project-800mw-offshore.

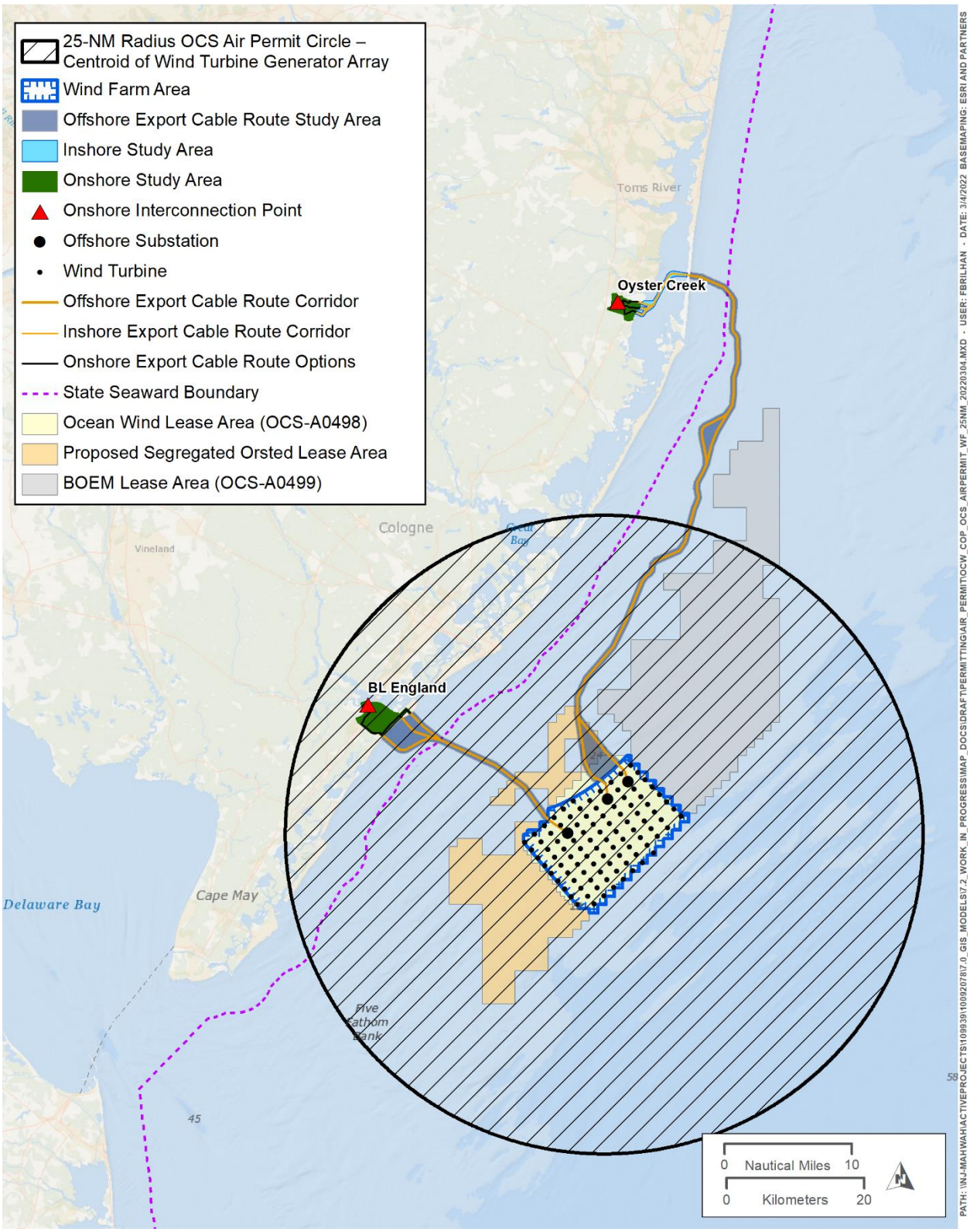


Figure 2-3. OCS Air Permit Circle with a 25-nm Radius.

to the seabed are used to pull the vessel along while cabling is installed. The anchors do not serve to keep the vessel stationary and so the vessels are not fixed in place. Therefore, the anchor-pulling vessels are not erected on the seabed and so they do not meet the definition of an OCS source.[6] No other vessels used in the offshore export cable installation process attach to the seabed.

In conclusion, there is one OCS source associated with the construction and commissioning phase of the Project, which is the WTA area. The OCS source includes all vessels associated with the construction and commissioning phase of the Project when those vessels are on-site (within the WTA area) or enroute to or from the WTA area when within 25 nm of the centroid of the WTA area. The potential emissions presented in this air permit application represent estimated emissions occurring within this circle. A unit of nautical miles is used, in accordance with EPA interpretation[7]. There is no OCS source associated with the offshore export cable installation or HDD installation activities, as explained above.

During the construction and commissioning phase, the following emission units will be considered OCS sources for a portion of time during the construction and commissioning phase. Emissions from all other emission units are included in the potential emissions of the Project but are not regulated as stationary source emissions.

1. **Jack-up vessels**
   The Project will employ jack-up vessels during foundation installation and WTG construction. Jack-up vessels have legs that extend to the ocean floor to elevate the hull above the ocean surface which provides a safe and stable work environment. Once at least three of the jack-up vessel's legs[8] have attached to the seafloor, it is considered an OCS source because the jack-up unit has become stationary and is no longer operating as a vessel. During the time three or more legs are attached to the seafloor, emissions from the vessel engines are regulated as stationary sources and will be subject to specific emission limits of the OCS air permit, as well as NSPS and NESHAP.
2. **WTG**
   During commissioning, there will be a diesel-fired engine powering a generator temporarily connected on each WTG. During the time the engine generator is installed on the WTG, the WTG is considered an OCS source and emissions from the engine are regulated as stationary sources.
3. **OSS**
   During commissioning, there will be a diesel-fired engine powering a generator installed on each OSS. During the time the engine generator is installed on the OSS, the OSS is considered an OCS source and emissions from the engine are regulated as stationary sources.
4. **Vessels attached to an OCS source**
   During construction and commissioning, fleet vessels may temporarily attach to a structure that is at that time considered an OCS source or to another vessel that meets the definition of an OCS source. The stationary source aspects of the vessels will be regulated while the fleet vessels are attached to an OCS source.
5. **Equipment onboard vessels while the vessel is an OCS source**
   The Project will utilize equipment onboard vessels powered independently from vessel engines. Emissions from equipment located on vessels considered OCS sources are regulated as stationary sources during the time the vessel is considered an OCS source.

[6] See discussion in Section IV.C.2. of the Fact Sheet for South Fork, LLC's OCS Air Permit (OCS-R1-04) supporting EPA's determination that the pull-ahead cable laying vessels are not considered OCS sources.
[7] EPA, Outer Continental Shelf Air Permits, Retrieved from https://www.epa.gov/caa-permitting/outer-continental-shelf-air-permits February 12, 2021.
[8] Based on EPA Region 1 determination as presented in the Fact Sheet and Statement of Basis to another recent OCS air permit, OCS-R1-03.

See Section 2.4 for additional details on the sequence of construction and commissioning activities and the OCS sources associated with each construction activity.

2.3.2 O&M

Ocean Wind has evaluated the PTE of the O&M phase against relevant thresholds (e.g. PSD and NNSR) separately from the PTE of the temporary construction and commissioning phase consistent with typical NSR procedures. In the O&M phase, the only permanent source of potential emissions are diesel generators that will be installed on the OSSs. The OSSs meet the definition of an OCS source due to these diesel generators. Potential emission estimates presented in this air permit application include potential emissions from the generators in addition to vessels while on-site (at the OSSs) or enroute to and from the OSSs. See **Appendix A** for additional discussion supporting the OCS source determination for the O&M phase and **Appendix B** for information regarding the O&M phase if an alternate approach is taken instead which includes WTGs in the OCS source during O&M. **Appendix B** includes an evaluation of the O&M phase for PSD and NNSR when using the PTE of the temporary temporary construction and commissioning phase to determine PSD and NNSR applicability during the O&M phase of the Project.

The Project is anticipated to have an operational life of 35 years. Ocean Wind has accounted for reasonably foreseeable planned and unplanned maintenance events in this timeframe. Maintenance activities will include both preventive and corrective maintenance. Preventive maintenance will be undertaken in accordance with scheduled services while corrective maintenance covers unexpected repairs, component replacements, retrofit programs and breakdowns.

The WTGs will not have permanent back-up diesel generators installed. The WTGs will be fitted with a Turbine Island Mode system. This system allows the WTG to produce power for its consumption and charge a battery package which it will rely on for low-wind periods. The inclusion of the Turbine Island Mode system means that the WTG will be able to rely on itself for back-up power during grid outages. The only circumstances which would require the use of a back-up diesel generator on a WTG during O&M is if all three of the following criteria were met at the same time:

1. An extended grid failure
2. A WTG was not able to produce power
3. The Turbine Island Mode system fails

The likelihood of all three criteria being met at the same time over the life of any WTG is very low. Therefore, the use of back-up diesel generators, even on a temporary basis, is not part of the operational design of the Project and emissions from temporary back-up diesel generators are not included in the PTE of the O&M phase. In this critical way, the source determination for Ocean Wind is different from South Fork Wind Farm, in that South Fork Wind Farm's source determination assumed the use of backup diesel generators on each WTG during the life of that project.

The air emission estimates include the potential annual use of a jack-up vessel at either the OSSs or at the WTGs. When the jack-up vessel has legs attached to the seafloor it is considered an OCS source. Potential emissions from the jack-up vessel while it is jacked up are included in the potential emissions presented in this air permit application. As described in Section 2.3 above, the EAB decision *In re Shell Gulf of Mex., Inc.,* 15 EAD 193, 220 (EAB 2011) states that the potential emissions of the OCS source must only include equipment in use and within 25 nautical miles of the OCS source during the time it is considered an OCS source (while the jack-up vessel is jacked up). It is anticipated a crew transfer vessel (CTV) will service the jack-up vessel while it is jacked up; therefore, the potential emission estimates include emissions from a CTV enroute to and from the jack-up vessel when within 25 nm of the jack-up vessel. No other vessels are anticipated to be on-site or enroute to and from the jack-up vessel while it is jacked up.

The following emission units will be considered OCS sources during the O&M phase. Emissions from all other emission units (i.e., vessels supporting the OCS sources) are included in the potential emissions of the Project but are not regulated as stationary source emissions.

1. **OSS**
   There will be one diesel-fired generator installed on each OSS (three total) during O&M. Emissions from the generator engines are regulated as stationary sources.
2. **Jack-up vessel**
   It is anticipated that a jack-up vessel will be utilized infrequently during the O&M phase. During the time three or more legs are attached to the seafloor, emissions from the vessel engines are regulated as stationary sources.
3. **Equipment onboard vessels while the vessel is an OCS source**
   It is anticipated there will be equipment powered independently onboard the jack-up vessel while the jack-up vessel is an OCS source. Emissions from equipment located on vessels considered OCS sources are regulated as stationary sources during the time the vessel is considered an OCS source.

2.4 Construction and Commissioning Schedule and Installation Sequencing

The anticipated construction and commissioning schedule is displayed in **Figure 2-4.** This schedule is the most aggressive (shortest) anticipated construction schedule. In the planning and development phase of the Project, Ocean Wind projected durations of use for each vessel and equipment projected to be utilized in the construction and commissioning phase. The projected durations utilized to estimate emissions are conservative as the durations presented in this air permit application are longer than anticipated actual usage. As a result, some of the individual durations of use of vessels utilized in emission estimations is longer than the durations of the associated activity shown in **Figure 2-4**. Therefore, the emission estimates presented in this air permit application are conservative.

Additionally, as described in the air dispersion modeling protocol, once the emissions were estimated using the conservatively long durations, it was then assumed that those emissions would occur within the shortest time frame possible (according to the most aggressive schedule). Therefore, the air dispersion modeling analysis conducted for the Project is conservative because the emissions calculated using the longest estimated durations were modeled assuming all emissions would occur within a single year. This maximizes the modeled 24-hour and annual emission rates.

2.4.1 Offshore Export Cable Installation

As indicated in the schedule provided in Figure 2-4, the first offshore construction activity anticipated is offshore export cable installation activities. Cables will typically be laid and post-lay or simultaneous lay and burial will be performed using a trenching tool. Cables can be installed using a tool towed behind the installation vessel to simultaneously open the seabed and lay the cable (i.e., simultaneous lay), or by laying the cable and following with a tool to imbed the cable (post-lay installation). It is anticipated that approximately 1 to 3 miles of cable will be installed per day during active installation. Ocean Wind anticipates that none of the vessels associated with offshore export cable installation will meet the definition of an OCS source. All vessels with engines associated with offshore export cable installation will utilize a dynamic positioning system (DPS).

2.4.2 Monopile Foundation Installation – WTG and OSS

The next activity to begin is the monopile foundation installation for the WTGs and OSS. At this time of Project development, it is anticipated that the OSS piles will be installed prior to the WTG piles. Seabed preparation for monopile foundations is usually minimal and typically limited to removal of boulders or other obstructions.

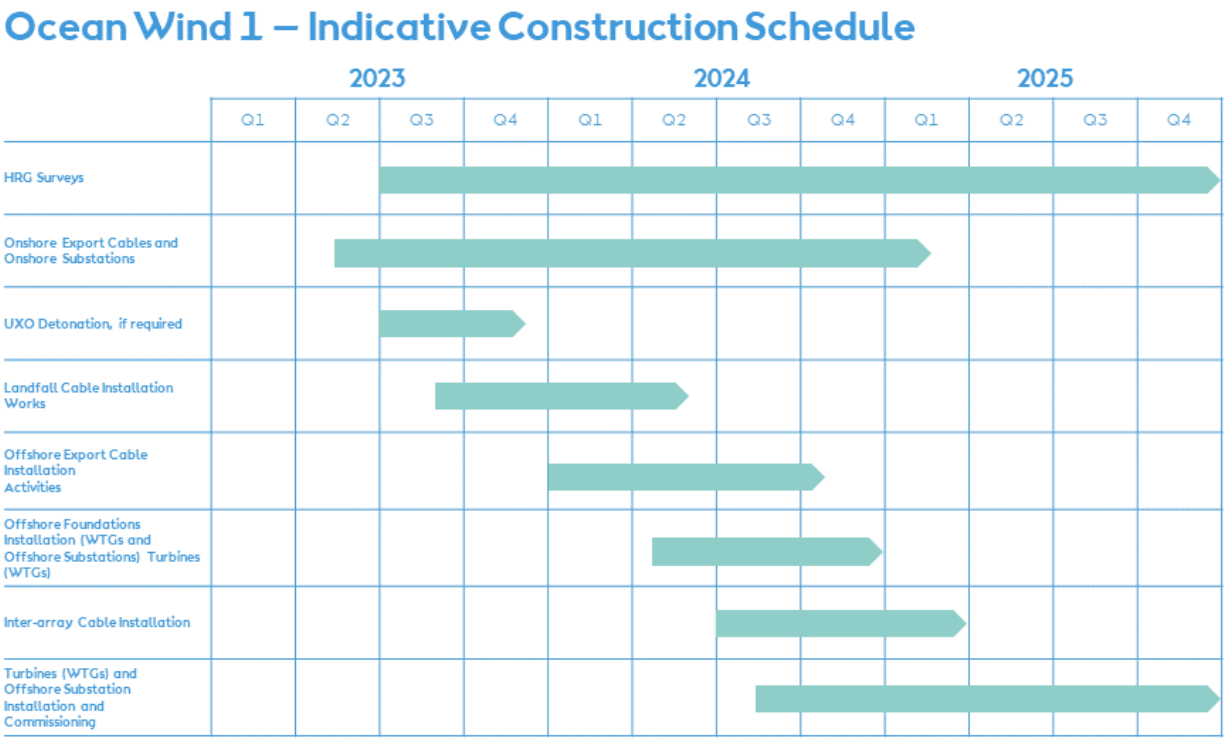


Figure 2-4. Indicative Construction Schedule.

Monopiles and transition pieces will be transported to the site on installation vessels or on dedicated transport vessels. Typical monopile construction activities include the following:

1. Monopile Delivery – Monopiles may be transported directly to the Wind Farm Area for construction or to the construction staging port. Monopiles (and transition pieces) are transported to site by an installation vessel or a feeder barge.
2. At the foundation location, the main installation vessel upends the monopile in a vertical position in the pile gripper mounted on the side of the vessel. The pile hammer is lifted on top of the pile to commence pile driving.
3. Pile Driving – Piles are driven until the target embedment depth is met, then the pile hammer is removed and the monopile is released from the pile gripper. If unfavorable sediment conditions do not allow pile driving, a drive-drill-drive solution may be required (following). In some cases, instead of hammer piling or drilling, vibropiling may be used to embed the foundation with vibration. After the monopile has reached its final position, the anode cage will be installed on the monopile. Subject to final permit conditions, pile driving during nighttime hours could potentially occur when a pile installation is started during daylight and, due to unforeseen circumstances, would need to be finished after dark. New piles could be initiated after dark to meet schedule requirements.
4. Drilling (optional) – If pile driving for the entire piling installation is not possible due to the presence of rock or hard sediment in some lower part of the substrate, the drive and drill method will be used. When the pile meets a point where it cannot be advanced (referred to as refusal), the monopile will be drilled out below the pile tip (typically several feet). Then, the piling will be

resumed and piled to its final position. If refusal occurs again, the drilling/driving would continue until the monopile has reached its final position. After the monopile has reached its final position, the anode cage will be installed on the monopile.

5. Transition Piece Installation – Once the monopile is installed to the target depth, the transition piece is lifted over the pile by the installation vessel. The transition piece comes fully fitted with boat fenders, access ladders, etc. It is also possible for the monopile and transition piece to be fabricated and installed as one component, with the boat landing and other ancillary features installed subsequently.
6. Grouting (or Bolting) – The joint between the monopile foundation and the transition piece may be cemented using grout, an inert cement mix. Grout is pumped from the installation vessel or another support vessel into the joint and carefully controlled and monitored to prevent loss of grout into the surrounding environment. Alternatively, the transition piece may be bolted to the monopile.
7. Completion – Once installation of the monopile and transition piece is complete, the vessel moves to the next installation location.
8. Scour Protection for Foundations – Several types of scour protection exist, including rock placement, mattress protection, sandbags, and stone bags. If scour protection is required, it encompasses the placement of large quantities of crushed rock around the base of the foundation structure is the most frequently used solution (rock placement). The rock placement scour protection solution may comprise a rock armor layer resting on a filter layer. The filter layer can either be installed before the foundation is installed (pre-installed) or afterwards (post-installed). Alternatively, by using heavier rock material with a wider gradation, it is possible to avoid using a filter layer and pre- or post-install a single layer of scour protection. The need for and amount of scour protection required will vary for the different foundation types being considered and based on the local site conditions. Flexibility in scour protection need and choice is required to accommodate changes in available technology and to allow for the most appropriate engineering solution within the design envelope and Project economics. The final choice as for the need for and detailed design of scour protection measures for the Project will be made after detailed design of the foundation structure, considering a range of aspects including geotechnical data, metocean data, water depth, foundation type, maintenance strategy, agency coordination, stakeholder concerns, and cost.

Of the vessels associated with monopile installation, only the jack-up vessel is anticipated to meet the definition of an OCS source. This is the first Project component or vessel anticipated to meet the definition of an OCS source. All other vessels will utilize DPS.

2.4.3 Inter-array Cable Installation

Depending on the array cable lengths, the array cables will be installed as either pre-cut sections, continuous lengths, or a combination of both. Cables will typically be laid, and post-lay burial will be performed using a jetting tool, if seabed conditions allow. Cables may remain on the seabed within the Wind Farm Area for up to two weeks. Alternatively, the array cables may be simultaneously laid and buried. Array cables can be installed using a tool towed behind the installation vessel to simultaneously open the seabed and lay the cable, or by laying the cable and following with a tool to imbed the cable. Possible installation methods for these options include jetting, vertical injection, control flow excavation, trenching, and plowing. DP2 vessels with associated support craft will be used to install the array cables.

After load-out of the first batch of cable section(s) at the load-out port, the DP2 cable installation vessel will transit to the Wind Farm Area and commence cable installation of the first section of subsea cable in the

direction of the OSS. At the OSS, a cable protection system is attached to the cable and the cable (pulling-head) will be pulled up by a winch through a dedicated J-tube onto the OSS cable deck, where it will be laid within the OSS cable management system. The following are steps in installing the cables.

2.4.3.1 First-end Pull

The array cables are typically pre-installed and terminated within the transition pieces before the WTGs are installed. The array strings may be energized before burial and by the time the WTGs arrive on site. This allows commissioning and the 240-hour run-test to be performed, as well as providing a back-feed to the WTG ancillary power supplies. As the cable installation vessel approaches a foundation/transition piece, a winch wire is passed to the vessel. A cable protection system is attached to the cable and the cable is directly pulled to the termination point (see **Figure 2-5**).

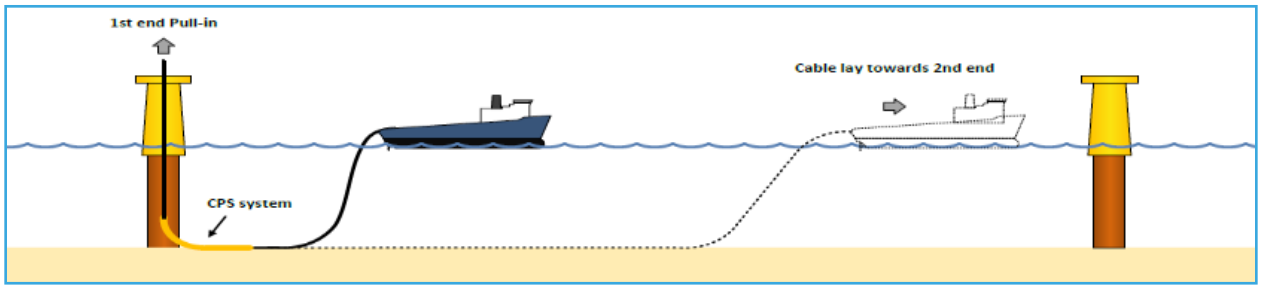


Figure 2-5. First-end Pull.

2.4.3.2 Second-end Pull

The second-end pull requires a “quadrant” to be deployed. As the vessel approaches the foundation/transition piece, a winch wire will be passed to the vessel. A cable protection system is attached to the cable and the cable is deployed to the seabed on a quadrant. Once the cable reaches the termination point, the quadrant is tipped, and the cable is released to the seabed (see **Figure 2-6**). However, situations might arise that the foundation/ transition piece is not in place. In these cases, the cable end will be temporarily laid down on the seabed near the foundation location and the position recorded. After installation of the foundation/transition piece, the cable end will be recovered to the cable lay vessel and a second end pull in will be executed.

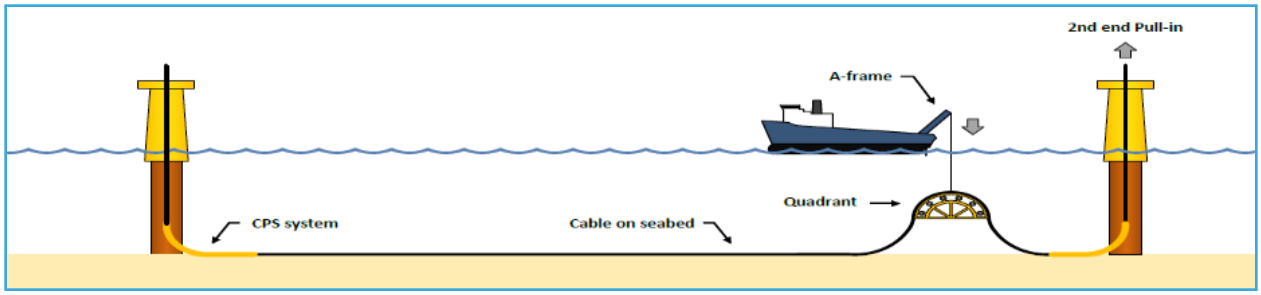


Figure 2-6. Second-end Pull.

Ocean Wind anticipates that none of the vessels associated with inter-array cable installation will meet the definition of an OCS source. All vessels associated with inter-array cable installation will utilize DPS.

2.4.4 WTG and OSS Topside Installation and Commissioning

Generally, turbines will be installed using the following process:

- Turbine components are loaded onto barges, installation vessels or dedicated transport vessels.

- The barge, transport or installation vessel will travel to the Wind Farm Area.
- The crane on the installation vessel will lift the components onto the existing monopile foundation.
- Components will be fastened together as they are lifted into place.

After pre-assembly of the WTGs, the WTG components (blades, nacelle, and tower) are loaded onto the Jones Act-compliant heavy lift installation and transportation vessel or other vessel, such as a barge. Once positioned at the offshore site, the installation vessel jacks-up and connects with a preinstalled foundation via gangway. Installation for each WTG is performed in five lifts; tower, nacelle, and three blades.

After installation, the WTG is connected to the grid and commissioned. Typically, the onshore substation will be energized and connected to the OSS, followed by the OSS, the array cables and finally the turbines. The array cables will typically be energized before burial and by the time the WTGs arrive on site to allow commissioning and the 240-hour run-test to be performed, as well as providing a back-feed to the WTG ancillary power supplies. If there is a delay in connecting a turbine to the grid, the turbines will need a back-up power supply until a connection can be made. A temporary backup diesel generator would be installed at the turbine until the connection is made.

Of the vessels associated with WTG topside installation, only the jack-up vessel is anticipated to meet the definition of an OCS source.

Similarly, an installation vessel will be used to lift the topside onto the pre-installed foundation substructure. Each substation is expected to require two primary installation vessels. Primary vessels may include self-propelled jack-up vessels, jack-up barges (towed by tugs), sheerleg barges (either self-propelled or towed by tugs), or Heavy-Lift Vessels. The primary installation vessels associated with OSS topside installation will meet the definition of an OCS source.

2.4.5 Construction Support Vessels

Finally, several vessels will be needed to support the construction activities described above. Vessel types include crew transport vessels, service operation vessels and safety vessels. Other than potentially attaching to another OCS source, none of these vessels meet the definition of an OCS source. Although several vessels will anchor to the seafloor, and therefore be ‘temporarily attached to the seabed’, none of them will be erected on the seafloor. As EPA describes in the Fact Sheet for the OCS Air Permit (Permit No. OCS-R1-04) issued to South Fork Wind, LLC (South Fork), a vessel must meet both criteria (in addition to a third criterion ‘for the purpose of exploring, developing, or producing resources’) to be considered an OCS source. The vessels anticipated to anchor to the seafloor include:

- Safety vessel (1)
- Crew transport vessels (6)

As EPA states in the Fact Sheet for South Fork, ‘erected thereon’ is ‘intended to reflect the process by which a vessel becomes attached to the seabed and used thereafter for the purpose of exploring, developing or producing resources from the seabed’. Additionally, EPA reasoned that attachment to the seabed must occur ‘at the location where OCS activity is reasonably expected to occur’ because the customary meaning of the verb ‘to erect’ is ‘to construct’ or ‘to build’. EPA gave an example of a drillship that does meet the definition of an OCS source and explained that when the drillship is ‘erected’ on the seabed, it remains stationary while it conducts its OCS activity, and is at the location where the OCS activity (e.g., exploratory drilling) is reasonably expected to occur. Conversely, safety vessels and crew transport vessels do not remain stationary at the location of the OCS activity (i.e., generation of power at WTGs) and are more akin to mobile sources. The main function of CTVs is to transfer crew and equipment from port to the WTA. Safety vessels will be on scene to advise mariners of construction activity to reduce the likelihood of an allision or collision during construction. Finally, EPA states ‘the fact the CLV is anchored to the seafloor is alone insufficient to make the CLV an OCS

source'. Likewise, the fact that the safety vessels and crew transport vessels anchor to the seafloor for some period is alone insufficient to make the vessels an OCS source.

If any of the construction support vessels attach to another OCS source, they will be considered an OCS source during the time it is attached and will be regulated as a stationary source.

2.5 Overview of Emission Units

2.5.1 Construction and Commissioning

Emission units associated with the construction and commissioning phase fall into three broad categories: vessel engines, engines of auxiliary equipment onboard vessels, and generator engines. Each of these categories is discussed in this section.

2.5.1.1 Marine Vessel Engines

As described in Section 2.3, for simplicity, the Project considers there to be one OCS source for marine vessels associated with the construction and commissioning phase of the Project. The centroid of the WTA is the center of the 25 nm radius circle that defines the potential emissions of the OCS source. All marine vessels associated with the construction and commissioning of the following Project components are included in the OCS source:

- WTG & OSS Foundation Installation
- OSS Topside Construction
- WTG Construction
- Array Cable Installation
- Interconnection Cable Installation
- Offshore Export Cable Installation[9]
- Construction Support Vessels (Vessels that support multiple Project component activities)

Additionally, all emissions of vessels enroute to and from the centroid of the WTA are included in the potential emission estimates of the OCS source, in accordance with 40 CFR § 55.2.

Vessels will be deployed in accordance with the construction schedule presented in Section 2.4. The exact make and model of the vessel that will be deployed cannot be known at the permitting stage of the Project. The offshore wind industry in the United States is in its infancy and so securing the requisite contractors and vessels is challenging, especially for a project of this magnitude. There are currently not enough US vessels with the capacity and design required to transport and install the components of the Project. Additionally, there are many other offshore wind projects scheduled to be under construction simultaneously with the Project, both in the U.S. and abroad. Therefore, the vessels required to construct the Project have limited availability.

A list of vessel types and numbers of vessels planned to be used for construction and commissioning is presented in **Table 2-1**. It is anticipated a total of 54 vessels will be utilized over the construction and commissioning phase.

Table 2-1. Vessel List – Construction and Commissioning Phase.

Vessels - Construction and Commissioning Phase		
WTG & OSS Foundation Installation	**Number of Vessel Type**	**Vessel Category [1 2]**
Heavy Lift Installation Vessel	1	Work Boat

[9] As described in Section 2.3, vessels associated with offshore export cable are only considered part of the OCS source when within 25 nm of the centroid of the WTA.

Vessels - Construction and Commissioning Phase		
Secondary Steel Installation	1	Jack-up Vessel (Work Boat)
Feeder Barge Tug	2	Tugboat
Feeder Barge (no engines)	1	None
Rock Dumping Vessel	1	Work Boat
Bubble Curtain Vessel	1	None
Heavy Transport Vessel	1	Crew and Supply Vessel
Crew Transport Vessel	1	Primary Crew Transport Vessel
Noise Monitoring Vessel	2	None
Platform Support Vessel	2	Work Boat
OSS Topside Construction	**Number of Vessel Type**	**Vessel Category [1]**
Heavy Transport Vessel	2	Crew and Supply Vessel
WTG Construction	**Number of Vessel Type**	**Vessel Category [1]**
Installation Vessel	1	Jack-up Vessel (Work Boat)
Towing Tug	2	Tugboat
Array Cable Installation	**Number of Vessel Type**	**Vessel Category [1]**
Pre-lay Grapnel Run (PLGR) Vessel	1	Work Boat
Pre-lay Survey Vessel	1	None
Boulder Clearance Vessel	1	Work Boat
Sandwave Clearance Vessel	1	Work Boat
Cable Laying Vessel	1	Work Boat
Cable Burial Vessel	1	Work Boat
Crew Transport Vessel	2	Primary Crew Transport Vessel
Walk to Work Vessel	1	Crew and Supply Vessel
Post-Lay Inspection Survey Vessel	1	None
DP2 Construction Vessel – Jack of All Trades	1	Work Boat
Offshore Export Cable & Interconnection Cable Installation	**Number of Vessel Type**	**Vessel Category [1]**
Cable Lay and Burial Vessel	1	Work Boat
Cable Burial Vessel	1	Work Boat
Anchor Handling Tug	1	Tugboat
Pull Tug for Barges	1	Tugboat
Pull ahead export cable tug for assist CLV	1	Tugboat
PLGR Vessel	1	Work Boat
Boulder Clearance Vessel	1	Work Boat
Crew Transport Vessel	2	Primary Crew Transport Vessel
Guard Vessel	5	None
Post-Lay Inspection Survey Vessel	2	None
General Work Vessel	1	Work Boat
Construction Support Vessels	**Number of Vessel Type**	**Vessel Category [1]**
Safety Vessel	1	None
Crew Transport Vessel	6	Primary Crew Transport Vessel
Service Operation Vessel	1	Crew and Supply Vessel

[1] Vessel category definitions are presented in Section 6.2.1.5 in the LAER Determination section. If a vessel does not meet any of the definitions provided in 17 CCR § 93118.5, the table indicates the vessel type is 'none'.

[2] Please note that vessels that meet the definition of an ocean-going vessel do not meet the definition of a crew and supply vessel (or a crew transport vessel since crew transport vessels are a type of crew and supply vessel). It is possible that some of the vessels denoted as crew and supply vessels or crew transport vessels will meet the definition of an ocean-going vessel, and would therefore not be considered a crew and supply vessel or a crew transport vessel.

2.5.1.2 Engines of Auxiliary Equipment Onboard Vessels

In addition to emissions from marine vessels engines, additional emissions will be generated from auxiliary equipment onboard vessels. The auxiliary equipment is powered by diesel engines and ranges in size from 5 horsepower to 760 horsepower. This equipment will not be used while the vessels are in transit but only while the vessels are onsite. A list of auxiliary equipment types and number of each type planned to be used for construction and commissioning is presented in **Table 2-2**.

Table 2-2. Auxiliary Equipment List – Construction and Commissioning Phase.

Auxiliary Equipment - Construction and Commissioning Phase	
WTG & OSS Foundation Installation	**Number of Equipment Type**
Heavy Lift Installation Vessel Generator	5
Heavy Lift Installation Vessel Power Pack	1
Multi-Purpose Supply Vessel Generator	3
Bubble Curtain Vessel Generator	46
Heavy Transport Vessel Generator	1
OSS Topside Construction	**Number of Equipment Type**
Heavy Lift Installation Vessel Generator	5
WTG Construction	**Number of Equipment Type**
Jack-up Vessel Generator	5
Jack-up Vessel Cherry Picker	2
Feeder Barge Generator	2
Service Operation Vessel Generator	6
Offshore Export Cable & Interconnection Cable Installation	**Number of Equipment Type**
Cable Laying Vessel Generator	2
Cable Laying Vessel Generator	7
Cable Laying Vessel Crane Type 1	3
Cable Laying Vessel Power Pack	1
Cable Laying Vessel Cherry Picker	1
Cable Laying Vessel Excavator	1
Barge Generator	2
Barge Cherry Picker	1

2.5.1.3 Generator Engines

During construction and commissioning, a number of generators will be employed. These generators will be located on either the OSS or WTG and will be used temporarily for purposes such as supplying OSS topside with power during installation and commissioning of the OSS, to pull in cable during offshore array cable installation and to power WTG temporarily during WTG commissioning when turbines are idling. One generator installed on each OSS (for a total of 3 generators) during construction will remain on the OSS during O&M and

serve as an emergency generator. All other generators will be removed once the construction and commissioning phase is complete. A list of generators and number of generators planned to be used for construction and commissioning is presented in **Table 2-3**.

Table 2-3. Generator List – Construction and Commissioning Phase.

Generators - Construction and Commissioning Phase	
OSS	**Number of Generators**
OSS Generator – Permanent	3 (1 per OSS)
OSS Generator – Temporary	6 (2 per OSS)
Array Cable Generator	3 (1 per OSS)
WTG	**Number of Generators**
Array Cable Generator	98 [1] (1 per WTG)

[1] Please note that there will be a limited number of generators moved to each of the 98 WTGs during commissioning, not 98 individual generators.

2.5.2 O&M

Emission units associated with O&M fall into four broad categories: vessel engines, auxiliary equipment engines, generator engines, and miscellaneous fugitive emissions. Each of these categories is discussed in this section.

2.5.2.1 Marine Vessel Engines

As described in Section 2.3.2, the only permanent OCS sources during O&M are the generators on the OSS platforms. Therefore, all vessel trips to and from the OSS while within 25 nm of the centroid of the WTA are included in the potential emission estimates. Additionally, it is anticipated a jack-up vessel may be utilized at the WTG and/or the OSS; therefore, emissions from the jack-up vessel while jacked up and vessels enroute to and from the jack-up vessel during the time it is jacked up are included in the potential emission estimates. Emissions from marine vessels enroute to and from the WTGs are not included in the potential emission estimates because the WTGs are not considered OCS sources. Please see **Appendix A** for additional discussion supporting the OCS source determination for the O&M phase and **Appendix B** for information regarding the O&M phase if an alternate approach is taken instead which includes WTGs in the OCS source during O&M.

It is conservatively assumed that all unplanned maintenance events occur in the same year as the year with the most planned maintenance events. A list of vessel types and numbers of vessels assumed to be used in a single year is presented in **Table 2-4**. It is anticipated up to 6 vessels may be utilized in a single year during the O&M phase.

Table 2-4. Marine Vessel List – O&M Phase.

Vessels - O&M Phase		
OSS or WTG	**Number of Vessel Type**	**Vessel Type [1]**
Jack-up Vessel	1	Jack-up Vessel (Work Boat)
Crew Transport Vessel	6	Primary Crew Transport Vessel
Feeder Barge (no engines)	1	NA
Feeder Barge Tug	1	Tugboat

[1] Vessel category definitions are presented in Section 6.2.1.5 in the LAER Determination section. If a vessel does not meet any of the definitions provided in 17 CCR § 93118.5, the table indicates the vessel type is 'none'.

2.5.2.2 Engines of Auxiliary Equipment Onboard Vessels

In addition to emissions from marine vessels engines, additional emissions will be generated from auxiliary equipment onboard vessels during O&M. The auxiliary equipment is powered by diesel engines and ranges in size from 5 horsepower to 760 horsepower. This equipment will not be used while the vessels are in transit but only while the vessels are onsite. A list of auxiliary equipment types and number each type planned to be used for O&M is presented in **Table 2-5**.

Table 2-5. Auxiliary Equipment List – O&M Phase.

Auxiliary Equipment - O&M Phase	
OSS or WTG	**Number of Vessel Type**
Jack-up Vessel Generator – Small	1
Jack-up Vessel Generator – Large	1
Jack-up Vessel Cherry Picker	1
Feeder Barge Crane Type 1	1

2.5.2.3 Generator Engines

Ocean Wind plans to include onediesel-fired generator on each OSS during the O&M phase. These engines will be installed on the OSS during the commissioning phase and used for purposes of commissioning (i.e., for non-emergency purposes). After the O&M phase begins, the engines will function as emergency engines. However, to meet the LAER requirements for the construction and commissioning phase, Ocean Wind will purchase generator engines that are certified by the manufacturer to Tier 4 non-emergency emission standards. Ocean Wind requests a limit of 1,000 hours per year of operation for each engine. A list of generators planned to be included on the OSS during the O&M phase is presented in **Table 2-6**.

The use of the engines during O&M is anticipated to occur for the following reasons:

1. Power outage in the entire windfarm
2. Failure in both primary sources of power (auxiliary transformers) supplying low voltage and utility systems
3. During the performance of normal testing and maintenance procedures.

Table 2-6. Generator List – O&M Phase.

Generators - O&M Phase	
OSS	**Number of Generators**
Generator	3 (1 per OSS)

2.5.2.4 Fugitive Emissions

During O&M, the wind turbine towers and foundations, as well as the OSS foundations, will undergo repair painting, resulting in fugitive emissions as components are painted.

Additionally, sulfur hexafluoride (SF_6) will be used to insulate electrical equipment at each WTG and OSS, potentially resulting in fugitive greenhouse gas (GHG) emissions from unexpected equipment leakage. Due to its extremely stable chemical properties, SF_6 is commonly used in electrical equipment to provide insulation for switchgear and to quench arcs. SF_6 is widely used in the power industry.

3. Project Emissions

While the proposed WTGs will not generate air emissions during operation, the Project will emit air pollutants during construction and commissioning and during O&M. Emissions were estimated from the construction and commissioning phase and the O&M phase for the emission sources identified in Section 2.3.1 and Section 2.3.2.

National Ambient Air Quality Standards (NAAQS) have been promulgated for six air pollutants, known as criteria air pollutants. The six criteria air pollutants are carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM) (including PM_{10} [particles with a diameter smaller than 10 micrometers] and $PM_{2.5}$ [particles with a diameter smaller than 2.5 micrometers]), and sulfur dioxide (SO_2). Ozone is primarily formed when VOCs and NO_x react with sunlight in the atmosphere. Therefore, emissions of precursors to ozone are quantified rather than ozone. GHGs are considered a regulated air pollutant if a Project is already considered major for another PSD pollutant (an “anyways” source). GHG emission totals are presented as carbon dioxide equivalents (CO_2e). The following pollutants are included in the emissions estimates:

- GHGs
  - Carbon dioxide (CO_2)
  - Methane (CH_4)
  - Nitrous oxide (N_2O)
  - SF6
- CO
- PM_{10}
- $PM_{2.5}$
- SO_2
- NO_x
- Lead
- VOC
- Hazardous Air Pollutants (HAP)

It is important to note that engine sizes and durations utilized as the basis of air emissions in this air permit application reflect the Project design and construction plan to the best of Ocean Wind’s knowledge at the time of submission. However, Ocean Wind is still negotiating contracts and finalizing Project design and construction planning; therefore, engine sizes, durations of use and other Project parameters may change after the submission of this application. Ocean Wind cannot know the exact vessel and vessel engines that will be utilized until much closer to the start of construction because construction plans are subject to change on short notice, the overall market demand for vessels with the necessary capabilities is large and projected to increase while the supply is limited and compliance with the Jones Act places limitations on available vessels. Therefore, the air emission estimates presented in this air permit application are subject to change.

3.1 Calculation Methodology

3.1.1 Marine Vessel Engines

Marine vessels will be used in both the construction and commissioning phase and the O&M phase of the Project. Key parameters in determining emissions for marine vessels include vessel type, load factor, and duration of use.

Emissions were estimated from marine vessels using the methodology developed by BOEM for Wind Tool. Wind Tool contains various defaults for marine vessels typically used to construct and operate offshore wind

energy facilities. To develop these defaults, the following vessel characteristics were compiled from Information Handling Service (I)'s Register of Ships dataset for each vessel type[10]:

- Propulsion engine power rating
- Auxiliary engine power rating
- Engine speed (i.e., slow, medium, high speed)
- Cylinder diameter and stroke length to calculate EPA engine category
- Year of manufacture
- Country of registration
- Design speed
- Gross registered and deadweight tonnage
- Length

The above vessel characteristics were then aggregated to match the engines used in the EPA 2014 National Emissions Inventory, which was used to develop default vessel emission factors and characteristics for each of the vessel types included in the fleet profiles in Wind Tool. Information entered by Wind Tool users includes the number of each vessel type used in each phase, the distance the vessels travel (distance from port to centroid of array), the number of trips each vessel will take, and the number of days each vessel will be used.

The equation to calculate emissions for all marine diesel engines is as follows:

$$E_{ab} = AH_{ab} \times kW_{ab} \times LF_{ab} \times {}^{EF}/_{100} \times CF$$

Where:

E_{ab}	=	Emissions for vessel type *a* and engine type *b* (tons)
AH_{ab}	=	Annual hours for vessel type *a* and engine type *b*
kW_{ab}	=	kilowatt (kW) rating for vessel type *a* and engine type *b*
LF_{ab}	=	Engine load factor for vessel type *a* and engine type *b* (%)
EF	=	Emission factor for engine Category and Tier (g/kW-hr)
CF	=	Conversion factor (g = 1.10231 E-6 ton)
a	=	Vessel type (e.g., tug, support vessel, survey vessel)
b	=	Engine type (e.g., main, auxiliary, or emergency generator)

Default emission factors and rated engine capacity (both main and auxiliary) were obtained from Wind Tool for all vessel types except for crew transfer vessels. The proposed LAER determination for crew transfer vessel engines is to meet the highest Tier standard for marine engines in 40 CFR § 1042.101, which is Tier 4 emission standards for engines at or above 600 kW and Tier 3 emission standards for engines below 600 kW. Therefore, the Project used the lowest (resulting in highest emissions) Tier 3 emission standards that may apply for a representative vessel engine for crew transfer vessel engines. The rated engine capacities of selected construction vessels were obtained from vessel specification sheets of representative vessels instead of Wind Tool defaults. The speed of all vessels, except for crew vessels, was assumed to be 10 knots, based on Orsted's experience with other offshore wind construction projects. The speed of crew vessels was obtained from Wind Tool. Wind Tool has a set of default marine vessels; however, not all the Project's vessel types were included in Wind Tool's defaults. Where this occurred, an 'equivalency' assumption was made based on vessels that are included in Wind Tool. The complete list of available vessels in Wind Tool is as follows:

- Anchor handling tugs
- Barge
- Cable laying

[10] Chang, R., B. Do, and R. Billings. 2017. Technical Summary for the Offshore Wind Energy Facilities Emission Estimating Tool. US Dept. of the Interior, Bureau of Ocean Energy Management, Sterling, VA. OCS Study BOEM 2017. 9 pp.

- Crew
- Dredging
- Ice breaker
- Jackup
- Research/survey
- Shuttle tanker
- Supply ship
- Tug

Table 3-1 describes the equivalency assumptions that were made for each vessel expected to be used for construction of the Project that was not included in Wind Tool's default vessels or for which the Project did not have Project-specific information available regarding engine size.

Table 3-1. Vessel Equivalency Assumptions.

Construction Activity	Project-Specific Vessel	Assumed Equivalent Wind Tool Vessel
Array Cable Installation	Sandwave Clearance Vessel	Dredging
	PLGR Vessel	Dredging
	Pre-lay Survey Vessel	Crew
	Post-lay Inspection Vessel	Crew
	Cable Burial Vessel	Cable Laying
Offshore Export Cable and Interconnection Cable Installation	Cable Burial Vessel	Cable Laying
	Cable Lay and Burial Vessel	Cable Laying
	PLGR Vessel	Dredging
	Post-lay Inspection Vessel	Crew
Construction Package	Safety Vessel	Supply Ship

The Project identified the type and number of marine vessels expected to be employed during the O&M phase, as well as for five activities necessary for offshore wind farm construction. The five construction activities are:

- Array cable installation
- Offshore export cable installation
- OSSs construction
- WTG foundation installation
- WTG construction

The Project also identified the ports of call each vessel is anticipated to use, the number of trips each vessel will take, and the number of days each vessel will be used.

3.1.1.1 Ports of Call

During construction, the Project will involve temporary construction laydown areas and construction ports. The primary ports that are expected to be used during construction, but which have independent utility and are not dedicated to the Project, are as follows:

- Atlantic City, NJ - construction management base. The site area is intended to offer an opportunity for a combined base for CTV operations for the construction phase.

- Paulsboro, NJ, Repauno, NJ, or Europe (directly) - for foundation scope. The port area is intended to offer an opportunity for both foundation fabrication facilities as well as staging and load-out operations in collaboration with a key subcontractor.
- Norfolk, VA or Hope Creek, NJ - for WTG scope. The port area is intended to offer an opportunity for WTG pre-assembly and load-out facility without any air draft clearance restrictions covering jack-up installation vessel assets.
- Port Elizabeth, NJ, Charleston, SC, or Europe (directly) - cable staging (unless transported directly from the cable supplier). The intended terminal area and quay infrastructure will be used for various cable staging and operation, if required.

The O&M phase of the Project will include the use of an onshore O&M facility in Atlantic City. The O&M Facility, which will service more than one wind farm and has independent utility, is not considered to be a component of the Project.

When calculating time spent in transit for the purpose of estimating emissions, the longest route was selected for each vessel as a conservative assumption.

All CTVs and vessels in the construction support package will utilize Atlantic City, New Jersey during the construction and commissioning phase. Ocean Wind has narrowed down the list of potential ports other vessels will use during all other construction activities. The list of potential ports is presented in **Table 3-2**.

Table 3-2. Ports During Construction.

Construction Activity	Ports Vessels Will Utilize
Array Cable, Offshore Export Cable, and Interconnection Cable Installation	Port Elizabeth, New Jersey
	Charleston, South Carolina
	Europe (directly)
OSS	Atlantic City, New Jersey
WTG and Platform Foundation Installation	Paulsboro, New Jersey
	Europe (directly)
WTG Construction	Hope Creek, New Jersey
	Norfolk, Virginia

All vessels will utilize Atlantic City, New Jersey during the O&M phase.

3.1.1.2 Load Factors

A load factor represents the portion of utilized engine power compared to the maximum rated engine power. Load factors vary from 0 (engine off) to 1 (engine fully utilized) based on a variety of factors. Wind Tool provides default load factors for main and auxiliary marine vessel engines during transit and on-site maneuvering for types of vessels that are based on national fleet data compiled from IIHS's Register of Ships. Wind Tool uses a default load factor of 0.82 for main engines in transit and 0.20 for main engines during

maneuvering, which are consistent with other available sources[11] [12] [13] of marine vessel load factors for propulsion engines at cruise speed and during maneuvering. Jack-up vessels use legs to remain in place while on-site, so it is assumed that jack-up vessels do not use main engines during on-site maneuvering.

Wind Tool provides a default load factor of 1 for all auxiliary activities. Auxiliary engines will not be always engaged at full power; therefore, more representative load factors were selected for auxiliary engines. The 2014 National Emissions Inventory[11] presents load factors for auxiliary engines (in Table 4-120 of that report) in various vessel types during hoteling at port and maneuvering. These load factors were used to estimate emissions from auxiliary engines during hoteling and maneuvering.

The 2014 National Emissions Inventory[11] states that vessels equipped with Category 1 and Category 2 propulsion engines do not engage main or auxiliary engines while hoteling because it is assumed that these vessels engage in cold ironing to conserve fuel. Category 1, 2 and 3 marine vessel engines are defined in 40 CFR § 1042.901 based on engine displacement. Because engine displacement information for the default marine vessels in Wind Tool is unknown, it was assumed that Category 1 and 2 marine vessel engines are typically smaller than 3,000 kW[12]; therefore, it is assumed that vessels with propulsion engines less than 3,000 kW do not engage engines during hoteling.

Marine vessel auxiliary engine load factors during transit are obtained from a 2009 study published by the U.S. EPA that surveyed methodologies in estimating emissions from mobile sources for port-related emission inventories[12]. Table 2-7 of the EPA document[12] contains load factors for marine vessel auxiliary engines while cruising and while operating in the Reduced Speed Zone (RSZ). Because the vessel types in Table 2-7 of the EPA document do not closely match the vessel types available in Wind Tool, the highest load factor among all load factors for cruise and RSZ, other than the cruise ship load factor, was assumed for all Ocean Wind vessels. The cruise ship load factor was removed from consideration because a cruise ship is not representative of Ocean Wind vessels given its very different function from offshore wind construction.

3.1.1.3 Duration of Use

Duration is another key parameter in estimating emissions using the Wind Tool methodology. Wind Tool assumes that every hour the vessel is not in transit or at port, it is being utilized for on-site maneuvering. Therefore, if it is estimated that a vessel will be used for a long period of time (e.g., 150 days), the Wind Tool methodology assumes all vessels are emitting 24 hours per day, 7 days per week for the entire duration (either in transit or during on-site maneuvering).

Ocean Wind has adopted this methodology and assumes each engine is emitting pollution 24 hours per day, 7 days per week for its entire estimated duration. Because Ocean Wind has not finalized a detailed construction schedule, the calculations currently assume the worst-case durations for each construction activity, resulting in conservative emission estimates.

The total construction activity duration was divided among the following vessel uses:

- Transit
- Hoteling at Port
- Maneuvering at Port

[11] U.S. Environmental Protection Agency Office of Air Quality Planning and Standards. (2018). *2014 National Emissions Inventory, version 2 Technical Support Document*. *2014 National Emissions Inventory, version 2 Technical Support Document*. Retrieved from https://www.epa.gov/sites/production/files/2018-07/documents/nei2014v2_tsd_05jul2018.pdf.
[12] ICF International. (2009). *Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories*. *Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories*. U.S. Environmental Protection Agency. Retrieved from https://www.epa.gov/sites/production/files/2016-06/documents/2009-port-inventory-guidance.pdf.
[13] U.S. Environmental Protection Agency Office of Transportation and Air Quality. (2000). *Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data. Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data*. Retrieved from https://nepis.epa.gov/Exe/ZyPDF.cgi/P1009Z2K.PDF?Dockey=P1009Z2K.PDF.

- Onsite Maneuvering

To estimate hours per year for transit, each vessel's number of trips per duration of the activity was multiplied by the distance the vessel was traveling and then divided by the speed of the vessel, resulting in hours/year. Hours spent hoteling at port and maneuvering at port were based on information contained in a white paper presented at the EPA Emission Inventory Conference[13] and in the 2014 National Emissions Inventory Technical Support Document[11].

To estimate hours per year for onsite maneuvering, the Wind Tool methodology was followed, which subtracts the hours per year the vessel is used for transit from the total number of hours in the duration of the activity. Additional hours for hoteling and maneuvering at port were then subtracted from the total number of hours. This approach is conservative since it is highly unlikely each vessel used for Project construction will be in use 24 hours a day for the entire estimated duration of the construction activity.

Once hours per year were estimated for each vessel in all five construction activities, these numbers were multiplied by the rated engine capacity, the emission factor, the load factor, and converted to tons. This results in tons/year.

The same process was applied to vessels used in the O&M phase.

3.1.2 Engines of Auxiliary Equipment Onboard Vessels

Auxiliary equipment onboard marine vessels will be used in both the construction and commissioning phase and the O&M phase of the Project. Key parameters in determining emissions for auxiliary equipment include equipment size, load factor, and duration of use.

The equation to calculate emissions for auxiliary equipment engines is as follows:

$$E = AH \times kW \times LF \times EF \times CF$$

Where:

E	=	Emissions (tons)
AH	=	Annual hours
kW	=	Maximum kilowatt (kW) rating
LF	=	Engine load factor (%)
EF	=	Emission factor (g/kW-hr)
CF	=	Conversion factor (g = 1.10231 E-6 ton)

Emission factors for CO_2, CH_4, N_2O, SO_2, and VOC were obtained from AP-42 Volume I, Section 3.3 and 3.4. The SO_2 emissions were calculated based on the maximum allowable sulfur content (0.0015 wt% S) of the diesel fuel with the assumption that all the sulfur present will be converted to SO_2 during the combustion process.

Emissions for NO_x, PM, PM_{10}, $PM_{2.5}$ and CO were based on the Tier 4 emission standards in 40 CFR 1039.101, which is proposed as LAER in Section 6.2.3. For Tier 4 emission standards presented as NO_x + NMHC, NO_x emissions were estimated to comprise 95% of NO_x + NMHC emissions in accordance with CARB guidance.[14] It is conservatively assumed that the PM emission standard is equal to the filterable portion of PM_{10} and $PM_{2.5}$. The condensable portion of PM_{10} and $PM_{2.5}$ was added using the AP-42 emission factor of 0.0077 lb/MMBtu from AP-42 Table 3.4-2 and converting to lb/hp-hr using the conversion factor 7,000 Btu/hp-hr from footnote 'e' of AP-42 Table 3.4-1, resulting in a condensable emission factor of 0.0000539 lb/hp-hr.

[14] CARB. 2004. Policy: CARB Emission Factors for CI Diesel Engines – Percent HC in Relation to NMHC + NOx. Retrieved from https://www.baaqmd.gov/~/media/files/engineering/policy_and_procedures/engines/emissionfactorsfordieselengines.pdf?la=en

A load factor obtained from EPA's Motor Vehicle Emission Simulator (MOVES) was applied to the auxiliary equipment because the nonroad construction equipment will not be used at full capacity for the entire duration of estimated use but will rather be used at varying loads as construction needs dictate. Engine size estimates and anticipated hours of operation were provided by Ocean Wind

3.1.3 Generator Engines

Generator engines will be used in both the construction and commissioning phase and the O&M phase of the Project. Key parameters in determining emissions from generator engines include equipment size and duration of use.

The equation to calculate emissions for generator engines is as follows:

$$E = AH \times HP \times EF \times CF$$

Where:

E	=	Emissions (tons)
AH	=	Annual hours
HP	=	Maximum horsepower (hp) rating
EF	=	Emission factor (lb/hp-hr)
CF	=	Conversion factor (lb = 5.0 E-4 ton)

Emission factors for CO_2, CH_4, N_2O, SO_2, and VOC were obtained from AP-42 Volume I, Section 3.3 and 3.4. The SO_2 emissions were calculated based on the maximum allowable sulfur content (0.0015 wt% S) of the diesel fuel with the assumption that all the sulfur present will be converted to SO_2 during the combustion process.

Emissions for NO_x, PM, PM_{10}, $PM_{2.5}$ and CO were based on the Tier 4 emission standards in 40 CFR 1039.101, which is proposed as LAER in Section 6.2.3. For Tier 4 emission standards presented as NO_x + NMHC, NO_x emissions were estimated to comprise 95% of NO_x + NMHC emissions in accordance with CARB guidance.[14] It is conservatively assumed that the PM emission standard is equal to the filterable portion of PM_{10} and $PM_{2.5}$. The condensable portion of PM_{10} and $PM_{2.5}$ was added using the AP-42 emission factor of 0.0077 lb/MMBtu from AP-42 Table 3.4-2 and converting to lb/hp-hr using the conversion factor 7,000 Btu/hp-hr from footnote 'e' of AP-42 Table 3.4-1, resulting in a condensable emission factor of 0.0000539 lb/hp-hr.

Engine sizes and anticipated hours of operation during construction were provided by Ocean Wind engineers. For the generators to be installed on each OSS during O&M, annual emissions are based on potential operation of 1,000 hours per year per generator. The emission factor was multiplied by the rated engine capacity and by the estimated number of operating hours per year to obtain annual emission estimates.

3.1.4 Fugitive Emissions

Project components will be painted prior to being brought out to the OCS so there are no fugitive emissions from painting during the construction and commissioning phase. During O&M, the wind turbine towers and foundations, as well as the OSS foundations, will undergo repair painting. The number of events was obtained from Table 6.1.2-7 of Volume I of Ocean Wind's COP dated March 2021[1]. The volume of paint was estimated based on other offshore wind projects. It is assumed that all VOC content is emitted during painting events.

SF_6 will be used to insulate electrical equipment. Fugitive emissions due to SF_6 leakage were estimated based on the SF_6 storage capacity of the equipment and an estimated annual leakage rate of 0.5%[15].

[15] Annual leakage rate obtained from: Blackman, J., Avery, M., & Taylor, Z. SF6 Leak Rates from High Voltage Circuit Breakers - U.S. EPA Investigates Potential Greenhouse Gas Emissions Source. Retrieved April 15, 2021, from https://www.epa.gov/sites/production/files/2016-02/documents/leakrates_circuitbreakers.pdf.

3.1.5 Emission Summary - Construction and Commissioning Phase

Air emissions during the construction and commissioning phase that are subject to permitting under 40 CFR Part 55 are summarized in **Table 3-3**.

The estimate of the Project's potential air emissions during construction and commissioning is based on the Project parameters and emission units described in Section 2 and emission calculation methodology described in Section 3.1.

Table 3-3. Emission Estimates – Construction and Commissioning Phase.

Pollutant	CO_2	CH_4	N_2O	CO_2e	CO	NO_x	PM	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC	HAP
	Tons/year												
Vessels	130,435	0.8	6.3	132,327	464	1,676	58.4	54.5	52.9	6.6	0.01	35.4	15.8
Auxiliary Equipment	5,301	0.2	0.04	5,319	75.2	17.3	0.5	0.5	0.7	0.2	NA	29.4	0.1
Generators	4,155	0.2	0.03	4,169	62.2	21.2	0.5	0.5	0.6	0.1	NA	15.2	0.07
Total	139,891	1.2	6.4	141,815	602	1,714	59.4	55.5	54.1	6.9	0.01	80.0	16.0

Detailed emission estimates and calculations are provided in **Appendix C**.

3.1.6 Emission Summary - O&M Phase

Air emissions during the O&M phase that are subject to permitting under 40 CFR Part 55 are summarized in **Table 3-4**. The estimate of the Project's potential air emissions during O&M are based on the Project parameters and emission units described in Section 2. The resulting summary is conservative for several reasons, including the assumption that all unplanned events occur in the same year as the year with the most scheduled maintenance events.

Table 3-4. Annual Emission Estimates – O&M Phase.

Pollutant	CO_2	CH_4	N_2O	CO_2e	CO	NO_x	PM	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC	HAP
	Tons/year												
Vessels	417	0.003	0.02	423	1.5	6.6	0.2	0.2	0.2	0.008	0.00003	0.09	0.04
Auxiliary Equipment	61.5	0.002	0.0005	61.7	0.8	3.7	0.1	0.1	0.1	0.002	NA	0.1	0.0007
Generators	497	0.02	0.004	499	6.9	1.3	0.06	0.06	0.08	0.01	NA	0.8	0.005
Fugitive	NA	NA	NA	1,381	NA	NA	NA	NA	NA	NA	NA	0.05	0.01
Total	976	0.03	0.02	2,365	9.2	11.6	0.4	0.4	0.4	0.02	0.00003	1.1	0.06

Detailed emission estimates and calculations are provided in **Appendix C**.

4. Applicable Regulatory Requirements

The following sections describe the federal and state requirements that apply to Ocean Wind per 40 CFR Part 55.

4.1 Federal Requirements

The federal requirements that apply to an OCS source are provided in 40 CFR § 55.13 and presented in **Table 4-1**. The applicability of these federal requirements is described in more detail in subsequent sections. The applicability of additional federal regulations is discussed in Section 4.1.5.

Table 4-1. Applicability of Federal Regulations per 40 CFR § 55.13.

40 CFR § 55.13 Citation	Federal Regulation	Applicability to Ocean Wind
55.13(c)	40 CFR Part 60 – NSPS	40 CFR Part 60 applies to the Project's stationary source activities.
55.13(d)	40 CFR 52.21 – PSD	The PSD program applies to the Project. A BACT analysis must be conducted for the Project's stationary source activities for those pollutants which exceed significant emission rate (SER) threshold(s). Additionally, any modeling conducted to support PSD permit application must be conducted using full Project potential emissions (not just stationary source emissions).
55.13(e)	40 CFR part 61, together with any other provisions promulgated pursuant to section 112 o– CAA - NESHAP	40 CFR Part 63 applies to the Project's stationary source activities.
55.13(f)	40 CFR part 71 and part 70 – Operating Permits	The State of New Jersey has been delegated authority by EPA to implement 40 CFR Part 70. The Project must comply with NJDEP operating permit requirements pursuant to New Jersey Administrative Code (N.J.A.C.) Title 7 Chapter 27 Subchapter 22.
55.13(g)	40 CFR 52.10, 40 CFR 52.24, and 40 CFR part 51 and accompanying appendix S – Review of New Sources and Modifications, Requirements for Preparation, Adoption, and Submittal of Implementation Plans, Statutory Restriction on New Sources, & Emission Offset Interpretive Ruling	These requirements are not in effect in the Corresponding Onshore Area (COA), New Jersey; therefore, they do not apply to the Project.

4.1.1 PSD Review

The PSD program, as set forth in 40 CFR § 52.21, is incorporated by reference 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.

4.1.1.1 Construction and Commissioning Phase

As described in Section 2.3.1, the WTA area is considered an OCS source during construction. The potential emissions during construction of one or more pollutants exceed the 250 ton per year threshold; therefore, the

facility, while under construction, is considered major for PSD. Once a single pollutant triggers PSD major status, the PTE of each remaining pollutant is compared against the SER threshold defined in 40 CFR § 52.21(b)(23)(i) to determine whether the pollutant is required to undergo PSD review. Potential emission estimates from the WTA area during construction are compared to PSD SER thresholds in **Table 4-2**.

Table 4-2. WTA Potential-to-Emit During Construction and Commissioning and PSD SER Thresholds.

Pollutant	PTE	SER	PSD Review Required [1]
	tons/year	tons/year	
CO	576.3	100	**YES**
NO_x	2,160.7	40	**YES** [1]
PM	69.6	25	**YES**
PM_{10}	69.6	15	**YES**
$PM_{2.5}$	67.0	10	**YES**
SO_2	13.8	40	No
VOC	81.4 [1]	NA [1]	No [1]
Sulfuric Acid (H_2SO_4)	0.6	7	No
Lead (Pb)	0.008	0.6	No
GHG (as CO_2e) [2]	135,329	75,000	**YES**

[1] In accordance with 40 CFR 52.21(i)(2), the substantive PSD requirements [paragraphs (j) through (r)] shall not apply to a major stationary source with respect to a particular pollutant if the source is in an area designated as nonattainment under section 107 of the Act. Such areas are subject to nonattainment new source review (NNSR) if emissions are major under that program. Because the COA is designated nonattainment for ozone, 40 CFR 52.21 paragraphs (j) through (r) do not apply to NO_x or VOC as ozone precursor emissions. However, NO_x emissions need to be treated as both PSD-regulated emissions for purposes of NO_2 impacts, and as NNSR-regulated emissions for purposes of ozone impacts.[2] The SER for GHG applies to sources subject to PSD for another pollutant, also known as "anyways sources".

PSD review elements are described in 40 CFR § 52.21(j) through (s). PSD review elements specific to the construction and commissioning phase of the Project include a BACT analysis, a source impact analysis, an air quality analysis, and an additional impact analysis. Additionally, the Project, in consultation with the Federal Land Manager (FLM), United States Fish and Wildlife Services (USFWS), of Brigantine Wilderness, has conducted an AQRV analysis. The AQRV modeling report is presented in **Appendix E**.

BACT Analysis

The Project must conduct a BACT analysis for each regulated NSR pollutant with a PTE in the construction and commissioning phase equal to or exceeding the SER threshold in 40 CFR § 52.21(b)(23). Based on the PTE shown in **Table 4-2,** the Project must conduct a BACT analysis for CO, NO_x, PM, PM_{10}, $PM_{2.5}$, and GHG; the BACT review is presented in Section 6.

Source Impact Analysis

The Project must conduct a source impact analysis for each regulated NSR pollutant with a PTE in the construction and commissioning phase equal to or exceeding the SER threshold in 40 CFR § 52.21(b)(23) for which there is a NAAQS and/or PSD increment (Class I and Class II). Therefore, the Project must conduct a source impact analysis for PM_{10}, $PM_{2.5}$, NO_2 and CO[16]. The source impact analysis was conducted in accordance with the revised Ocean Wind Modeling Protocol submitted to EPA and NJDEP on June 20, 2022.

[16] Even though the Project exceeds the TSP threshold, NJDEP modeling guidance (page 3) states that the Department assumes that if the NAAQS for PM_{10} and $PM_{2.5}$ are met, then the TSP NJAAQS will also be met. Also, there is no NAAQS for VOC therefore a modeling analysis is not required for VOC.

Based on comment received from EPA during a call on June 28, the Ocean Wind Modeling Protocol was revised to include a discussion on platform downwash, fumigation, and an updated meteorological evaluation. This revised version is dated July 15, 2022 and is provided in **Appendix D**. The source impact analysis modeling results are provided in **Appendix E**.

Air Quality Analysis

The Project included an analysis of ambient air quality in the vicinity of the Project in Appendix B of the revised Ocean Wind Modeling Protocol submitted to EPA and NJDEP on June 20, 2022. The revised Ocean Wind Modeling protocol is provided in **Appendix D**.

Additional Impact Analysis

The Project conducted an additional impact analysis as required by 40 CFR § 52.21(o). The analysis is presented in Section 9.

4.1.1.2 O&M Phase

As described in Section 2.3.2, certain equipment and vessels within the WTA area that will be utilized for O&M activities are considered OCS sources. The OSSs will be equipped with diesel-fired generators, causing the OSSs to be considered OCS sources. Additionally, there is anticipated to be one jack-up vessel at the OSS or the WTGs during the O&M phase. The jack-up vessel is also considered an OCS source. There will be one CTV enroute to and from the jack-up vessel while it is jacked up (considered an OCS source); potential emissions include emissions from this CTV. The combined potential emissions of all OCS sources within the WTA area during O&M are presented and compared to PSD major source thresholds in **Table 4-3**. The potential emissions include emissions from the generators and vessel traffic to and from the OSSs. Vessel traffic to and from the WTGs during O&M is excluded because the WTGs are not considered OCS sources (see Section 2.3.2 and **Appendix A**).

Table 4-3. Potential-to-Emit During O&M and PSD Major Source Thresholds.

Pollutant	PTE	PSD Threshold	PSD Major Source
	tons/year	tons/year	
CO	9.2	250	No
NO_x	11.6	250	No
PM	0.4	250	No
PM_{10}	0.4	250	No
$PM_{2.5}$	0.4	250	No
SO_2	0.02	250	No
VOC	1.1	NA [1]	No [1]
Lead (Pb)	0.00003	250	No

[1] In accordance with 40 CFR 52.21(i)(2), the substantive PSD requirements [paragraphs (j) through (r)] shall not apply to a major stationary source with respect to a particular pollutant if the source is in an area designated as nonattainment under section 107 of the Act. Such areas are subject to nonattainment new source review (NNSR) if emissions are major under that program. Because the presumed COA is designated nonattainment for ozone, 40 CFR 52.21 paragraphs (j) through (r) do not apply to NO_x or VOC as ozone precursor emissions. However, NO_x emissions need to be treated as both PSD-regulated emissions for purposes of NO_2 impacts, and as NNSR-regulated emissions for purposes of ozone impacts.

Table 4-3 demonstrates that the O&M phase is not subject to PSD permitting.

4.1.2 Title V Operating Permit

The State of New Jersey has an EPA-approved CAA Title V operating permit program. Operating permit program requirements are promulgated in N.J.A.C. Title 7 Chapter 27 Subchapter 22. Please refer to Section 4.2.16 for the applicability of Subchapter 22 to the Project.

4.1.3 New Source Performance Standards (NSPS)

Pursuant to 40 CFR § 55.13(c), NSPS apply to OCS sources in the same manner as in the COA. Only the OCS source emissions, that is, stationary source activities, are subject to NSPS. This section discusses NSPS potentially applicable to the Project.

4.1.3.1 Subpart Dc – Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units and Subpart Db – Standards of Performance for Industrial-Commercial-Institutional Steam Generating Units

The affected unit under NSPS Db and NSPS Dc is a steam generating unit, which is defined as "*a device that combusts any fuel or byproduct/waste and produces steam or heats water or heats any heat transfer medium*" in Subpart Db and, similarly, as "*a device that combusts any fuel and produces steam or heats water or heats any heat transfer medium*" in Subpart Dc. Subpart Db is applicable to each steam generating unit that commences construction, modification, or reconstruction after June 19, 1984, and that has a heat input capacity of greater than 100 million British thermal units (MMBtu) per hour. Subpart Dc is applicable to each steam generating unit that commences construction, modification, or reconstruction after June 9, 1989, and has a maximum heat input of 100 MMBtu per hour or less but greater than or equal to 10 MMBtu per hour.

It is anticipated that boilers present on vessels considered OCS sources will be unfired boilers and will not meet the definition of a steam generating unit. Therefore, it is not anticipated that NSPS Subpart Db or NSPS Subpart Dc will apply to the Project.

4.1.3.2 Subpart IIII – Standards of Performance for Stationary Compression Ignition (CI) Internal Combustion Engines (ICE)

Per 40 CFR § 60.2400, the provisions of NSPS Subpart IIII are applicable to owners and operators of stationary CI ICE that commence construction after July 11, 2005, where the stationary CI ICE are manufactured after April 1, 2006, and are not fire pump engines. For purposes of NSPS Subpart IIII, the date that construction commences is the date the engine is ordered by the original owner or operator. NSPS Subpart IIII also applies to owners and operators of any stationary CI ICE that are modified or reconstructed after July 11, 2005, and any person that modifies or reconstructs any stationary CI ICE after July 11, 2005. Additionally, the provisions of 40 CFR § 60.4208 applies to all owners and operators of stationary CI ICE that commence construction after July 11, 2005.

It is anticipated that many, or all, of the following engines will be subject to NSPS Subpart IIII:

1. Internal combustion engines located on WTG or OSS
2. Internal combustion engines powering equipment onboard vessels while the vessels are operating as OCS sources
3. Internal combustion engines powering vessels while the vessels are operating as OCS sources.

Owners and operators of non-emergency CI ICE must comply with emission standards in 40 CFR § 60.4204 and owners and operators of emergency CI ICE must comply with emission standards in 40 CFR § 60.4205. Owners and operators must operate and maintain CI ICE that achieve the emission standards in 40 CFR § 60.4204 and 40 CFR § 60.4205 for the life of the engine.

Emission standards prescribed in 40 CFR § 60.4204 for non-emergency CI ICE with a displacement of less than 30 liters per cylinder are presented in **Table 4-4**. Most of the engines that will be subject to NSPS Subpart IIII are anticipated to be considered non-emergency engines.

Table 4-4. NSPS Subpart IIII Emission Standards for Non-Emergency CI ICE with a Displacement of Less Than 30 Liters Per Cylinder.

Model Year	Engine Size kW	Displacement Liters per Cylinder	Emission Standard
Pre-2007	All	< 10	Table 1 of NSPS Subpart IIII
Pre-2007	All	10 ≤ D ≤ 30	Tier 1 emission standards in 40 CFR Part 1042, Appendix I [equivalent to emission standards of 40 CFR 94.8(a)(1) for engines at or above 37 kW]
2007 or later	**≤ 2,237 kW**	**< 10**	Emission standards for new nonroad CI engines in 40 CFR 1039.101, 1039.102, 1039.104, 1039.105, 1039.107, 1039.115, and 40 CFR Part 1039, Appendix I, as applicable, for all pollutants for the same model year and maximum engine power
2007 – 2010	> 2,237 kW	< 10	Table 1 of NSPS Subpart IIII
2011 or later	**> 2,237 kW**	**< 10**	Emission standards for new nonroad CI engines in 40 CFR 1039.101, 40 CFR 1039.102, 40 CFR 1039.104, 40 CFR 1039.105, 40 CFR 1039.107, and 40 CFR 1039.115, as applicable, for all pollutants, for the same maximum engine power
2007 – 2012	All	10 ≤ D ≤ 30	Tier 2 emission standards for new marine CI engines as described in 40 CFR Part 1042, Appendix I, for all pollutants, for the same displacement and rated power
2013	≥ 3,700 kW	10 ≤ D ≤ 15	
2013	All	15 ≤ D ≤ 30	
2013	< 3,700 kW	10 ≤ D ≤ 15	Emission standards and other requirements for new marine CI engines in 40 CFR 1042.101, 40 CFR 1042.107, 40 CFR 1042.110, 40 CFR 1042.115, 40 CFR 1042.120, and 40 CFR 1042.145, as applicable, for all pollutants, for the same displacement and maximum engine power
2014 and later	All	10 ≤ D ≤ 30	

Per 40 CFR § 60.4201(f), certain stationary non-emergency CI ICE may be certified to the provisions of 40 CFR Part 1042 for commercial engines that are applicable for the engine's model year, displacement, power density, and maximum engine power if the engines will be solely used in marine offshore installations instead of meeting the applicable requirements in § 60.4201. The types of engines that qualify for this option are bolded in **Table 4-4**.

Emission standards prescribed in 40 CFR § 60.4204 for non-emergency CI ICE with a displacement of 30 liters or more per cylinder are presented in **Table 4-5**. 40 CFR § 60.4219 defines "installed" as *the engine is placed and secured at the location where it is intended to be operated*. For engines installed on vessels, Ocean Wind is interpreting this to mean the date the engine is placed and secured on the vessel since that is the location the engine is intended to be operated.

Table 4-5. NSPS Subpart IIII Emission Standards for Non-Emergency CI ICE with a Displacement of 30 Liters or More Per Cylinder.

Engine Installation Year	NO_x Limit g/kWh			PM
	n < 130	130 ≤ n < 2000	n ≥ 2000	
Pre-2012	17.0	$45 * n^{-0.2}$	9.8	Reduce PM emissions by 60 percent or more, or limit the emissions of PM in the stationary CI ICE exhaust to 0.15 g/kW-hr.
January 1, 2012-December 31, 2015	14.4	$44 * n\text{-}0^{.23}$	7.7	
January 1, 2016 and later	3.4	$9.0 * n^{-0.20}$	2.0	
n = maximum engine speed in revolutions per minute				

The NSPS Subpart IIII NO_x standards presented in **Table 4-5** are identical to the NO_x standards of International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI, with minor differences in applicability. Requirements of Annex VI potentially applicable to vessels utilized by the Project are discussed in detail in Section 4.1.5.

The engines powering generators installed on the OSS during O&M will be operated as emergency engines under NSPS Subpart IIII. To be considered emergency, the reciprocating internal combustion engine (RICE) must meet all criteria specified under the definition of *emergency stationary internal combustion engine* in 40 CFR § 60.4219. However, in accordance with the proposed LAER determination, Orsted will purchase generator engines that are certified by the manufacturer to meet Tier 4 non-emergency standards in 40 CFR § 60.4204.

Emission standards prescribed in 40 CFR § 60.4204 for emergency CI ICE with a displacement of less than 30 liters per cylinder are presented in **Table 4-6**. It is anticipated that the diesel engines powering the generators will have a displacement of 10 liters or less per cylinder. If the engines selected have a displacement of ten liters per cylinder or greater but less than 30 liters per cylinder, the emission standards of **Table 4-7** would apply rather than the emission standards in **Table 4-6**.

Table 4-6. NSPS Subpart IIII Emission Standards for Emergency CI ICE with a Displacement of Less Than 10 Liters Per Cylinder.

Model Year	Engine Size kW	Displacement Liters per Cylinder	Emission Standard
Pre-2007	All	< 10	Table 1 of NSPS Subpart IIII
Pre-2007	All	10 ≤ D ≤ 30	Tier 1 emission standards in 40 CFR Part 1042, Appendix I [equivalent to emission standards of 40 CFR 94.8(a)(1) for engines at or above 37 kW]
2007	**< 37**	**< 10**	Tier 2 emission standards in 40 CFR Part 1039, Appendix I, for all pollutants and the smoke standards as specified in 40 CFR 1039.105
2008 and later	**< 37**	**< 10**	Emission standards for new nonroad CI engines in 40 CFR 1039.104, 40 CFR 1039.105, 40 CFR 1039.107, 40 CFR 1039.115, and Table 2 of NSPS Subpart IIII

Model Year	Engine Size kW	Displacement Liters per Cylinder	Emission Standard
2007 and later	**37 ≤ P ≤ 2,237**	**< 10**	Tier 2 or Tier 3 emission standards for new nonroad CI engines for the same rated power as described in 40 CFR Part 1039, Appendix I, for all pollutants and the smoke standards as specified in 40 CFR 1039.105 beginning in model year 2007
2007 – 2010	> 2,237	< 10	Table 1 of NSPS Subpart IIII
2011 and later	> 2,237	< 10	Tier 2 emission standards in 40 CFR Part 1039, Appendix I, for all pollutants and smoke standards specified in 40 CFR 1039.105

Table 4-7. NSPS Subpart IIII Emission Standards for Emergency CI ICE with a Displacement of 10 Liters per Cylinder or More and Less Than 30 Liters Per Cylinder.

Model Year	Engine Size kW	Displacement Liters per Cylinder	Emission Standard
2007 – 2012	All	10 ≤ D < 30	Tier 2 emission standards for new marine CI engines as described in 40 CFR Part 1042, Appendix I, for all pollutants
2013 and later	≥ 3,700	10 ≤ D < 15	
2013	All	15 ≤ D < 30	
2014	≥ 2,000	15 ≤ D < 30	
2013 and later	< 3,700	10 ≤ D < 15	Tier 3 emission standards for new marine CI engines in 40 CFR 1042.101, 40 CFR 1042.107, 40 CFR 1042.115, 40 CFR 1042.120, and 40 CFR 1042.145, for all pollutants, for the same displacement and maximum engine power
2014 and later	< 2,000	15 ≤ D < 30	

Per 40 CFR § 60.4202(g), certain stationary emergency CI ICE may demonstrate compliance based on manufacturer certification to the provisions of 40 CFR Part 1042 for commercial engines that are applicable for the engine's model year, displacement, power density, and maximum engine power if the engines will be solely used in marine offshore installations instead of meeting the applicable requirements in 40 CFR § 60.4202. The engine types that qualify for this option are bolded in **Table 4-6**. Additionally, engines qualifying for this option that would be subject to the Tier 4 standards in 40 CFR Part 1042 and that are used solely in marine offshore installations may instead continue to be certified to the appropriate Tier 3 standards in 40 CFR Part 1042.

Emission standards prescribed in 40 CFR § 60.4205 for emergency CI ICE with a displacement of 30 liters or more per cylinder are presented in **Table 4-8**. 40 CFR § 60.4219 defines "installed" as *the engine is placed and secured at the location where it is intended to be operated*. For engines installed on vessels, Ocean Wind is interpreting this to mean the date the engine is placed and secured on the vessel since that is the location the engine is intended to be operated.

Table 4-8. NSPS Subpart IIII Emission Standards for Emergency CI ICE with a Displacement of 30 Liters or More Per Cylinder.

Engine Installation Year	NO_x Limit g/kWh			PM
	n < 130	130 ≤ n < 2000	n ≥ 2000	
Pre-2012	17.0	$45 * n^{-0.2}$	9.8	Limit the emissions of PM in the stationary CI ICE exhaust to 0.40 g/kW-hr.
January 1, 2012 and later	14.4	$44 * n\text{-}0^{.23}$	7.7	
n = maximum engine speed in revolutions per minute				

40 CFR § 60.4207 requires that the diesel fuel combusted in CI ICE with a displacement less than 30 liters per cylinder subject to NSPS Subpart IIII meet the requirements of 40 CFR § 1090.305 for nonroad diesel fuel. It also requires that diesel fuel combusted in CI ICE with a displacement greater than or equal to 30 liters per cylinder subject to NSPS Subpart IIII have a maximum per-gallon sulfur content of 1,000 parts per million. Diesel fuel is defined in 40 CFR § 60.4219 as *any liquid obtained from the distillation of petroleum with a boiling point of approximately 150 to 360 degrees Celsius. One commonly used form is number 2 distillate oil*.

Owners and operators of CI ICE must comply with the monitoring and notification requirements of 40 CFR § 60.4209 and 60.4214 as well as the compliance requirements of 40 CFR § 60.4211.

4.1.3.3 Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines

It is not anticipated that any of the engines used to power vessels, generators, or auxiliary equipment as part of the Project will be spark ignition. Therefore, NSPS Subpart JJJJ is not anticipated to apply to any emission units associated with the Project.

4.1.4 National Emission Standards for Hazardous Air Pollutants (NESHAP)

40 CFR § 52.13(e) states that provisions promulgated pursuant to section 112 of the [Clean Air] Act applies 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.

4.1.4.1 Subpart ZZZZ – NESHAP for Stationary RICE

NESHAP Subpart ZZZZ applies to owners and operators of stationary RICE at major or area sources of HAP emissions, unless the RICE is being tested at a stationary RICE test cell/stand. The Project construction and commissioning phase is an area source of HAP, as shown in **Table 3-3** and the O&M phase is an area source of HAP, as shown in **Table 3-4**.

NESHAP Subpart ZZZZ will apply to engines that are considered OCS sources. 40 CFR § 63.6590(c)(1) states that new or reconstructed RICE located at an area source meets the requirements of Subpart ZZZZ by meeting the requirements of NSPS Subpart IIII for CI engines and NSPS Subpart JJJJ for spark ignition engines. Per 40 CFR § 63.6590(a)(2)(iii) a RICE located at an area source of HAP emissions is new if construction of the RICE was commenced on or after June 12, 2006. Engines planned to be utilized by the Project that were constructed on or after June 12, 2006, are required to meet the requirements of NSPS Subpart IIII and are not subject to further requirements under NESHAP Subpart ZZZZ.

All internal combustion engines utilized by the Project that were constructed or reconstructed before June 12, 2006, and that are considered OCS sources are subject to 40 CFR § 63.6603. NESHAP Subpart ZZZZ

contains emissions limits and operating requirements that apply to these engines, including the fuel requirements in 40 CFR § 63.6604.

4.1.4.2 Subpart JJJJJ – NESHAP for Industrial, Commercial, and Institutional Boiler Area Sources

NESHAP Subpart JJJJJ applies to owners and operators of industrial, commercial, or institutional boilers as defined in 40 CFR § 63.11237 that are located at an area source of HAP. *Commercial boiler* is defined in 40 CFR § 63.11237 as a boiler used in commercial establishments such as hotels, restaurants, and laundries to provide electricity, steam, and/or hot water. *Industrial boiler* is defined in 40 CFR § 63.11237 as a boiler used in manufacturing, processing, mining, and refining or any other industry to provide steam, hot water and/or electricity. *Institutional boiler* is defined in 40 CFR § 63.11237 as a boiler used in institutional establishment such as, but not limited to, medical centers, nursing homes, research centers, institutions of higher education, elementary and secondary schools, libraries, religious establishments, and governmental buildings to provide electricity, steam, and/or hot water.

It is anticipated that boilers present on vessels considered OCS sources will be unfired boilers and will not meet the definition of a commercial, industrial, or institutional boiler. Therefore, it is not anticipated that NESHAP Subpart JJJJJ will apply to the Project.

4.1.5 Other Federal Regulations for Marine Compression-Ignition Engines and Non-Road Compression-Ignition Engines

The Project will utilize several vessels ranging in size and with a variety of purposes. Some vessels with be U.S.-flagged and some will be foreign-flagged.

The MARPOL treaty, set forth by the International Maritime Organization, is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. The U. S. is a signatory of the MARPOL treaty and has implemented it through 40 CFR Part 1043. Annex VI of the MARPOL treaty addresses air pollution prevention requirements. It contains limits on NO_x emissions and limits on fuel sulfur contents which reduces SO_x and PM emissions. The MARPOL provisions apply to both U.S.-flagged and foreign-flagged vessels operating within U.S. waters.

The NO_x emission limits set by Annex VI are presented in **Table 4-9**. The NO_x emission limits of Annex VI apply to installed marine diesel engines, both main and auxiliary, of over 130 kW output power other than those used solely for emergency purposes which are installed on a ship constructed, or which undergo major conversion, on or after January 1, 2000. ‘Installed’ and ‘marine diesel engine’ are defined within MARPOL. The Tier III emission limits only apply to ships while operating within defined Emission Control Areas (ECA); outside such areas Tier II emission limits apply. The Project area is located within the North American Emission Control Area; therefore, foreign-flagged and U.S.-flagged vessels utilized by the Project must comply with Tier III emission limits if the ship is constructed on or after January 1, 2016.

Table 4-9. MARPOL Annex VI NO_x Emission Limits.

Tier	Ship Construction Date On or After	NO_x Limit g/kWh		
		n < 130	130 ≤ n < 2000	n ≥ 2000
I	January 1, 2000	17.0	$45 * n^{-0.2}$	9.8
II	January 1, 2011	14.4	$44 * n\text{-}0^{.23}$	7.7
III	January 1, 2016	3.4	$9.0 * n^{-0.20}$	2.0
n = engine's rated speed (revolutions per minute)				

The fuel oil sulfur limit applies to the Project because the Project is within the North American Emission Control Area and will occur after January 1, 2015, is 0.1%, or 1000 parts per million (ppm). More stringent fuel sulfur content limits may apply while vessels are considered OCS sources; see Section 4.1.3.2 and discussion under 40 CFR Part 80 and 40 CFR Part 1090.

Additional federal regulations govern emissions from marine diesel engines installed on U.S.-flagged and foreign-flagged vessels. Regulations potentially applicable to the Project include the following:

40 CFR Part 80 – Regulation of Fuels and Fuel Additives.

The requirements of 40 CFR Part 80 relevant to marine diesel fuel have been moved to 40 CFR Part 1090 as part of the Fuels Regulatory Streamlining action published in the Federal Register December 4, 2020[17]. See discussion on 40 CFR Part 1090 below.

40 CFR Part 89 – Control of Emissions from New and In-Use Nonroad Compression-Ignition Engines. Per 40 CFR § 89.1, EPA has migrated the Tier 1, Tier 2, and Tier 3 engine standards originally promulgated in Part 89 to Part 1039 with additional testing and compliance provisions in Parts 1065 and 1068. If the Project utilizes engines originally certified under Part 89, the engines must continue to comply with applicable requirements of Part 89 as described in Part 1039.1.

40 CFR Part 94 – Control of Emissions from Marine Compression-Ignition Engines. Per 40 CFR § 94.1, EPA has migrated engine standards for engines with a model year of 2004 or later to Part 1042, with additional testing and compliance provisions in Parts 1065 and 1068. If the Project utilizes engines originally certified under Part 94, the engines must continue to comply with applicable requirements of Part 94 as described in Part 1042.1.

40 CFR Part 1039 – Control of Emissions from New and In-Use Nonroad Compression-Ignition Engines. Applicable to all new compression-ignition nonroad engines unless exempted under 40 CFR § 1039.5. New nonroad engine is defined under 40 CFR § 1039.801. Part 1039 sets emission standards and other requirements for nonroad engines. Part 1039 may be applicable to Project engines when considered OCS sources.

40 CFR Part 1042 – Control of Emissions from New and In-Use Marine Compression-Ignition Engines and Vessels. Applicable to all new compression-ignition marine engines on U.S.-flagged vessels and U.S.-flagged vessels containing such engines. The definition of 'new engine' and 'new vessel' is provided in 40 CFR § 1042.901. Per 40 CFR § 1042.2, requirements of Part 1042 are generally addressed to engine manufacturers other than requirements in Subpart I which addresses remanufactured marine engines. Part 1042 contains emission standards for Category 1, Category 2, and Category 3 marine engines. Per Part 1042.901, a

[17] Fuels Regulatory Streamlining. 85 Fed. Reg. 78,412 (December 4, 2020).

Category 1 marine engine is a marine engine with a specific engine displacement below 7.0 liters per cylinder. A Category 2 marine engine has a specific engine displacement at or above 7.0 liters per cylinder but less than 30.0 liters per cylinder. A Category 3 engine has a specific engine displacement at or above 30.0 liters per cylinder.

40 CFR Part 1043 – Control of NO_x, SO_x, and PM Emissions from Marine Engines and Vessels Subject to the MARPOL Protocol. Applicable to all U.S.-flagged vessels utilized for the Project unless the vessel contains no engines with a specific engine displacement at or above 30.0 liters per cylinder, the vessel operates only domestically and all compression-ignition engines on the vessel fully conform to all applicable provisions of 40 CFR Parts 94 and 1042. Also applicable to foreign-flagged vessels utilized for the Project, including vessels flagged by a country that is not a party to Annex VI. The requirements of 40 CFR Part 1043 include obtaining an Engine International Air Pollution Prevention (EIAPP) certificate for certain engines, the NO_x emission limits and fuel sulfur contents of Annex VI, and various recordkeeping and reporting obligations.

Because U.S.-flagged ships must comply with both MARPOL Annex VI and with applicable regulations in U.S. federal air pollution control rules, the EPA published a document describing how these regulations interact[18]. One significant difference is that Annex VI requires that vessel operators be responsible for ensuring the vessel meets the air pollution control requirements of Annex VI while EPA requires that vessel manufacturers be responsible for ensuring vessels comply with applicable air pollution control requirements for the full useful life of the vessel.

40 CFR Part 1090 – Regulation of Fuels, Fuel Additives, and Regulated Blendstocks. Specifies fuel quality standards for gasoline and diesel fuel introduced into commerce in the U. S. Requires that all diesel fuel has a maximum sulfur content of 15 ppm unless specifically exempted by 40 CFR § 1090.300(a), which states that alternative sulfur standards apply for ECA marine fuel. 40 CFR § 1090.325 sets sulfur standards that apply to any person who produces or handles ECA marine fuel which is fuel used in marine vessels within designated ECAs as specified by MARPOL Annex VI. “ECA marine fuel” is defined in 40 CFR § 1090.325 as *diesel, distillate, or residual fuel used, intended for use, or made available for use in C3 marine vessels while the vessels are operating within an ECA, or an ECA associated area*. “C3 marine vessel” is defined as *a vessel that is propelled by an engine(s) that meets the definition of “Category 3” in 40 CFR* § *1042.901*. “Category 3” is defined in 40 CFR § 1042.901 as *a reciprocating marine engine with a specific engine displacement at or above 30.0 liters per cylinder*.

40 CFR § 1090.325 requires that ECA marine fuel must have a maximum sulfur content of 1,000 ppm unless the fuel meets exceptions of 40 CFR § 1090.325(c). The first exception listed is for residual fuel for use in a steamship or C3 marine vessel if the U.S. government exempts the vessel from MARPOL Annex VI fuel standards; diesel fuel and other distillate fuel used in diesel engines operated on such vessels must comply with the sulfur content limit of 1,000 ppm. 40 CFR § 1043.55 permits the use of fuels not meeting the fuel sulfur requirements of Annex VI provided approval is requested for U.S.-flagged vessels or the Administration of a foreign-flagged vessel certifies the vessel is equipped with controls achieving emission levels equivalent to those achieved using fuels meeting the applicable fuel sulfur limits of Annex VI. Additionally, as noted in the footnote to Table 2 in 40 CFR § 1043.60, Regulation 3 and Regulation 4 of Annex VI allows for the use of noncompliant fuel in certain circumstances, such as securing the safety of a ship or saving life at sea.

---

[18] US Environmental Protection Agency (EPA). 2002. *Emission Standards for New Marine Diesel Engines. Relationship Between EPA's Control Program and MARPOL Annex VI*. Retrieved November 8, 2021, from https://nepis.epa.gov/Exe/ZyPDF.cgi/P1009YZS.PDF?Dockey=P1009YZS.PDF.

Therefore, unless residual fuel usage is considered exempt from the U.S. government from MARPOL Annex VI standards, it must meet the maximum sulfur content limit of 1,000 ppm.

The second exception is for distillate global marine fuel that is exempt under 40 CFR § 1090.650, which applies to distillate global marine fuel that is produced, imported, sold, offered for sale, supplied, offered for supply, stored, dispensed, or transported for use in steamships or Category 3 marine vessels when operating outside of ECA boundaries. The second exception does not apply to Project vessels.

4.1.6 Coastal Zone Management Act Requirements

Per 40 CFR § 930.57, the Project is required to provide a certification that it will comply with the Coastal Zone Management Act requirements. The Coastal Zone Consistency Assessment submitted with the COP as Appendix Q is included as **Appendix F** to this application. The Coastal Zone Consistency Assessment was submitted to NJDEP on March 30, 2021, as documented in the stay agreement between Ocean Wind and NJDEP dated March 31, 2021. The stay agreement between Ocean Wind and NJDEP dated March 31, 2021 is provided in **Appendix F**. It states that the NJDEP consistency determination is due no later than October 28, 2022, though this date can change by mutual agreement of NJDEP and the Project to correspond with other permitting schedules.

4.2 State Requirements

40 CFR § 55.3(b) requires OCS sources within 25 miles of a State's seaward boundary comply with the state or local air emissions requirements of the COA.

EPA designated New Jersey the COA for the Project. Upon receipt of the NOI, EPA conducted a consistency review of regulations in the COA and updated 40 CFR Part 55 to include all applicable federal, state, and local requirements in accordance with 40 CFR § 55.5. EPA published a Final Rule to incorporate New Jersey air pollution control requirements applicable to OCS Sources as of October 6, 2021, into 40 CFR Part 55, Appendix A (87 FR 11962, March 3, 2022).

The New Jersey regulations (as of February 23, 2022) are incorporated into 40 CFR Part 55 by reference and are listed in Appendix A of Part 55. The following is a summary of the New Jersey rules incorporated by reference into 40 CFR Part 55 and an explanation of how these requirements apply to the Project.

4.2.1 Chapter 27 Subchapter 2 - Control and Prohibition of Open Burning (Effective 6/20/1994)

N.J.A.C. Chapter 27, Subchapter 2 prohibits open burning without obtaining requisite permit(s). Since there will be no open burning or aggregated storage of combustible material associated with the Project, Chapter 27, Subchapter 2 is not applicable to the Project.

4.2.2 Chapter 27 Subchapter 3 - Control and Prohibition of Smoke From Combustion of Fuel (Effective 2/4/2002)

N.J.A.C. Chapter 27, Subchapter 3 prohibits smoke (exclusive of visible condensed water vapor) from combustion of fuel in 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, as detailed in the rule. Ocean Wind will achieve compliance with these standards through the use of good combustion practices and use of good operating and maintenance standards.

4.2.3 Chapter 27 Subchapter 4 - Control and Prohibition of Particles From Combustion of Fuel (Effective 4/20/2009)

N.J.A.C. Chapter 27, Subchapter 4 prohibits the emission of particulate emissions in excess of rates established in Table 7:27-4.2 or determined by interpolation. This subchapter applies to each fuel combustion source associated with the Project. Compliance with these standards will be achieved through the use of good combustion practices and the use of good operating and maintenance standards.

4.2.4 Chapter 27 Subchapter 5 - Prohibition of Air Pollution (Effective 10/12/1977)

N.J.A.C. Chapter 27, Subchapter 5 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 the Project. Compliance with this standard will be achieved through compliance with the requested permit and limitations consistent with the evaluation herein and compliance with other applicable regulations.

4.2.5 Chapter 27 Subchapter 6 - Control and Prohibition of Particles From Manufacturing Processes (Effective 6/12/1998)

N.J.A.C. Chapter 27, Subchapter 6 prohibits the emission of particulate emissions and opacity from listed processes. The Project will not include any listed source operations, as defined in Subchapter 6; therefore, this subchapter is not applicable to the Project.

4.2.6 Chapter 27 Subchapter 7 - Sulfur (Effective 11/6/2017)

N.J.A.C. Chapter 27, Subchapter 7 prohibits emission of sulfur compounds except within the bounds enumerated within the Subchapter. N.J.A.C. 7:27-7.2(k) specifically excludes the discharge of sulfur compounds resulting from the combustion of commercial fuel from the requirements of this subchapter. The only sulfur emissions emitted by the Project are the result of the combustion of commercial fuel. Therefore, this subchapter is not applicable to the Project.

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

N.J.A.C. Chapter 27, Subchapter 8 establishes a general prohibition for construction of a stationary source unless the source obtains the appropriate air quality pre-construction and operating approvals. As a result of the processes established in 40 CFR § 55.14, requirement applies to both the construction and commissioning phases of the Project. The Project will comply with the requirements to evaluate NSR requirements under Chapter 27, Subchapter 18, and the air quality impact analysis requirements of N.J.A.C. 7:27-8.5. See Section 4.1.1 for additional information regarding the air quality impact analysis the Project conducted. Because the O&M phase will not be a major source, Ocean Wind does not anticipate obtaining a Title V permit under Chapter 27, Subchapter 22 referenced within this subchapter.

The requirements of Subchapter 8 apply to significant sources as described in N.J.A.C. 7:27-8.2(c). Most of the emission units associated with the Project meet the criteria of N.J.A.C. 7:27-8.2(c)(1) for commercial fuel burning equipment with a maximum rated heat input of 1 MMBtu per hour or greater.

However, except for the generators on the OSS which will remain after construction and serve as emergency generators, all equipment meets the exemption listed in N.J.A.C. 7:27-8.2(d)(15) for equipment used to conduct construction, repair, or maintenance (CRM) activities, provided that the equipment is portable and is located on site for no longer than one year. It is anticipated that each individual piece of commercial fuel burning equipment, such as vessel engines, auxiliary equipment, and portable generators, utilized in the construction

and commissioning phase will be located on site for less than one year, other than the generators installed on the OSS during commissioning. Similarly, in the O&M phase, all commercial fuel burning equipment other than the generators located on the OSS will be portable, located on site for less than one year, and used to conduct repair or maintenance activities. As a result, the only significant sources under Subchapter 8 are the generators installed on the OSS.

The Project will meet the requirements of NSPS, NSR, and SOTA requirements as elsewhere described within this application. No emission offset requirements apply to the Project as most emissions will be generated during the construction phase which is specifically excluded from the requirements under N.J.A.C. Chapter 27, Subchapter 8.3. See Section 8 for additional detail.

4.2.8 Chapter 27 Subchapter 9 - Sulfur in Fuels (Effective 9/20/2010)

N.J.A.C. Chapter 27, Subchapter 9 establishes the requirements for sulfur content in fuel (ppm) used and stored in New Jersey. It also establishes the maximum sulfur dioxide emissions (lb/MMBtu). N.J.A.C. 7:27-9.3 specifically excludes fuel used by ocean-going vessels from the provisions of Subchapter 9. However, the rule will apply to fuel used by the Project's auxiliary equipment and generators. The Project will comply with applicable fuel sulfur limitations as described in Section 4.1.

4.2.9 Chapter 27 Subchapter 10 - Sulfur in Solid Fuels (Effective 9/6/2011)

N.J.A.C. Chapter 27, Subchapter 10 establishes the requirements for sulfur content in solid fuels. No solid fuels will be used as part of this Project and therefore these provisions are not applicable to the Project.

4.2.10 Chapter 27 Subchapter 11 - Incinerators (Effective 5/4/1998)

N.J.A.C. Chapter 27, Subchapter 11 establishes requirements for the construction and use of incinerators. No incinerators will be used as part of this Project therefore this Subchapter is not applicable to the Project.

4.2.11 Chapter 27 Subchapter 12 - Prevention and Control of Air Pollution Emergencies (Effective 5/20/1974)

N.J.A.C. Chapter 27, Subchapter 12 establishes the conditions for air pollution emergency declarations by the Governor. Ocean Wind will prepare standby plans consistent with the requirements of this subchapter that establish the appropriate response during periods of a declared air pollution emergency.

4.2.12 Chapter 27 Subchapter 16 - Control and Prohibition of Air Pollution by VOCs (Effective 1/16/2018)

N.J.A.C. Chapter 27, Subchapter 16 establishes the requirements and procedures concerning the control and prohibition of air pollution by VOC and CO emissions. This provision requires that any stationary source operation use reasonably available control technology (RACT) to control VOC emissions where applicability thresholds in the subchapter are met.

The provisions of N.J.A.C. 7:27-16.2 apply to stationary storage tank that stores applicable VOC; this section will not apply to fuel storage tanks.

The provisions of N.J.A.C. 7:27-16.10 apply to any stationary reciprocating engine that is subject to the provisions of N.J.A.C. 7:27-19 except emergency generators. As discussed in Section 4.2.14, none of the emission units associated with the Project are subject to the provisions of N.J.A.C. 7:27-19, therefore Subchapter 16 is not applicable to the Project's engines.

4.2.13 Chapter 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)

N.J.A.C. Chapter 27, Subchapter 18 establishes the ambient air quality requirements that a project must meet for the Department to issue an air quality preconstruction permit.

An application must comply with this subchapter if it meets the following criteria:

1. the facility has the PTE any of the air contaminants equal to or exceeding the NJDEP major source thresholds; and
2. any allowable emissions proposed in the application would result in a significant net emission increase of any contaminant listed in Table 3 of N.J.A.C. 7:27-18.7, and
3. the facility is located at an area which is nonattainment for the respective criteria pollutant(s) corresponding to that air contaminant.

The COA of the Project is designated nonattainment for ozone. The construction and commissioning phase of the Project exceeds the NJDEP major source thresholds for one or more pollutants and exceeds the listed significant net emission increase thresholds for ozone precursor NO_x.. Therefore, the construction and commissioning phase of the Project is subject to NNSR for the ozone precursor pollutants NO_x and VOC. However, pursuant to N.J.A.C. 7:27-18.4(a), ozone is excluded from the requirement to conduct an air quality impact analysis. Therefore, there is no required air quality impact analysis specific to NNSR requirements.

The construction and commissioning phase of the Project must comply with N.J.A.C. 7:27-18.3(b) which requires that air emissions from the equipment proposed to be constructed will be controlled to the degree which represents the LAER and certify, in accordance with N.J.A.C. 7:27-1.39, that all existing facilities in New Jersey, which are owned or operated by the person applying for the permit, or by any entity controlling, controlled by, or under common control with such person, are operating:

1. In compliance with the provisions of [Subchapter 18] and with all applicable emission limitations and standards promulgated pursuant to the Federal Clean Air Act; or
2. In conformance with an enforceable compliance schedule approved by the Department.

Only the construction and commissioning phase of the Project exceeds the NJDEP major source thresholds for one or more pollutants. Offsets are not required for the construction and commissioning phase of the Project because in accordance with N.J.A.C. 7:27-18.3(h), emissions resulting from temporary emission increases occurring directly from the construction of the project are not subject to offset requirements.

The O&M phase of the Project does not exceed the NJDEP major source thresholds for any pollutant; therefore, the O&M phase is not subject to the requirements of Subchapter 18.

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

N.J.A.C. Chapter 27, Subchapter 19 establishes requirements and procedures concerning prohibition of air pollution by NO_x. The provisions of this chapter establish RACT requirements for NO_x. This subchapter applies to types of equipment and source operations identified in N.J.A.C. 7:27-19.2(b) and (c). However, because none of the emission units associated with the Project will be connected to the electric power distribution grid per N.J.A.C. 7:27-19.2(g), this subchapter is not applicable to the Project.

4.2.15 Chapter 27 Subchapter 21 - Emission Statements (Effective 1/16/2018)

N.J.A.C. Chapter 27, Subchapter 21 establishes requirements for submittal of emission statements for facilities that have the PTE any air contaminant greater than the thresholds listed in Table 1 of Subchapter 21. Emissions associated with delivery loading vessels are included in determination of applicability. The PTE of the construction and commissioning phase of the Project exceeds the thresholds listed in Table 1 for one or more pollutants. The PTE during the O&M phase of the Project does not exceed the thresholds listed in Table 1 for any pollutant. Therefore, Ocean Wind will submit the required emission statements during the construction and commissioning phase. Upon commencement of the O&M phase this subchapter ceases to be applicable to the Project.

4.2.16 Chapter 27 Subchapter 22 - Operating Permits (Effective 1/16/2018)

N.J.A.C. Chapter 27, Subchapter 22 establishes the Major Source Operating Permit Requirements. This applies to any facility that is major for HAP, including fugitive emissions, or exceeds the thresholds presented in **Table 4-10**. When comparing facility emissions to thresholds in **Table 4-10** fugitive emissions are not included unless the facility falls into one of 28 listed source categories. The Project does not fall into one of the listed 28 source categories; therefore, fugitive emissions are not included when comparing to the thresholds.

Table 4-10. Operating Permit Facility Thresholds.

Air Contaminant	Threshold Level tpy
CO	100
PM_{10}	100
$PM_{2.5}$	100
Total Suspended Particles (TSP)	100
SO_2	100
SO_2 (as $PM_{2.5}$ precursor)	100
NO_x	25
NO_x (as $PM_{2.5}$ precursor)	100
VOC	25
Lead	10
Any other air contaminant, except CO_2	100

The O&M phase is not considered a major source of HAP, as presented in **Table 3-4**. Potential emissions from the O&M phase do not exceed the thresholds in **Table 4-10**. Ocean Wind believes that the PTE of the O&M phase should be considered separately from the PTE of the construction and commissioning phase when comparing PTE to the thresholds in **Table 4-10**. It is Ocean Wind's understanding that EPA has preliminarily determined that the various components (emitting and non-emitting) are part of the same OCS facility, which is why Ocean Wind has aggregated emissions during the construction and commissioning phase. Because it is Ocean Wind's understanding that EPA HQ is still considering whether or how to aggregate sources during the O&M phase, Ocean Wind is providing the requested information to prevent a potential delay in permit issuance. Please see revised **Appendix B** with an alternate analysis of the Project PTE to operating permit thresholds.

Subchapter 22 also applies to an affected Title IV (Acid Rain) facility, defined at N.J.A.C. 7:27-22.1; a facility with any source operation in a source category designated by EPA; a facility with a solid waste incineration unit which combusts municipal waste and has a combustion capacity greater than 250 tons per day; or a facility which elects to obtain an operating permit pursuant to N.J.A.C. 7:27-22.2(e).

The Project is not considered an affected Title IV facility, as defined at N.J.A.C. 7:27-22.1. The Project does not have a source operation in a source category designated by EPA. The Project does not have a solid waste incineration unit.

The Project is not required to obtain a Title V operating permit for the O&M phase under N.J.A.C. 7:27-22.

4.2.17 Chapter 27B Subchapter 1 - Sampling and Analytical Procedures for Determining Emissions of Particles From Manufacturing Processes and From Combustion of Fuels (Effective 6/21/1976)

N.J.A.C. Chapter 27B, Subchapter 1 establishes analytical procedures to be used to demonstrate compliance with requirements. Ocean Wind will adhere to these procedures.

4.2.18 Chapter 27B Subchapter 2 - Procedures for Visual Determination of the Opacity (Percent) and Shade or Appearance (Ringelmann Number) of Emissions From Sources (Effective 6/21/1976)

N.J.A.C. Chapter 27B, Subchapter 1 establishes analytical procedures to be used to demonstrate compliance with requirements. Ocean Wind will adhere to these procedures.

4.2.19 Chapter 27B Subchapter 3 - Air Test Method 3: Sampling and Analytical Procedures for the Determination of VOCs From Source Operations (Effective 12/1/2008)

N.J.A.C. Chapter 27B, Subchapter 1 establishes analytical procedures to be used to demonstrate compliance with requirements. Ocean Wind will adhere to these procedures.

5. Analysis of Alternative Sites, Sizes, Production Processes, Pollution Prevention Measures, and Environmental Control Techniques

N.J.A.C. 7:27-18.3(c) requires that any person subject to Subchapter 18 pursuant to N.J.A.C. 7:27-18.2(a) and 18.2(b)(1) submit to the Department 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.

5.1 Analysis of Alternative Sites, Sizes, and Production Processes

The Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (Lease Area OCS-A 0498) from BOEM allows Ocean Wind the exclusive right to seek BOEM approval for the development of a leasehold. The lease allows Ocean Wind the exclusive right to submit a Site Assessment Plan (SAP) and a COP, and to conduct activities in the leased area that are described in the SAP or COP as approved by BOEM.

Ocean Wind has requested that BOEM segregate portions of 160,480-acre original Lease Area OCS-A 0498 into a new lease area of approximately 84,955 acres (see **Figure 2-1**). BOEM approved the lease segregation on March 21, 2021. The new lease number is OCS-A 0532 and was assigned to a separate affiliate of Orsted. Ocean Wind is continuing to develop the Project on the remaining portions of Lease Area OCS-A 0498, which would total approximately 75,525 acres (see **Figure 2-1**).

The location of Lease Area OCS-A 0498 was the result of a multi-year effort by state and federal regulatory agencies to identify OCS areas suitable for offshore renewable energy development.[19] An extensive review of site characterization and an assessment of potential impacts was conducted, including environmental, economic, cultural, and visual resources, and use conflicts. Additionally, the Project conducted project screening and siting evaluations and a review of potential impact producing factors on various resources, including physical, biological, socioeconomic and others; these evaluations are presented in the COP[1].

5.2 Pollution Prevention Measures and Environmental Control Techniques

Ocean Wind conducted LAER and BACT analyses as required to evaluate environmental controls for the Project's OCS sources (See Section 6). The LAER analysis concluded that add-on air pollution control is not technically feasible for the engines. However, the Project will select engines that are certified by the

[19] Bureau of Ocean Energy Management (BOEM). 2012. *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf (OCS) Offshore New Jersey, Delaware, Maryland, and Virginia.* U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs.

manufacturer to comply with applicable NSPS and RICE Maximum Achievable Control Technology (MACT) standards. In addition, Ocean Wind will utilize good combustion practices, as defined in Section 6.1.1.13, at all times. Ocean Wind will also utilize low-sulfur fuel whenever possible and will always comply with all applicable fuel sulfur content regulations, as described in Section 4.1.5.

5.3 Minimizing Environmental Costs

As part of the OCS air permitting effort, Ocean Wind conducted air dispersion modeling for PM_{10}, $PM_{2.5}$, NO_2 and CO to demonstrate that the Project will not cause or contribute to an exceedance of ambient air quality standards or PSD increment. Additionally, the Project will minimize environmental costs by complying with LAER and BACT standards as presented in Section 6.2 and 6.3. Finally, the use of wind to generate electricity results in a net reduction of regional air pollution over the life of the Project through displacement of electricity generated by fossil fuel-fired power plants. Therefore, by definition, the Project minimizes environmental cost.

5.4 Minimizing Social Costs

The Project generally results in social benefits to the community by providing clean energy. Construction activities may result in short-term and negligible to minor impacts to the population and local economies due to increased noise, traffic, and visible structures. During the O&M phase, the Project may have long-term impacts to the population and local economies due to noise and visible structures. However, these long-term impacts are anticipated to be negligible. More information on potential impacts to population, economy, and employment resources are discussed in Section 2.3.1.1.3 of Volume II of the Project's COP[1].

6. Air Pollution Control Technology Review – LAER/BACT/SOTA

6.1 Technology Review

There are essentially two broad categories of technologies that can be used to reduce air pollutants from diesel marine engines: 1) design and retrofits impacting operational parameters and 2) add-on controls. Technologies in the first category are described in Section 6.1.1 and technologies in the second category are described in Section 6.1.3.

6.1.1 Design and Retrofit Technologies

There are several technologies affecting operational parameters that may be incorporated into new engine designs or retrofitted to existing engines. The operational parameters targeted by these technologies include:

1. Peak cylinder pressure
2. Peak cylinder temperature
3. Injection pressure
4. Compression ratio
5. Fuel injection mixing
6. Air-fuel mixing

6.1.1.1 Fuel Injection Pressure and Timing

The formation of NO_x emissions has a strong exponential direct relationship to combustion temperature. Delaying the injection of fuel into the cylinder can significantly reduce NO_x emissions from a diesel engine by lowering the temperature and pressure of combustion gases. Waiting to inject fuel until after the piston has begun to move down results in the removal of heat through expansion of air in the cylinder. Although this can increase hydrocarbon (HC), CO and PM emissions since cylinder temperature and pressure are too low for complete combustion, optimization of the injection strategy can minimize this effect. Electronic control of

injection timing has been used by highway, nonroad, locomotive, and marine diesel engine manufacturers to lower NO_x emissions while minimizing unwanted impacts on PM emissions, fuel efficiency, engine performance and engine durability. Fuel injection technology for marine use includes high-pressure common rail injection systems, which are described next.[20]

6.1.1.2 Common Rail Fuel Injection Systems

Common rail fuel injection systems reduce NO_x and PM emissions by precisely controlling the fuel injection event and breaking it up into discrete, multiple phases. Injection of a small amount of fuel before the piston reaches top-dead-center limits the rapid increase in pressure and temperature, limiting NO_x formation. Then the remainder of the fuel is injected into the flame established by the initial injection, allowing for a steady burn that also reduces combustion temperature and therefore NO_x emissions. The second injection can be further split into two events to allow further combustion of the soot cloud formed during combustion, thereby limiting PM emissions. Common rail fuel injection systems can incorporate retarded injection timing, breaking up fuel injection into multiple events, and rate shaping (to control the level and duration of peak combustion temperatures). This combined fuel delivery strategy allows the engine to be operated in a manner which balances NO_x emissions, PM emissions, and fuel consumption under all operating conditions.[20]

6.1.1.3 Slide Valves

According to a report prepared for the California Air Resources Board, slide valves have been utilized in slow speed two-stroke engines to optimize spray distribution of fuel injection in the combustion chamber while maintaining a constant engine temperature. Compared to conventional fuel injectors, the improved spray distribution increases mixing and results in lower heat release. Since NO_x emissions are directly related to combustion temperature, the use of slide valves results in lower NO_x emissions.[21]

6.1.1.4 Reduced Oil Consumption

Reducing oil consumption through the redesign of the power assembly (piston, piston rings and cylinder liner) decreases the organic fraction of PM emissions. There are a few ways the power assembly can be redesigned to reduce oil consumption, including the addition of valve stem seals to reduce oil leakage and improvements to the closed-crankcase ventilation systems.[22] The cylinder lubrication system can be controlled electronically to ensure direct delivery of oil onto the cylinder ring packs, minimizing waste.[21] Additionally, when catalytic exhaust controls are also present, reducing oil consumption improves the durability of catalyst systems by reducing the amount of zinc- and phosphorous-containing oil additives passing through the catalyst.[22]

6.1.1.5 Emulsified Fuel

Fuel mixed with water produces an emulsification. Emulsified fuel reduces NO_x and PM emissions because the vaporization of water during combustion increases fuel dispersion which encourages complete combustion. There are two types of emulsified fuel: unstable emulsions and stable emulsions. Unstable emulsions mix the fuel just prior to injection. This approach is effective for heavy diesel fuel commonly used by ocean going vessels. Stable emulsions are mixed prior to being brought on-board the vessel and are stabilized with a chemical additive to prevent separation of the fuel and water. Ocean Wind is not aware of the use of stable emulsions for ocean going vessels.[21]

---

[20] US Environmental Protection Agency (EPA). 2009. *Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines.* (EPA-420-R-09-019)
[21] Hefanzi, H., & Rahai, H.R. 2008. *Emission Control Technologies for Ocean Going Vessels (OGVs).*
[22] US Environmental Protection Agency (EPA). 2008. *Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less Than 30 Liters per Cylinder* (EPA-420-R-08-001).

6.1.1.6 Direct Water Injection

Introducing water into the combustion chamber or intake manifold during the combustion process is called direct water injection. Direct water injection can be electronically controlled, allowing optimization of the water-to-fuel ratio. The injected water absorbs combustion energy, limiting peak combustion temperature, resulting in reduced NO_x emissions. When water is injected directly into the combustion chamber separately from fuel, electronic control of the water injection allows optimum NO_x reduction while minimizing impact on other criteria pollutants (VOC, CO, and PM).[20]

6.1.1.7 Intake Air Humidification

Like emulsified fuel and direct water injection, increasing the humidity of the intake air reduces the peak temperature of combustion which reduces NO_x emissions. Humidity is increased by injecting water mist into the intake air as it exits the compressor stage of the turbocharger. As the humidified intake air is compressed by the turbocharger its temperature increases, which facilitates the evaporation of the injected water mist. Intake air humidification requires approximately double the amount of water consumed in fuel emulsification or direct water injection.[20]

6.1.1.8 Charge Air Cooling (Aftercoolers)

Another way to lower the peak temperature of combustion, thereby reducing NO_x emissions, is to lower the intake manifold temperature through cooling intake gases through a heat exchanger. This heat exchanger is commonly referred to as a charge air cooler or aftercooler. Marine applications with access to seawater heat-exchanger coolant loops typically have excess heat rejection capacity. The cooling capacity may be limited by certain hull designs, but new hull designs can usually overcome these limitations. The majority of Category 1 and 2 marine engines are equipped with aftercooling.[22]

6.1.1.9 Turbocharger Improvements

Like aftercoolers, the majority of Category 1 and Category 2 marine engines are equipped with turbochargers. Turbochargers introduce additional oxygen into the combustion process which allows for more complete combustion and a more efficient use of fuel. Improvements to the turbocharger can further encourage complete combustion. Improvements include maintaining sufficient air flow to the engine during high load operation. These improvements reduce PM emissions and other products of incomplete combustion.[22]

6.1.1.10 Exhaust Gas Recirculation System

Exhaust gas recirculation is a technique that routes exhaust gas from the exhaust system to be mixed with incoming combustion air. The recirculated exhaust gas is non-combustible, has a lower oxygen content, and absorbs some heat released by combustion. As a result, peak combustion temperature is lowered, reducing NO_x emissions.[20] For exhaust gas recirculation to be effective, the recirculated exhaust gas should be free of PM. This is difficult to obtain, especially when ocean-going vessels utilize residual oil. Additionally, the use of residual fuel with exhaust gas recirculation results in corrosion and contamination risks due to the high sulfur and ash content in the exhaust gas.[21] Exhaust gas recirculation can cause an increase in PM emissions because the recirculated exhaust can reduce the amount of fuel burned during combustion, resulting in increased incomplete combustion. Many diesel engines that employ exhaust gas recirculation are equipped with a filter to reduce the amount of PM in the exhaust stream.[23]

[23] Nelson, Bradley. 2010. *Alternative Control Techniques Document: Stationary Diesel Engines.* Retrieved from https://www.epa.gov/sites/default/files/2014-02/documents/3_2010_diesel_eng_alternativecontrol.pdf.

6.1.1.11 Open and Closed Crankcase Ventilation System

Both open and closed crankcase ventilation systems use centrifugal force or filtration to remove oil mist and particulates from the crankcase gas stream. In open systems, the gas is exhausted from the engine after exiting the crankcase system. In closed systems, the purified gas is routed to the air intake manifold of the engine, where it is used as combustion gas. Turbocharged engines with closed systems can experience fouling and engine performance degradation due to the impurities present in the recirculated gas. Open and closed crankcase ventilation systems reduce PM emissions since particulates are removed from the gas stream.[23]

6.1.1.12 De-Rating of Existing Engines

A vessel's engine and propellor are optimized and designed for specific operational and maximum speeds. If a vessel is consistently operated at a speed lower than the speed for which the vessel was optimized, then the vessel engines will be inefficient resulting in increased combustion emissions. De-rating the engine by replacing various engine and turbocharger components and installing a new propellor can reduce emissions by improving the match between a vessel's operational speed and rated speed.[24]

6.1.1.13 Good Combustion Practices

Good combustion practices include operating the vessel and engine in accordance with the manufacturer's specifications, including any applicable evaluations, inspections, and maintenance.

6.1.2 Fuel Alternatives

All marine fuel used today is created from the same distillation process used to create other liquid HCs such as motor gasoline, heating oil, and kerosene. Most marine vessel engines fire marine distillate or marine residual fuel. Marine distillate and residual fuels are required to meet international fuel specifications established in the International Organization for Standardization (ISO) specification 8217 Petroleum products – Fuels (class F) – Specifications of Marine Fuels.[23] These fuels, and other fuel types, are presented in this section.

6.1.2.1 Marine Distillate Fuel

There are four marine distillate fuel types: DMX, DMA, DMB, and DMC. Generally, only DMA, also known as marine gas oil (MGO) and DMB, also known as marine diesel oil (MDO) are used in the marine industry. MGO is a light distillate fuel and is relatively clean compared to other marine fuels. It is best suited for higher RPM engines due to its high cetane value and density. Typically, MGO is used for propulsion in small- to medium-sized marine vessels and for emergency, maintenance, and auxiliary engines in larger vessels. MDO is slightly heavier than MGO and is usually created by blending MGO with small amounts of residual fuel oil. The addition of residual fuel oil results in a sulfur content higher than the maximum allowable level for MGO.[20] MGO is typically used in Category 1 engines and MDO is typically used in Category 2 and Category 3 engines.[22]

6.1.2.2 Marine Residual Fuel

Marine residual fuel is considered a 'waste' product of the traditional petroleum refining process. It is dense and viscous and tends to have a high sulfur content and contain heavy metals and other contaminants. Residual fuel oil is categorized by the viscosity of the fuel at a set reference temperature; there are several categories of residual fuel oil. The most commonly used types in the marine industry are Intermediate Fuel Oil (IFO) 180 and 380. Typically, residual fuel is not usable as a standalone fuel, primarily due to its viscosity; thus, it is usually blended with lighter components for use in marine engines. IFO fuels typically have such a high viscosity that

[24] Marine Inbox. 2020, January 2. *Derating*. Retrieved from http://marineinbox.com/marine-exams/derating-change-of-engine-smcr/.

they are solid at ambient temperatures and require constant heating to pump and combust it in diesel engines.[20]

6.1.2.3 Ultra-Low Sulfur Diesel (USLD) Fuel

Ultra-low sulfur diesel (ULSD) fuel is limited to a maximum sulfur content of 15 ppm by 40 CFR Part 80 Subpart I. The use of ULSD greatly reduces SO_x emissions compared to marine distillate and marine residual fuels. Marine fuels have a minimum flash point of 60°F to ensure onboard safety while onroad diesel has a minimum flash point of 52°F. However, most distillate fuels are created in the same way and so most onroad diesel flash points are above 60°F and meet the marine fuel specification.

6.1.2.4 Natural Gas

Natural gas is a naturally occurring gas primarily composed of methane. There are dual-fuel marine engines capable of combusting either diesel fuel or liquified natural gas. Operating these engines in natural gas mode mostly eliminates SO_2 emissions and greatly reduces NO_x and PM emissions. Additionally, liquified natural gas combustion can reduce CO_2 emissions compared to diesel or residual fuel combustion.[21]

6.1.2.5 Liquefied Petroleum Gas (LPG)

LPG consists of propane and butane, along with smaller amounts of other light HCs. LPG can be produced from natural gas processing or oil refining. The use of LPG in marine engines would result in negligible amounts of SO_x emissions and lower CO_2 emissions compared to marine distillate and marine residual fuel oil. The impact on NO_x emissions depends on the engine technology used.[25]

6.1.2.6 Biodiesel

Biodiesel is created by the reaction of animal fat and vegetable oil with methanol or ethanol. Pure biodiesel can be used in diesel engines only with major engine modifications. Blending 20 percent biodiesel with diesel fuel eliminates the need for engine modifications. Use of 20 percent biodiesel reduces CO, VOC, SO_x, and PM emissions and increases NO_x emissions, compared to diesel fuel alone.[21] For several reasons, the marine industry has been slow to adopt the use of biodiesel and biodiesel blends. One reason is storage and handling issues, considering the harsh ambient conditions for storage and handling on board a ship. Another reason is uncertainty of meeting International Maritime Organization (IMO), or other applicable emission standards, including NO_x emission limits when firing biodiesel or biodiesel blends. As a result, the industry considers the use of biodiesel and biodiesel blends to still be in the trial phase of development.[26]

6.1.2.7 Methanol

Methanol is a liquid alcohol fuel with a lower energy content than distillate or residual fuels. Methanol produces fewer emissions of SO_x, NO_x, and PM compared to distillate and residual fuels. Second generation MAN dual fuel engines using methanol can achieve Tier III NO_x standards without add-on controls.[27] However, methanol is not currently readily available as a commercial fuel.

---

[25] The World LPG Association. 2021. *LPG for Marine Engines: The Marine Alternative Fuel.* Dublin. Retrieved from https://www.wlpga.org/wp-content/uploads/2021/06/LPG-for-Marine-Engines-2021-compressed.pdf.
[26] Lloyd's Register. 2021. *Does biodiesel have a place in the marine fuel purchasing portfolio?* Retrieved from https://www.lr.org/en/insights/articles/biodiesel-marine-fuel-purchasing-portfolio/.
[27] Methanex Corporation. *Methanol as a Marine Fuel*. Retrieved from https://www.methanex.com/about-methanol/methanol-marine-fuel.

6.1.2.8 Diesel-Ethanol Fuel Blend

Diesel fuel blended with ethanol results in fewer PM, CO, and NO_x emissions compared to ULSD. Ethanol is an oxygenate with an oxygen content of thirty-five percent. However, this diesel-ethanol blend is very flammable and has a high risk of fire and explosion.[21]

6.1.2.9 Diesel Fuel with Hydrogen

Modifying diesel fuel with a hydrogen additive can lower NO_x emissions. At about five percent hydrogen, NO_x emissions are reduced at all engine loads. However, at higher percentages of hydrogen, NO_x emissions are only reduced at low (less than forty percent) loads and increase at higher loads.[21]

6.1.3 Add-On Controls

Diesel engine exhaust emissions can be reduced through the addition of control technologies that do not significantly adversely impact how the engine is designed or functions. These technologies are referred to as aftertreatment technologies or add-on controls.

6.1.3.1 Selective Catalytic Reduction (SCR)

In SCR technology, a catalyst uses a reducing agent (typically aqueous ammonia (NH_3) or urea) to convert NO_x into nitrogen gas (N_2) and water (H_2O) in high-temperature (>250°C) exhaust streams. There are several types of catalysts compatible with SCR, including base and precious metals. Typically, the method used to supply ammonia to mobile engines is to inject an aqueous urea-water solution into the exhaust stream. The urea hydrolyzes to form NH_3 and CO_2 and the NH_3 is stored on the surface of the SCR catalyst where it is used to reduce NO_x into N_2 and H_2O. It is theoretically possible to achieve 100% conversion of NO_x; however, given space limitations and potential system deterioration over time due to thermal sintering, catalyst plugging and catalyst poisoning, high NO_x conversion rates are balanced against the potential for NH_3 slip (where NH_3 passes through the catalyst unreacted).[22] Additionally, if SO_x emissions are present in the exhaust, which is generally true for vessels using residual fuel, then they oxidize to form H_2SO_4 which causes corrosion of the SCR system and reduces the system performance and life.[21]

6.1.3.2 Selective Non-Catalytic Reduction (SNCR)

Selective non-catalytic reduction (SNCR) technology works the same as SCR except without a catalyst. For the reaction to take place without a catalyst, high exhaust gas temperatures are required. If the exhaust stream is cooler than the optimum range, ammonia slip occurs; if the exhaust stream is hotter than the optimum range, the reducing agent oxidizes, and additional NO_x is formed. The optimal temperature range is 870°C to 1150°C.[28]

6.1.3.3 Lean NO_x Catalyst (LNC)

LNC is SCR where the reducing agent is fuel or another HC instead of ammonia. The EPA[23] estimates that peak NO_x conversion efficiencies of LNC systems are 10 to 30 percent.

6.1.3.4 NO_x Scrubber

Approximately 5 to 10 percent of typical diesel engine exhaust stream is nitrogen dioxide (NO_2); most of the remaining NO_x is NO. NO_2 is soluble in water and so a water scrubber can be used to remove NO_2 from the exhaust stream. It is possible to treat the exhaust stream upstream of the scrubber to convert more of the NO_x to NO_2. However, if the scrubber effluent were discharged to the ocean, it would add to the nitrogen loading of the water. Ocean Wind is not aware of the application of NO_x scrubbers to vessel engines.[20]

---

[28] US Environmental Protection Agency. *Air Pollution Control Technology Fact Sheet*. (EPA-452 / F-03-031) Retrieved from https://www3.epa.gov/ttncatc1/dir1/fsncr.pdf

6.1.3.5 NO_x Adsorber/Lean NO_x Trap (LNT)

NO_x adsorbers, also known as LNT, trap NO_x in the form of a metal nitrate during lean operation (excess air in air-to-fuel ratio) of the engine and release and catalytically reduce the stored NO_x under rich (excess fuel in air-to-fuel ratio) conditions. The engine operates in lean mode until the compound used to store NO_x becomes saturated; at this point, the compound is regenerated by operating the engine in rich mode for a brief period during which time NO_x is oxidized to N_2 or NH_3. The LNT catalyst can be combined with a zeolite-based SCR catalyst to trap ammonia and further reduce NO_x via a SCR reaction.[23]

6.1.3.6 SO_x Scrubber

SO_x scrubbers are a well-established SO_x reduction technology in stationary source applications. When applied to marine diesel engine exhaust streams, SO_x scrubbers can remove up to 95 percent of SO_x from vessel exhaust. There are two main designs that can be implemented on a vessel: 1) an open loop design that uses seawater as exhaust washwater and discharges treated washwater back to the ocean and 2) a closed loop design that uses fresh water as washwater with caustic soda injected into the washwater. A small amount of washwater is bled off and treated to removed sludge in closed loop systems. In both systems, the solids are collected from the effluent and held for onshore disposal. SO_x scrubbers also reduce PM emissions because sulfates are a large portion of PM emitted from ships using high sulfur fuels. Additionally, removing SO_x emissions prevents SO_x from reacting in the atmosphere to form secondary PM.[20]

6.1.3.7 Diesel Particulate Filter

There are two main categories of diesel particulate filters (DPF): catalyzed DPF and active DPFs.[23] Catalyzed DPFs usually contain two chambers, one for the oxidation of NO to NO_2 using a platinum catalyst and one with a ceramic filter where NO_2 reacts with the particulates to form oxidized compounds. Catalyzed DPFs can easily become deactivated when sulfur is present in the fuel because the sulfur is absorbed along with NO in the first chamber. In addition to controlling PM, the catalyst also reduces emissions of HCs and CO through oxidation of these compounds.[21] Active DPFs collect PM from a filter unit and then heat the collected PM to the combustion temperature of the PM.[23]

6.1.3.8 Flow-Through Filter

Like DPF, flow-through filters (FTF) reduce PM emissions from the exhaust stream of a diesel engine by capturing a portion of the PM and then oxidizing it using a catalyst. The difference between diesel particulate filters and FTF lies in the design of the filter. Nelson (2010)[23] reports that FTF can achieve PM reductions of 30 to 75 percent. Catalyzed FTF offer the same co-benefits of PM reduction as well as HC and CO reduction as DPFs. FTF are less susceptible to plugging or blockage of the exhaust gas channels than other filtration systems such as DPFs.

6.1.3.9 Diesel Oxidation Catalyst

Diesel oxidation catalysts contain a honeycomb structure with a large surface area coated with a catalyst. The catalyst oxidizes CO, gaseous HCs, and liquid HC particles (unburned fuel and oil) in the exhaust gas to carbon dioxide and water. Because a portion of the total PM mass of diesel exhaust is liquid HCs, diesel oxidation catalysts reduce PM emissions, in addition to CO and VOCs. High sulfur concentrations can result in increased PM emissions because at high temperatures sulfur dioxide can oxidize to form sulfates. Because of this, some diesel oxidation catalyst manufacturers recommend a maximum sulfur content of 500 ppm.[23] [21]

6.1.3.10 4-Way Catalytic Converter

One type of four-way catalytic converters utilizes oxidation-reduction catalysts to reduce CO, HCs, nitrogen oxides and PM to carbon dioxide, water, oxygen gas and nitrogen gas.[29] Another type uses catalysts to reduce CO, HCs, nitrogen oxides to carbon dioxide, water, oxygen gas and nitrogen gas and then the carbon dioxide is adsorbed and captured for storage.[30]

6.2 LAER Determination

New Jersey regulations for NNSR are found in N.J.A.C. 7:27-18 Control and Prohibition of Air Pollution from New or Altered Source Affecting Ambient Air Quality (Emission Offset Rules). An application must comply with this subchapter if it meets the following criteria:

1. the facility has the PTE any of the air contaminants equal to or exceeding the thresholds listed in Table 2, shown in **Table 6-1** below; and
2. any allowable emissions proposed in the application would result in a significant net emission increase of any contaminant listed in Table 3 of N.J.A.C. 7:27-18.7, shown in **Table 6-2** below; and
3. the facility is located at an area which is nonattainment for the respective criteria pollutant(s) corresponding to that air contaminant.

Table 6-1. NJDEP Major Facility Thresholds.

Pollutant	Construction and Commissioning PTE	Threshold	Exceeds Threshold?
	tons/year	tons/year	
SO_2	13.8	100	No
SO_2 (as $PM_{2.5}$ precursor)	13.8	100	No
TSP [1]	69.6	100	No
PM_{10}	69.6	100	No
$PM_{2.5}$	67.0	100	No
CO	576.3	100	**YES**
NO_x	2,161	25	**YES**
NO_x as $PM_{2.5}$ precursor	2,161	100	**YES**
VOC	81.4	25	**YES**
Pb	0.008	10	No

[1] It is assumed TSP is equivalent to PM_{10}.

[29] Trivedi, S., Prasad, R. 2018. *A four-way catalytic system for control of emissions from diesel engine*. Sādhanā 43, 130. https://doi.org/10.1007/s12046-018-0884-0
[30] Nirmal, Nideep V. K. and Kumar, Anil B. C. 2015. *Experimental investigation into the effects of four-way catalytic converter on four stroke diesel engine emissions*. International Journal of Engineering Research and Technology, V4(10). https://doi.org/10.17577/ijertv4is100387

Table 6-2. NJDEP Significant Net Emission Increases.

Pollutant	Construction and Commissioning PTE	Threshold	Exceeds Threshold?
	tons/year	tons/year	
SO_2	13.8	40	No
SO_2 (as $PM_{2.5}$ precursor)	13.8	40	No
TSP [1]	69.6	25	**YES**
PM_{10}	69.6	15	**YES**
$PM_{2.5}$	67.0	10	**YES**
CO	576.3	100	**YES**
NO_x	2,161	25	**YES**
NO_x as $PM_{2.5}$ precursor	2,161	40	**YES**
VOC	81.4	25	**YES**
Pb	0.008	0.6	No

[1] It is assumed TSP is equivalent to PM_{10}.

As shown in **Table 6-1** and **Table 6-2** above, the Project exceeds the listed significant net emission increase thresholds for NO_x and VOC (as well as PM_{10}, $PM_{2.5}$ and CO) and, per 40 CFR Part 55, the COA of the Project is designated nonattainment for ozone. Therefore, the Project is subject to Subchapter 18 for the ozone precursor pollutants NO_x and VOC. Pursuant to N.J.A.C. 7:27-18.4(a), ozone is excluded from the requirement to conduct an air quality impact analysis. Therefore, there is no required air quality impact analysis specific to NNSR requirements.

The Project must comply with N.J.A.C. 7:27-18.3(b) which requires that air emissions from the equipment proposed to be constructed will be controlled to the degree which represents the LAER and certify, in accordance with N.J.A.C. 7:27-1.39, that all existing facilities in New Jersey, which are owned or operated by the person applying for the permit, or by any entity controlling, controlled by, or under common control with such person, are operating:

1. In compliance with the provisions of [Subchapter 18] and with all applicable emission limitations and standards promulgated pursuant to the Federal Clean Air Act; or
2. In conformance with an enforceable compliance schedule approved by the Department.

Subchapter 18 defines LAER 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.*

6.2.1 Engines Powering Vessels Meeting the Definition of an OCS Source – NO_x

Compression-ignition internal combustion engines powering vessels used to construct the Project will be subject to LAER while the vessels meet the definition of an OCS source. Ocean Wind anticipates that jack-up

vessels will meet the definition of an OCS source. Other vessels that may meet the definition of an OCS source include any vessels tethered to an OCS source while performing an activity that supports the construction of the Project. As described in this section, the Project will use vessel engines that comply with the most stringent NO_x emission limit identified in any SIP, the most stringent limit achieved in practice, or the most stringent limit identified in any applicable NSPS or NESHAP.

6.2.1.1 NO_x Limits in SIPs

Ocean Wind conducted a review of SIPs for coastal states and territories, including states bordering the Great Lakes. EPA-approved rules related to compression-ignition marine vessel engines identified in the SIP review are presented in **Table 6-3**.

Table 6-3. Rules Related to Marine Vessel Engines Identified in SIPs.

State / Territory	Rule	Rule Reference	Rule Summary
California	Airborne Toxic Control Measure for Auxiliary Diesel Engines Operated on Ocean Going Vessels At-Berth in a California Port	13 California Code of Regulation (CCR) § 2299.3 and 17 CCR § 93118	Requires that any person who owns, operates, container vessel, passenger vessel, or refrigerated cargo vessel that visits a California port comply with section 93118.3 relating to the operation of auxiliary diesel engines on ocean-going vessels (OGV) at-berth in a California port.
California	Airborne Toxic Control Measure for Commercial Harbor Craft	17 CCR § 93118.5, excluding (e)(1)	Applicability, exemptions, definitions, engine emission requirements, alternative control provisions, recordkeeping and reporting requirements, test methods. Excluded subsection relates to the low sulfur fuel use requirement.

The rule promulgated in 13 CCR § 2299.3 applies to vessels while at-berth in California ports. The requirements of this rule are not technically feasible for vessels that are not at-berth, so it does not apply to vessels associated with the Project.

The rule promulgated in 17 CCR § 93118.5(e)(3) requires all newly acquired engines in in-use harbor craft that are intended to operate in Regulated California Waters to be certified to EPA Tier 2 or Tier 3 marine engine standards in effect at the time of acquisition. A newly acquired engine is not required to meet Tier 4 standards unless it is replacing an engine on the in-use vessel that was certified as meeting Tier 4 standards. Additionally, § 93118.5(e)(4) requires that any newly acquired harbor craft for use in Regulated California Waters must meet the applicable Tier 2, Tier 3, or Tier 4 standards in effect on the date of vessel acquisition.

17 CCR § 93118.5(e)(6) applies to pre-Tier 1 and Tier 1 certified engines on ferries, excursion vessels, tugboats, towboats, push boats, and multipurpose harbor craft. It requires that Tier 1 and pre-Tier 1 engines in the specified vessel types meet the emissions limits equal to or more stringent than Tier 2 EPA marine engine standards through engine replacement, modification, or retrofit by dates provided in the compliance schedule. The rule applies to boats as defined in 17 CCR § 93118.5. The definitions are presented below.

Ferries – a harbor craft having provisions only for deck passengers or vehicles, operating on a short run, on a frequent schedule between two points over the most direct water route, and offering a public service of a type normally attributed to a bridge or tunnel.

Excursion Vessels – a self-propelled vessel that transports passengers for purposes including, but not limited to, dinner cruises; harbor, lake, or river tours; scuba diving expeditions; and whale watching tours. "Excursion vessel" does not include crew and supply vessels, ferries, and recreational vessels.

Tugboats – any self-propelled vessel engaged in, or intending to engage in, the service of pulling, pushing, maneuvering, berthing, or hauling alongside other vessels, or any combination of pulling, pushing, maneuvering, berthing, or hauling alongside such vessels in harbors, over the open seas, or through rivers and canals. Tugboats generally can be divided into three groups: harbor or short-haul tugboats, ocean-going or long-haul tugboats, and barge tugboats. "Tugboat" is interchangeable with "towboat" and "push boat" when the vessel is used in conjunction with barges.

Towboats – any self-propelled vessel engaged in or intending to engage in the service of pulling, pushing, or hauling alongside barges or other vessels, or any combination of pulling, pushing, or hauling alongside barges or other vessels.

Push Boats – any self-propelled vessel engaged in or intending to engage in the service of pulling, pushing, or hauling alongside barges or other vessels, or any combination of pulling, pushing, or hauling alongside barges or other vessels. "Push boats" is interchangeable with "towboats".

Multipurpose Harbor Craft – a harbor craft that serves as a ferry, excursion vessel, tugboat, or towboat but is also used as a work, crew and supply, pilot, fishing, supply, or other vessel. According to California Air Resources Board (CARB) guidance[31] this rule applies to work boats and crew and supply vessels regardless of whether those vessels first meet the definition of a ferry, excursion vessel, tugboat, or towboat.

Harbor Craft – any private, commercial, government, or military marine vessel including, but not limited to, passenger ferries, excursion vessels, tugboats, ocean-going tugboats, towboats, push-boats, crew and supply vessels, work boats, pilot vessels, supply boats, fishing vessels, research vessels, U.S. Coast Guard vessels, hovercraft, emergency response harbor craft, and barge vessels that do not otherwise meet the definition of ocean-going vessels or recreational vessels.

Crew and Supply Vessel – a self-propelled vessel used for carrying personnel and/or supplies to and from off-shore and in-harbor locations (including, but not limited to, off-shore work platforms, construction sites, and other vessels).

Work Boat – a self-propelled vessel that is used to perform duties such as fire/rescue, law enforcement, hydrographic surveys, spill/response, research, training, and construction (including drilling).

Barge – a vessel having a flat-bottomed rectangular hull with sloping ends and built with or without a propulsion engine.

Ocean-going Vessel – a commercial, government, or military vessel meeting any one of the following criteria:

(A) A vessel greater than or equal to 400 feet in length overall as defined in 50 CFR § 679.2, as adopted June 19, 1996;
(B) A vessel greater than or equal to 10,000 gross tons per the convention measurement (international system) as defined in 46 CFR 69.51-.61, as adopted September 12, 1989; or
(C) A vessel propelled by a marine compression-ignition engine with a per-cylinder displacement of greater than or equal to 30 liters.

Vessels that meet the definition of a multipurpose harbor craft, including crew, supply, and work vessels, under the California rule would be required to replace their Tier 1 and earlier Category 1 and 2 engines with those

[31] California Air Resources Board. 2014, January 15. *Commercial Harbor Craft*. Retrieved from https://ww2.arb.ca.gov/sites/default/files/2020-07/chcpamphlet01162014.pdf.

meeting Tier 2 or higher emission standards if they were in Regulated California Waters. Note that ocean-going vessels, as defined in the rule, do not meet the definition of a multipurpose harbor craft. It is anticipated that Ocean Wind will utilize vessels that meet the definition of a crew and supply vessel and/or a work boat and will be considered an OCS source. For instance, the jack-up vessel will perform construction duties and will be considered an OCS source.

Ocean Wind's review of SIPs for coastal states and territories, including the Great Lake states, did not reveal any other NO_x emission limitations applicable to marine vessel engines.

Regulations at 40 CFR Part 60, Subpart IIII and 40 CFR Part 63, Subpart ZZZZ have been incorporated by reference into multiple SIPs and are discussed in Section 6.2.1.3.

6.2.1.2 NO_x Limits Achieved in Practice

Several sources were used to evaluate LAER NO_x emission rates that have been achieved in practice. First, a search on EPA's RACT/BACT/LAER Clearinghouse (RBLC) website was conducted. The RBLC was searched using the "Basic Search" option for all sources with a process name containing "vessel," "ship," "boat," or "marine" for pollutant "NO_x" for the past ten years in the United States, Canada, and Mexico. No matching entries were found for any LAER determinations. Several entries were found for marine flares which are not relevant to Ocean Wind. One PSD permit was found containing BACT limits for NO_x from diesel engines on lifeboats. The engines were rated at 39 hp and 110 hp. No emission limits were specified.

A search of the CARB BACT Determination Tool was conducted for portable and stationary internal combustion engines fueled by diesel. No determinations for engines similar to the Project's marine engines were found.

A search of the Texas Commission on Environmental Quality (TCEQ) Current BACT Spreadsheet[32] was conducted. No emission limits for compression-ignited internal combustion engines were identified.

The EPA Verified Technologies List was reviewed[33]. Ten technologies were identified; six marine engine emissions upgrade kits for specific models of Caterpillar engines used in marine applications with a model year between 1994-2006 and four marine engine emissions upgrade kits for specific models of Caterpillar engines used in marine applications with a model year 1994 and newer. Most upgrade kits are verified to reduce PM, NO_x, hydrocarbons (HC), and CO emissions; some only reduce a subset of these pollutants.

A search of the CARB Verified Technologies List was conducted for emission control technologies for marine diesel engines. The only technology identified, Rypos, Inc. Active Diesel Particulate Filter,[34] is not applicable to NO_x emissions control; it is designed to control PM.

The South Coast Air Quality Management District (SCAQMD) Best Available Control Technology Guidelines was reviewed[35]. No BACT guidelines were identified for marine engines.

The EPA's Air Permit Policy and Guidance Databases were searched using keywords "marine engine" with either "BACT" or "LAER". The search results did not yield anything in addition to controls already identified through other sources described in this permit application.

---

[32] Texas Commission on Environmental Quality (TCEQ). 2021, July 28. *BACT guidelines for Combustion Sources*. Retrieved from https://www.tceq.texas.gov/permitting/air/nav/air_bact_combustsources.html.
[33] US Environmental Protection Agency. *Verified Technologies List for Clean Diesel*. Retrieved from https://www.epa.gov/verified-diesel-tech/verified-technologies-list-clean-diesel.
[34] California Air Resources Board (CARB). *Verified Technology List*. Retrieved from https://ww2.arb.ca.gov/our-work/programs/verification-procedure-marine.
[35] South Coast Air Quality Monitoring District (SCAQMD). *Best Available Control Technology Guidelines.* Retrieved from http://www.aqmd.gov/home/permits/bact/guidelines.

Numerous emission control technologies for marine diesel engines were identified in EPA regulatory impact analysis documents *Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines*[20] and *Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder* (EPA-420-R-08-001, March 2008). These control technologies are described in Section 6.1 of this permit application.

Several emission control technologies for marine diesel engines were identified in *Alternative Control Techniques Document: Stationary Diesel Engines* (Nelson, 2010) and *Emission Control Technologies for Ocean Going Vessels (OGVs)* (Hefanzi & Rahai, 2008). These control technologies are described in Section 6.1 of this permit application.

An online review was conducted of marine diesel engine and marine diesel engine control technology vendors, including Wartsila, MAN Diesel & Turbo, and GE, was conducted. No additional control technologies were identified other than controls already identified elsewhere in this permit application.

Finally, recent OCS air permits issued by the EPA were identified and reviewed. Permits reviewed include:

- Cape Wind Energy Project – Offshore Renewable Wind Energy Project (Permit No. OCS-R1-01)
- Vineyard Wind 1, LLC – Offshore Renewable Wind Energy Project (Permit No. OCS-R1-03)
- South Fork Wind, LLC – Offshore Renewable Wind Energy Project (Permit No. OCS-R1-04)

LAER determinations found in this list of permits are presented in the next section.

6.2.1.2.1 Recent LAER Determinations

Ocean Wind reviewed recently issued OCS air permits for sources like the marine engines associated with the Project. During this review, Ocean Wind identified three OCS air permits that included a LAER determination for NO_x: 1) Cape Wind Offshore Renewable Energy Project; 2) Vineyard Wind Offshore Renewable Energy Project' and 3) South Fork Offshore Wind Renewable Energy Project.

Cape Wind Offshore Renewable Energy Project

The Cape Wind Offshore Renewable Energy Project, as proposed by Cape Wind Associates, LLC (Cape Wind), intended to install 130 wind turbines and other supporting equipment. Cape Wind was issued an air permit on January 7, 2011. The project was never built. Cape Wind conducted a comprehensive LAER analysis for NO_x for the project's proposed OCS sources in their revised permit application submitted March 12, 2009.

The Cape Wind LAER determination was reviewed in the Vineyard Wind permit application; as such, it is not discussed further.

Vineyard Wind Offshore Renewable Energy Project

The Vineyard Wind Offshore Renewable Energy Project, as proposed by Vineyard Wind 1, LLC (Vineyard Wind), is an 800-MW project utilizing sixty-two (62), 13 MW GE Haliade-X wind turbines connected to an OSS, where power generated by the turbines will be transferred to two offshore export cables that will make landfall at Covell's beach. The Project broke ground on November 19, 2021.[36] EPA Region 1 issued Vineyard Wind an OCS air permit on May 19, 2021.

Vineyard Wind conducted an extensive LAER analysis for NO_x and VOC for the Project's OCS sources in their August 2018 OCS air permit application. Vineyard Wind's LAER analysis included identifying previous permit limits and LAER determinations for similar sources from other projects. Vineyard Wind's search of the RBLC

[36] Vineyard Wind. 2021, November 19. *Vineyard wind breaks ground on first-in-the-nation commercial scale offshore windfarm.* Retrieved from https://www.vineyardwind.com/press-releases/2021/11/19/vineyard-wind-breaks-ground-on-first-in-the-nation-commercial-scale-offshore-windfarm.

database did not identify any previous permits or LAER determinations for emission sources similar to those proposed for the Vineyard Wind project.[37]

Based on precedent and available technical guidance, Vineyard Wind determined that replacing or retrofitting vessel engines, including implementing add-on controls, such that the engines meet a particular emission standard is not technically feasible for several reasons, including:

- *Vineyard Wind will not know what vessels (and hence engines) will be used until much closer to the start of construction; vessel data is highly speculative at this stage of the Project…"*
- *The Project's vessels, and their operating schedule are not under Vineyard Wind's control (all vessels that are OCS sources will be third-party vessels)*
- *Mandating upgrades to specific marine engines for a project's short-term construction period would inhibit Vineyard Wind (or any other offshore wind developer) from being able to substitute vessels in response to schedule changes or other construction issues, which could impose significant costs or delays that prevent the Project (or any other offshore wind project) from being built.*

Additionally, Vineyard Wind determined that waiting until particular vessels are available which have engines that are retrofitted or employ add-on control technologies is not feasible because:

> *Waiting for vessels that use add-on NO_x controls would significantly damage the Project's construction schedule, which would likely result in higher actual overall NO_x emissions and impose significant costs that could prevent the Project (and similarly any other offshore wind project) from being built. Similarly, retrofitting engines that will only be used during 1-2 years of construction or for periodic O&M activities with NO_x add-on control technologies is not achievable as LAER because it would impose control costs so great that no major offshore wind farm could be built. Furthermore, Vineyard Wind will not own any vessels that are subject to LAER and will have limited ability to demand retrofits to vessels that the company does not own.*

As described in the draft New Source Review Workshop Manual[38]:

> 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.

Therefore, because replacing, retrofitting, or waiting for vessels that utilize add-on controls would impose significant costs that could prevent the Project and other similar offshore wind projects from being built, these control measures are not considered achievable as LAER.

In the OCS air permit issued by EPA Region 1 (Permit No. OCS-R1-03), LAER was determined to be the highest tier internal combustion engine at the time of deployment as follows:

<u>Category 1 and 2 engines on all domestic and foreign-flagged feeder jack-up vessels, domestic and foreign-flagged supply vessels, and secondary crew transfer vessels, while those vessels are operating as OCS sources</u> – meet Tier 4 marine engine emission limits in 40 CFR § 1042.101 unless the total emissions associated with the use of a Tier 4 engine would be greater than the total emissions associated with the use of a vessel with Tier 3 (40 CFR § 1042.101) or Tier 2 (40 CFR § 94.8) engine(s). When determining the total emissions associated with the use of a vessel with a particular engine, the Permittee may include the emissions

[37] Epsilon Associates, Inc. 2018, August 17. *Outer Continental Shelf Air Permit Application: Vineyard Wind Project.* Retrieved from https://www.regulations.gov/docket/EPA-R01-OAR-2019-0355/document.
[38] US Environmental Protection Agency (EPA). 1990, October. *New Source Review Workshop Manual. Prevention of Significant Deterioration and Nonattainment Area Permitting.* Retrieved from https://www.epa.gov/nsr/nsr-workshop-manual-draft-october-1990.

of the vessel that would occur when the vessel would be in transit to the wind turbine area from the vessel's starting location. If the Project uses a vessel with Tier 2 or Tier 3 engine(s), a vessel with a higher Tier engine(s) must not be available within two hours of when the vessel must be deployed.

Category 1 and 2 engines for U.S.-flagged vessels operating as an OCS source, including a U.S.-flagged Anchored Cable Laying vessel, that do not meet the definitions for any type of feeder jack-up vessel, supply vessel, or primary or secondary crew transfer vessel – meet Tier 4 marine engine emission limits in 40 CFR § 1042.101 unless the total emissions associated with the use of a Tier 4 (40 CFR § 1042.101) engine would be greater than the total emissions associated with the use of a vessel with Tier 3 (40 CFR § 1042.101), Tier 2 (40 CFR § 94.8) or Tier 1 (40 CFR § 94.8) engine(s). When determining the total emissions associated with the use of a vessel with a particular engine, the Permittee may include the emissions of the vessel that would occur when the vessel would be in transit to the wind turbine area from the vessel's starting location. If the Project uses a vessel with Tier 1, Tier 2 or Tier 3 engine(s), a vessel with a higher Tier engine(s) must not be available within two hours of when the vessel must be deployed. All engines operating on any vessel that is not a jack-up vessel, supply vessel, or primary or secondary crew transfer vessel while that vessel meets the definition of an OCS source, shall be certified as meeting the emission limits for a Tier 3 or 4 marine engine in 40 CFR § 1042.101 or Tier 1 or 2 in 40 CFR Part 94, depending on whichever Tier the marine engine is certified to meet.

All engines on all foreign-flagged vessels not regulated by permit conditions described above, including a foreign-flagged Anchored Cable Laying Vessel, and category 3 engines on U.S.-flagged vessels, while those vessels are operating as an OCS source – meet IMO or Tier 3 marine engine standards unless the total emissions associated with the use of an IMO or Tier 3 engine would be greater than the total emissions associated with the use of a vessel with IMO or Tier 2 engine or IMO or Tier 1 engine(s). When determining the total emissions associated with the use of a vessel with a particular engine, the Permittee may include the emissions of the vessel that would occur when the vessel would be in transit to the wind turbine area from the vessel's starting location. If the Project uses a vessel with Tier 1 or Tier 2 engine(s), a vessel with a higher Tier engine(s) must not be available within two hours of when the vessel must be deployed. All marine engines operating on a foreign vessel while that vessel meets the definition of an OCS source, shall be certified as meeting the NO_x emission limits for IMO or EPA Tier 1, 2, or 3 marine engines, depending on whichever IMO or EPA Tier the marine engine is certified to meet.

All engines while operating as OCS sources – use good combustion practices based on the most recent manufacturer's specifications issued for the engines at the time engines are operating under the permit.

Primary crew transfer vessel while operating as an OCS source – all engines certified as meeting the highest Tier for marine engines in 40 CFR § 1042.101. Tier 4 emission standards apply to engine(s) at or above 600 kW and Tier 3 emission standards apply to engine(s) below 600 kW.

South Fork Offshore Renewable Energy Project

The South Fork Wind Offshore Renewable Energy Project, as proposed by South Fork Wind, LLC (South Fork), is a 180-MW project utilizing up to fifteen (15), 6 to 12 MW wind turbines connected to an OSS, where power generated by the turbines will be transferred to an offshore export cable that will make landfall in East Hampton, New York. EPA Region 1 issued South Fork an OCS air permit on January 18, 2022.

South Fork conducted an extensive LAER analysis for NO_x for the Project's OCS sources in their September 2020 OCS air permit application.[39] The LAER determination for engines while vessels are operating as OCS

[39] CH2M. 2020, September. South Fork Wind *Outer Continental Shelf Air Permit Application: South Fork Wind, LLC.* Retrieved from https://www.regulations.gov/document/EPA-R01-OAR-2021-0392-0002.

sources in the OCS air permit issued by EPA Region 1 (Permit No. OCS-R1-04) was almost identical to the LAER determination for Vineyard Wind, with minor wording differences.

6.2.1.3 Applicable NSPS or NESHAP NO_x Limits

NSPS and NESHAP applicability is presented in Section 4.1.3 and 4.1.4, respectively. NSPS Subpart IIII contains emission limits applicable to CI ICE associated with the Project when the emission units are considered OCS sources. The applicable emission limit depends on the engine use, model year, size, displacement per cylinder, and classification of the Project site. The Project will be an area (i.e., non-major) source of HAP. NESHAP Subpart ZZZZ applies to RICE associated with the Project when the emission units are considered OCS sources. Per 40 CFR § 63.6590(c)(1), Project RICE constructed or reconstructed on or after June 12, 2006, meet the requirements of NESHAP Subpart ZZZZ by meeting the requirements of NSPS Subpart IIII for CI engines.

All internal combustion engines utilized by the Project that were constructed or reconstructed before June 12, 2006, and that are considered OCS sources are subject to 40 CFR § 63.6603. NESHAP Subpart ZZZZ contains emissions limits and operating requirements that apply to these engines, including the fuel requirements in 40 CFR § 63.6604.

6.2.1.4 Evaluation of Potential LAER Techniques for NO_x

LAER determinations may consist of one or more of the following techniques: 1) a change in the raw material processed, 2) a process modification, and 3) add-on controls. Each technique is discussed in this section.

6.2.1.4.1 Change in Raw Materials

The emission units associated with the Project generate emissions when combusting fuel. Therefore, a change in raw materials would be a change in the type of fuel combusted. Fuel combusted by marine vessel engines must be readily available, capable of being stored on board the vessel and suitable for current marine vessel engine technology. These constraints limit the potential change in type of fuel combusted by Project vessels to marine residual fuel, marine distillate fuel, ULSD, LNG, liquified LPG, and methanol.

Ocean Wind is aware of two jack-up vessels worldwide capable of combusting LNG and suitable for offshore wind turbine installation.[40] [41] Ocean Wind is also aware of one jack-up vessel designed to construct offshore WTG currently being built capable of combusting methanol. It is anticipated this vessel will enter the market in 2024.[42] There is a dual-fuel engine available capable of combusting LPG[43] but Ocean Wind is not aware of any jack-up vessels worldwide with this engine installed.

Although there are two jack-up vessels worldwide capable of combusting LNG and one being built capable of combusting methanol, it is not feasible for the Project to wait for these vessels to become available for several reasons, including:

- Jack-up vessels must meet Project specifications regarding size, power, and other characteristics. There are only a few jack-up vessels worldwide that meet these specifications
- There are several other offshore wind projects around the world scheduled to be under construction at the same time as Ocean Wind.

[40] Offshore Energy. 2019, January 22. *DEME's Apollo Jack-up Vessel Completes First Decom Job.* Retrieved from https://www.offshore-energy.biz/demes-apollo-jack-up-vessel-completes-first-decom-job/.
[41] Offshore Energy. 2018, November 21. *DEME Launches LNG-fueled Offshore Installation Vessel.* Retrieved from https://www.offshore-energy.biz/deme-launches-lng-fueled-offshore-installation-vessel/.
[42] Offshore Wind Biz. 2021, October 1. *Van Oord Order Mega Jack-up for 20 MW Offshore Wind Turbines.* Retrieved from https://www.offshorewind.biz/2021/10/01/van-oord-orders-mega-jack-up-for-20-mw-offshore-wind-turbines/.
[43] MAN Energy Solutions. n.d. Introducing the MAN B&W ME-LGIP: the world's first dual-fuel LPG marine engine. Retrieved from https://www.man-es.com/marine/products/lgip.

- Restrictions to limit vessel pool to two, or potentially three, vessels would likely result in higher overall NO_x emissions because:
    - The lower NO_x-emitting vessel would likely need to travel significant distances to reach the Project because there are currently only two jack-up vessels capable of installing large offshore wind turbines that combust LNG available in the world. A vessel capable of combusting methanol may also become available by the time the Project starts construction, but it is not certain.
    - The Project's other construction equipment would idle during the delay caused by waiting for the lower NO_x-emitting vessel to arrive on-site.

Therefore, Ocean Wind will not be able to maintain the Project's construction schedule without the flexibility to use jack-up vessels with engines combusting traditional marine vessel fuels.

Vessels which are OCS sources must comply with NSPS IIII while the vessels are considered OCS sources (and thus are also subject to LAER while considered OCS sources). NSPS IIII requires that diesel fuel combusted in CI ICE with a displacement less than 30 liters per cylinder subject to NSPS Subpart IIII meet the requirements of 40 CFR § 1090.305 for nonroad diesel fuel, which requires that diesel fuel has a maximum sulfur content of 15 ppm (equivalent to ULSD) for Category 1 and Category 2 engines. NSPS IIII also requires diesel fuel combusted in CI ICE with a displacement greater than or equal to 30 liters per cylinder subject to NSPS Subpart IIII have a maximum per-gallon sulfur content of 1,000 parts per million. Under NSPS IIII, diesel fuel is defined as *any liquid obtained from the distillation of petroleum with a boiling point of approximately 150 to 360 degrees Celsius. One commonly used form is number 2 distillate oil.*

Additionally, the Project vessels must comply with rules governing fuel sulfur content in 40 CFR Part 80 and 40 CFR Part 1090. Refer to Section 4.1.5 for a discussion on rule applicability.

The Project will comply with all applicable rules regarding usage of marine residual fuel, marine distillate fuel and ULSD. Although the combustion of ULSD would result in fewer NO_x emissions than residual or distillate fuel, the use of ULSD is not always technically feasible especially for Category 3 engines. As described by ABS[44], there are several reasons use of ULSD may not be technically feasible for certain engines, including the low lubricity, low viscosity, and low density of ULSD compared to traditional marine fuels.

6.2.1.4.2 Process Modifications

The process that generates emissions is marine vessel engines combusting fuels. A process modification refers to a change in the method engines utilize to accomplish its intended task of providing power to the vessel. Process modifications include retrofitting engines to reduce NO_x emissions during combustion. Several sources were reviewed to identify technologies that have demonstrated capabilities of reduce NO_x emissions from marine internal combustion engines. The sources reviewed are described in Section 6.2.1.2. The review identified ten Marine Engine Emissions Upgrade Kits listed on the EPA Verified Technologies List. The upgrade kits are for specific models of Caterpillar diesel engines used in marine applications with model year 1994 and newer. The upgrade kits are designed to bring these specific engine types into compliance with EPA Tier 1, Tier 2, or Tier 3 marine diesel standards.

The upgrade kits are not technically feasible NO_x control technologies for the Project. Ocean Wind does not know exactly which engines will be utilized during construction as the vessels used by the Project will be third-party vessels not owned by Ocean Wind. Additionally, construction plans and schedules are subject to change on short notice and the Jones Act imposes limitations on vessel usage. Finally, there will be several other

[44] ABS. n.d. *Fuel Switching Advisory Notice*. Retrieved from https://ww2.eagle.org/content/dam/eagle/publications/reference-report/FuelSwitchingAdvisoryNotice.pdf.

offshore wind farms being built concurrently with the Project; this will impact the availability of specific vessels for the Project's use.

There are several process modification technologies that can be employed by vessel or marine engine manufacturers during initial construction or major reconstruction to reduce NO_x emissions. These technologies were reviewed in detail in Section 6.1.1 and include:

- Fuel Injection Pressure and Timing
- Common Rail Fuel Injection Systems
- Slide Valves
- Emulsified Fuels
- Direct Water Injection
- Intake Air Humidification
- Charge Air Cooling (After Coolers)
- Exhaust Gas Recirculation System
- De-Rating of Existing Engines

Process modifications are generally intrinsic to the design of the marine engine and/or vessel. Some of the listed technologies can be implemented via retrofits; some must be incorporated into the original design. If Ocean Wind were to utilize process modifications to reduce NO_x emissions, they would need to require the third-party vessel contractor to:

1. Wait for a vessel to become available that incorporates one or more of these process modifications, or
2. Replace old engines with engines that use one or more of these technologies, or
3. Retrofit an existing engine to apply one or more of these technologies.

Waiting for Vessels with Lower NO_x Emissions

It is not feasible for Ocean Wind to modify, delay or extend the Project's construction schedule to wait for a vessel with lower NO_x emissions to become available.

Ocean Wind anticipates that most NO_x emissions from OCS sources will be emitted from jack-up vessels. There is a limited supply of vessels worldwide that are capable of installing offshore WTG components as the installation vessel must meet specifications regarding power, size, and other characteristics. Additionally, there are several other offshore wind projects scheduled to be under construction at the same time as Ocean Wind. Therefore, Ocean Wind cannot feasibly wait for the individual jack-up vessel with the lowest potential NO_x emissions to be available while maintaining the Project's construction schedule. For the same reason, it is not feasible to limit the pool of potential jack-up vessels to those with engines meeting specific Tier standards. Finally, such restrictions would likely result in higher overall NO_x emissions because:

- The lower NO_x-emitting vessel would likely need to travel significant distances to reach the Project because there are a limited number of jack-up vessels capable of installing large offshore wind turbines available in the world
- The Project's other construction equipment would idle during the delay caused by waiting for the lower NO_x-emitting vessel to arrive on-site.

Ocean Wind will not be able to maintain the Project's construction schedule without the flexibility to use jack-up vessels with engines meeting a range of Tier standards (Tier 2 through Tier 4 for Category 1, 2, and 3 engines).

Similarly, Ocean Wind will have limited to no ability to place restrictions on vessels that could become OCS sources if they anchor or attach to OCS sources while performing work. The specific vessels which could anchor or attach to an OCS source could easily change with little notice because of variable availability and

limitations associated with the Jones Act. Numerous other offshore wind projects are scheduled to be constructed at the same time as Ocean Wind and will be drawing from the same supply of vessels as Ocean Wind. Ocean Wind cannot feasibly limit the pool of third-party vessels while maintaining the Project's construction schedule.

Replacing or Retrofitting Vessel Engines

It is not feasible for Ocean Wind to require that third-party contractors replace or retrofit vessel engines to reduce NO_x emissions for reasons similar to those discussed above. Ocean Wind does not know specifically which vessels will be utilized during construction and vessel availability is subject to change on short notice. Because several other offshore wind projects will be under construction at the same time as Ocean Wind, vessel availability is anticipated to be constrained, in addition to limitations imposed by the Jones Act. Additionally, the vessels that will be utilized during construction are not under Ocean Wind's control since all vessels that will be OCS sources will be third-party vessels. Requiring the replacement or retrofit of specific vessel engines for a short-term construction project would prevent Ocean Wind from being able to substitute vessels on short notice due to schedule changes or other construction issues. For reasons discussed above, it is not feasible for Ocean Wind to wait for specific vessels to be available. Finally, the third-party contractor and/or Ocean Wind would not be able to recoup the high costs of retrofit or replacement. Requiring such process modifications would impose control costs so great that no major offshore wind farm could be built.

6.2.1.4.3 Add-On Controls

Add-on controls remove emissions after they have been generated by a process. In this case, add-on controls would remove emissions from the internal combustion engine exhaust stream. As described above in Section 6.2.1.2, no verified NO_x add-on control technologies for marine internal combustion engines were identified in a review of the EPA Verified Technologies List and the California Air Resources Board Verified Technologies List. Ocean Wind identified several potential add-on control technologies to reduce NO_x emissions that could be implemented by vessel or marine engine manufacturers during initial construction or major reconstruction. These technologies are described in Section 6.1.3 and include:

- SCR
- Selective Non-catalytic Reduction (SNCR)
- LNC
- NO_x Scrubber
- LNT
- 4-way Catalytic Converter

None of these technologies are considered technically feasible for the reasons listed below:

SCR

Although this technology has been implemented on marine diesel engines, this technology has been considered technically infeasible in other OCS air permit applications (Vineyard Wind, 2018[37]; Anadarko, 2014[45]) to retrofit existing engines. EPA Region 4 concurred SCR is technically infeasible for large internal combustion engines and third-party engines as described in the Preliminary Determination and Statement of Basis for Anadarko Petroleum, Inc. EGOM Drilling Project, stating: *This option is technically infeasible due to limited space availability for the SCR unit itself as well as the necessary ancillary equipment (e.g., urea storage tanks). In addition, the variable loads of the main diesel engines cannot maintain the required temperature for*

[45] US Environmental Protection Agency Region 4. 2014, June 19. *Preliminary Determination and Statement of Basis: Outer Continental Shelf Air Permit OCS-EPA-R4015 for Andarko Petroleum, Inc. EGOM Drilling Project.* Retrieved from https://www.epa.gov/sites/default/files/2015-08/documents/anadarko_egom_pd_061714_-_final.pdf

the catalyst to work. The emergency diesel engine, third party engines, and the stimulation vessel pumps will not operate for time periods long enough for the catalyst to reach the necessary working temperature. Similar reasons were given in the Cape Wind OCS air permit application, as described in the Vineyard Wind permit application.

Selective Non-catalytic Reduction (SNCR)

SNCR is technically infeasible because the vessel engines will operate at temperatures lower than the SNCR required operating temperature, which ranges from 900 to 1,000 °C.[21]

LNC

This technology is not available for marine engines; furthermore, it operates best at constant loads and is therefore not suitable for marine engines operating at varying loads.[45]

NO_x Scrubber

This technology has not been demonstrated for use on marine vessels or engines and is still in the development phase.[45] Additionally, scrubber wash water would contain nitrogen and add to the nitrogen loading of the water in which the ship is operating.[12]

NO_x Adsorber/LNT

The fuel sulfur content of diesel fuels presents a significant challenge for the application of NO_x adsorbers because fuel sulfur can convert to stable sulfates which compete with NO_x for storage sites in the adsorber.[23]

4-way Catalytic Converter

This technology operates best at steady state loads and exhaust temperatures. Additionally, non-combustible elements present in engine lube oils may collect over time and damage the catalyst. Finally, this technology is still in the development stage and is not available for marine diesel engines.[45]

As described above, no add-on technologies were identified as technically feasible for marine engines. Furthermore, use of these technologies would require Ocean Wind to wait for a vessel with this technology installed, or require third-party contractors to replace old engines or retrofit existing engines with add-on controls. None of these options are feasible for reasons described in Section 6.2.1.4.2.

6.2.1.5 LAER Determination

The offshore wind installation industry is unique in that LAER is being applied to vessels that are temporarily supplied by third-party contractors. Additionally, the construction schedule for a large offshore wind project is complex and subject to change with little notice. Therefore, Ocean Wind cannot identify specific individual marine engines that will be the OCS sources subject to NNSR and required to comply with LAER.

Ocean Wind proposes the following as feasible as LAER for NO_x:

- Vessels, foreign and domestic, that meet the definition of work boat or crew and supply vessel, as defined in 17 CCR § 93118.5, and are OCS sources, that have Category 1 and 2 engines will meet marine engine Tier 2 (40 CFR § 1042 Appendix I) or better (Tier 4 or Tier 3 in 40 CFR § 1042.101) emission standards. The proposed LAER determination will only apply to vessels that are considered OCS sources (i.e., it would not apply to a crew transfer vessel that does not meet the definition of an OCS source, even if the crew transfer vessel meets the definition of a crew vessel as defined in 40 CFR § 1042.101).
- Domestic vessels that do not meet the definition of work boat or crew and supply vessel, as defined in 17 CCR § 93118.5, and are OCS sources, that have Category 1 and 2 engines will meet marine

engine Tier 1 (40 CFR § 1042 Appendix I) or better (Tier 2 in 40 CFR § 1042 Appendix I, Tier 3 or Tier 4 in 40 CFR § 1042.101) emission standards.

- All engines on foreign vessels that do not meet the definition of work boat or crew and supply vessel, as defined in 17 CCR § 93118.5, and are OCS sources, will meet marine engine Tier 1 (40 CFR § 1042 Appendix I for Category 1 and 2 engines or 40 CFR § 1042.104 for Category 3 engines) or better (Tier 2 in 40 CFR § 1042 Appendix I, Tier 3 or Tier 4 in 40 CFR § 1042.101 for Category 1 and 2 engines, or Tier 2 or 3 in 40 CFR § 1042.104 for Category 3 engines) or IMO Tier 1 or better (IMO Tier 2 or Tier 3) emission standards.
- All Category 3 engines on domestic vessels that are OCS sources will meet marine engine Tier 1 (40 CFR § 1042.104) or better (Tier 2 or Tier 3 in 40 CFR § 1042.104) or IMO Tier 1 or better (IMO Tier 2 or Tier 3) emission standards.
- All engines on primary crew transfer vessels will meet the highest Tier standard for marine engines in 40 CFR § 1042.101. Tier 4 emission standards apply to engine(s) at or above 600 kW and Tier 3 emission standards apply to engine(s) below 600 kW. The primary crew transfer vessels are different than all of the other vessels in the construction and commissioning phase because they will be needed on a daily basis. Therefore, as described in the BACT determination section of the fact sheet accompanying the South Fork OCS Air Permit, "The use of the highest tiered engine at the 'time of deployment' identified as the option for BACT for vessel engines other than the primary crew transport vessel does not apply to the primary crew transport vessel which will be used on an almost daily basis for the entire life of the [Project]".

As described in Section 6.2.1.4.2, Ocean Wind has determined the following as not feasible as LAER for NO_x:

- It is not feasible for Ocean Wind to modify, delay or extend the Project's construction schedule to wait for a vessel with lower NO_x emissions to become available.
- It is not feasible for Ocean Wind to limit the pool of potential engines on jack-up vessels to those meeting Tier 3 (Category 3) or Tier 3 or 4 (Category 1 and 2) standards because of the very limited pool of jack-up vessels available worldwide that can construct the Project.
- It is not feasible for Ocean Wind to place restrictions on vessels that could become OCS sources if they anchor or attach to OCS sources while performing work. Ocean Wind has not specifically anticipated the use of such vessels but cannot rule out their potential use. The specific vessels which could anchor or attach to an OCS source could easily change with little notice because of variable availability and limitations associated with the Jones Act. Numerous other offshore wind projects are scheduled to be constructed at the same time as Ocean Wind and will be drawing from the same supply of vessels as Ocean Wind. Ocean Wind cannot feasibly limit the pool of third-party vessels while maintaining the Project's construction schedule.
- The LAER determination treats foreign-flagged vessels differently than U.S.-flagged vessels (other than foreign-flagged vessels that meet the definition of a work boat or crew and supply vessel as defined in 17 CCR § 93118.5) because foreign-flagged vessels are not required to comply with 40 CFR§ 1042.101. Foreign vessels are only required to comply with 40 CFR Part 1043, which requires engines over 130 kW on foreign-flagged vessels to have a valid EIAPP certifying that the engine(s) meets the applicable emission standards of IMO Annex VI for engines on Party vessels and evidence of conformity with Regulation 13 of Annex VI for engines installed on non-Party vessels.
- Finally, the LAER determination groups Category 3 engines on domestic vessels with foreign-flagged vessels (all engines) not meeting the definition of a work boat, or crew and supply vesselfor the following reasons:
    - Category 3 engines are not required to comply with 17 CCR § 93118.5 since they meet the definition of *ocean-going vessel*, which are not subject to the rule; and

- There are no Tier 4 emission standards in 40 CFR § 1042 for Category 3 engines.

6.2.2 Engines Powering Vessels Meeting the Definition of an OCS Source – VOC

Compression-ignition internal combustion engines powering vessels used to construct the Project will be subject to LAER while the vessels meet the definition of an OCS source. Ocean Wind anticipates that jack-up vessels will meet the definition of an OCS source. Other vessels that may meet the definition of an OCS source include any vessels tethered to an OCS source while performing an activity that supports the construction of the Project. As described in this section, the Project will use vessel engines that comply with the most stringent VOC emission limit identified in any SIP, the most stringent limit achieved in practice, or the most stringent limit identified in any applicable NSPS or NESHAP.

The NO_x LAER analysis is referred to in this section, as appropriate.

6.2.2.1 VOC Limits in SIPs

The rules identified in California's SIP in Section 6.2.1.1 apply to VOC as well. The same requirements apply as detailed in Section 6.2.1.1. Other states SIPs (Delaware, Illinois, Louisiana, Maryland, Oregon, Pennsylvania, Rhode Island, Texas) regulate VOC emissions from marine liquid transport vessel loading but the rules apply to liquids with higher Reid vapor pressures (more volatile) than the fuels that the Project anticipates will be used by the Project's vessels.

6.2.2.2 VOC Limits Achieved in Practice

The same sources used to evaluate LAER for NO_x were used to evaluate LAER for VOC. The sources are identified in Section 6.2.1.2.

6.2.2.2.1 Recent LAER Determinations

The LAER determinations for NO_x in OCS air permits reviewed were also considered LAER for VOC. The Vineyard Wind and South Fork permit conditions described in Section 6.2.1.2.1 that were considered LAER for NO_x are also considered LAER for VOC.

6.2.2.3 Applicable NSPS or NESHAP VOC Limits

The NSPS and NESHAP identified in Section 6.2.1.3 for NO_x are applicable to VOC emissions as well.

6.2.2.4 Evaluation of Potential LAER Techniques

6.2.2.4.1 Change in Raw Materials

As described in Section 6.2.1.4.1, for marine internal combustion engines, the raw material is the fuel combusted by the engines. For Ocean Wind, potential fuels are limited to marine residual fuel, marine distillate fuel, ULSD, LNG, LPG, and methanol.

6.2.2.4.2 Process Modifications

The process that generates emissions is marine vessel engines combusting fuels. A process modification refers to a change in the method engines utilize to accomplish its intended task of providing power to the vessel. Process modifications include retrofitting engines to reduce VOC emissions during combustion. Several sources were reviewed to identify technologies that have demonstrated capabilities of reduce VOC emissions from marine internal combustion engines. The sources reviewed are described in Section 6.2.1.2. The review identified ten Marine Engine Emissions Upgrade Kits listed on the EPA Verified Technologies List; five of which are verified to reduce HC emissions. The upgrade kits are for specific models of Caterpillar diesel engines used in marine applications with model year from 1994 to 2006. The upgrade kits verified to reduce HC emissions

are designed to bring these specific engine types into compliance with EPA Tier 1 or Tier 2 marine diesel standards.

The upgrade kits are not technically feasible VOC control technologies for the Project. Ocean Wind does not know exactly which engines will be utilized during construction as the vessels used by the Project will be third-party vessels not owned by Ocean Wind. Additionally, construction plans and schedules are subject to change on short notice and the Jones Act imposes limitations on vessel usage. Finally, there will be several other offshore wind farms being built concurrently with the Project; this will impact the availability of specific vessels for the Project's use. It is not feasible for Ocean Wind to wait for vessels with the lowest VOC emissions or to reduce the pool of available vessels to those with the upgrade kits installed as this would be detrimental to the Project's construction schedule and could result in the Project not being built.

Ocean Wind did not identify any other process modification technologies that reduce VOC emissions from marine internal combustion engines.

6.2.2.4.3 Add-On Controls

Add-on controls remove emissions after they have been generated by a process. In this case, add-on controls would remove emissions from the internal combustion engine exhaust stream. As described above in Section 6.2.1.2, no verified VOC add-on control technologies for marine internal combustion engines were identified in a review of the EPA Verified Technologies List and the California Air Resources Board Verified Technologies List. Ocean Wind identified several potential add-on control technologies to reduce VOC emissions that could be implemented by vessel or marine engine manufacturers during initial construction or retrofitted. These technologies are described in Section 6.1.3 and include:

- Catalytic Diesel Particulate Filter
- Flow-Through Filter
- Diesel Oxidation Catalyst
- 4-way Catalytic Converter

None of these technologies are considered technically feasible for the reasons listed below:

Catalytic Diesel Particulate Filter

Catalytic diesel particulate filters require sufficient exhaust temperatures sustained for long periods of time to facilitate regeneration of HC compounds by the catalyst. EPA determined that marine vessel engines cannot sustain the required temperatures for high catalyst performance because of their variable loads. Non-combustible elements present in engine oils may collect over time and damage the catalyst. Additionally, this technology can cause pressure drop across the exhaust flow, resulting in back pressure on the engine that can cause plugging of the engine, which is a safety concern.[45] Finally, if engines use fuel with high (over 150 ppm) sulfur content, the performance of the catalytic diesel particulate filter is greatly reduced.[23] For these reasons, a catalytic diesel particulate filter is not technically feasible to reduce VOC emissions.

Flow-Through Filter

Ocean Wind is not aware of any instances where this technology has been designed for or tested on a commercially available marine internal combustion engine. It is not considered technically feasible for marine engine applications.

Diesel Oxidation Catalyst

Diesel oxidation catalysts require sufficient exhaust temperatures sustained for long periods of time to facilitate regeneration of HC compounds by the catalyst. EPA determined that marine vessel engines cannot sustain the required temperatures for high catalyst performance because of their variable loads. Non-combustible elements

present in engine oils may collect over time and damage the catalyst. Additionally, this technology can cause pressure drop across the exhaust flow, resulting in back pressure on the engine that can cause plugging of the engine, which is a safety concern.[45] Finally, if engines use fuel with high (over 150 ppm) sulfur content, the performance of the diesel oxidation catalyst is greatly reduced.[23] For these reasons, a diesel oxidation catalyst is not technically feasible to reduce VOC emissions.

4-way Catalytic Converter

Four-way catalytic converters require sufficient exhaust temperatures sustained for long periods of time to facilitate regeneration of HC compounds by the catalyst. EPA determined that marine vessel engines cannot sustain the required temperatures for high catalyst performance. Non-combustible elements present in engine oils may collect over time and damage the catalyst.[45] Additionally, Ocean Wind is not aware of any instances where this technology has been designed for or tested on a commercially available marine internal combustion engine.

As described above, no add-on technologies were identified as technically feasible for marine engines. Furthermore, use of these technologies would require Ocean Wind to wait for a vessel with this technology installed, or require third-party contractors to replace old engines or retrofit existing engines with add-on controls. None of these options are feasible for the reasons described in Section 6.2.1.4.2.

6.2.2.5 LAER Determination

The offshore wind installation industry is unique in that LAER is being applied to vessels that are temporarily supplied by third-party contractors. Additionally, the construction schedule for a large offshore wind project is complex and subject to change with little notice. Therefore, Ocean Wind cannot identify specific individual marine engines that will be the OCS sources subject to NNSR and required to comply with LAER.

Ocean Wind proposes LAER for VOC is the same as what was proposed for NO_x in Section 6.2.1.5.

6.2.3 Engines Powering Electric Generators on WTG and OSS and Engines Powering Auxiliary Equipment Onboard Vessels Considered OCS Sources – NO_x and VOC

The diesel generators that will be used on WTG and OSS during construction and commissioning are subject to NNSR and must comply with LAER. There will be up to 6 generators used on the OSS (2 per OSS) during commissioning with engines rated up to 209 horsepower (hp), up to 3 generators used on the OSS (1 per OSS) during commissioning with engines rated up to 102 hp, and up to 98 generators used on the WTG (1 per WTG) during commissioning with engines rated up to 50 hp. There will be up to 3 generators used on the OSS (1 per OSS) installed permanently that will begin operation during commissioning with engines rated up to 800 hp. Additionally, any diesel engine powering equipment, such as a diesel generator or cherry picker, used onboard a vessel that becomes an OCS source is also subject to NNSR while the vessel is considered an OCS source. Additional emission units onboard the jack-up vessel include a generator with an engine rated up to 5 hp and a cherry picker rated up to 90 hp. As described in this section, the Project will use engines that comply with the most stringent NO_x and VOC emission limit(s) identified in any SIP, the most stringent limit achieved in practice, or the most stringent limit identified in any applicable NSPS or NESHAP.

6.2.3.1 Limits in SIPs

Stationary internal combustion engines are subject to 40 CFR Part 60, Subparts IIII and JJJJ, and 40 CFR Part 63, Subpart ZZZZ. These subparts are incorporated into many SIPs and are discussed below in Section 6.2.3.3. Newer non-emergency internal combustion engines are also subject to 40 CFR Part 1039, which introduced Tier 4 engine standards.

Ocean Wind is not aware of any other rules or limits in SIPs that apply to stationary internal combustion engines.

6.2.3.2 Limits Achieved in Practice

Several sources were used to evaluate LAER NO_x and VOC emission rates that have been achieved in practice. The application for South Fork[46] contained the results of an RBLC search for the following categories:

17.100 – Large ICEs (> 500 HP)
- 17.110 – Fuel Oil (ASTM #1, 2, includes kerosene, aviation, diesel fuel)
- 17.120 – Other liquid fuel and liquid fuel mixtures

17.200 – Small ICEs (< 500 HP)
- 17.210 – Fuel Oil (ASTM #1, 2, includes kerosene, aviation, diesel fuel)
- 17.220 – Other liquid fuel and liquid fuel mixtures

The South Fork application divided the results into three tables: 1) from OCS air permit determinations, 2) large emergency/non-emergency engines (> 500 HP), and 3) small emergency/non-emergency engines (<500 HP). The results tables from the South Fork application are included as **Appendix G**. Additionally, Ocean Wind reviewed the RBLC database on January 28, 2022, to determine whether additional entries newer than the most recent entry listed in the tables have been added. The results of Ocean Wind's review for large engines (> 500 HP) are contained in **Table 6-4** and the results of the review for small engines (<500 HP) are contained in **Table 6-5**.

[46] CH2M. 2020, September. *South Fork Wind Outer Continental Shelf Source Air Permit Application – South Fork Wind, LLC.* Retrieved from https://www.regulations.gov/document/EPA-R01-OAR-2021-0392-0002.

Table 6-4. RBLC Database Updated Review for Large (>500 HP) Engines.

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
TX-0933	11/17/2021	11/18/2021	17.110	Emergency Generator	Diesel	Limited to 100 hours per year of non-emergency operation EPA Tier 2 (40 CFR § 1039.101) exhaust emission standards	None Listed
MI-0447	01/07/2021	9/10/2021	17.110	Emergency Engine	Diesel	ULSD Good combustion practices NSPS Compliant Catalytic oxidation was the control considered technically feasible. However, it was not considered economically feasible.	CO – 3.5 G/kW-Hr PM – 0.2 G/kW-Hr PM10 – 1.0 lb/hr PM2.5 – 1.0 lb/hr CO2e – 590 TPY 12-month rolling
TX-0911	12/15/2020	5/10/2021	17.110	Emergency Engine	ULSD	ULSD	None Listed
VA-0333	12/09/2020	5/19/2021	17.110	Emergency Engine Generator	Diesel	None Listed	PM10 – 1.1 lb/hr PM2.5 – 1.1 lb/hr CO2e – 2.543 lb/hr
AL-0328	11/09/2020	10/05/2021	17.110	Diesel Emergency Engines	Diesel	NSPS	CO – 2.6 g/bhp-hr NOx – 3.0 g/bhp-hr FPM – 0.15 g/bhp-hr SO2 – 15 ppm
LA-0383	09/03/2020	12/20/2021	17.110	Emergency Engines	Diesel	Comply with NSPS Subpart IIII	None Listed
AK-0085	08/13/2020	03/31/2021	17.110	Black Start Generator Engine	ULSD	Oxidation Catalyst Good combustion practices ULSD Limit operation to 500 hours per year	CO – 3.3 G/Hp-Hr NOx – 3.3 G/Hp-Hr TPM – 0.045 G/Hp-Hr PM10 – 0.045 G/Hp-Hr PM2.5 – 0.045 G/Hp-Hr SO2 – 15 ppmw sulphur in fuel VOC – 0.18 G/Hp-Hr

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
TX-0888	04/23/2020	11/12/2020	17.110	Emergency Generators	ULSD	Well-designed and properly maintained engines Each limited to 100 hours per year of non-emergency use	None Listed
KS-0040	12/03/2019	08/25/2020	17.110	Emergency Generator	Diesel	Emergency Diesel Engine Subject to NSPS Subpart IIII Combustion Control Limited Operating Hours	PM/PM10/PM2.5 - 0.2 G/kW-Hr
MI-0445	11/26/2019	12/23/2020	17.110	Emergency Generator	Diesel	Good Combustion Practices Meeting NSPS Subpart IIII requirements. Use of ULSD Restricted to 4 hours/day, except during emergency conditions and stack testing, and 500 hours/year on a 12-month rolling time period basis.	CO – 3.5 G/kW-Hr NMHC + NOx – 6.4 G/kW-Hr PM – 0.2 G/kW-Hr PM10/PM2.5 – 1.58 lb/hr CO2e – 928 tons/yr on a rolling 12-month basis
AR-0161	09/23/2019	5/5/2021	17.110	Emergency Engine	Diesel	Good Operating Practices Limited hours of operation Compliance with NSPS Subpart IIII	FPM/PM10/PM2.5 – 0.02 G/kW-Hr VE – 20% SO2 – 0.007 G/kW-Hr VOC – 1.9 G/kW-Hr CO – 3.5 G/kW-Hr NOx – 0.4 G/kW-Hr CO2e – 164 lb/MMBtu
OK-0181	09/11/2019	9/10/2021	17.110	Emergency Engine > 500 hp	Diesel	Good Combustion Practices Certified to meet EPA Tier 3 engine standards Gen-1 and FP-1 shall be limited to operate not more than 500 hours per year. SP-1 shall be limited to operate not more than 876 hours per year.	VOC – 3.0 G/kW-Hr
MI-0442	08/21/2019	8/9/2021	17.110	Emergency Engines	Diesel	Good combustion practices ULSD Compliance with NSPS IIII	NOx – 5.3 G/Hp-Hr CO – 0.15 G/Hp-Hr PM – 0.04 G/Hp-Hr PM10 – 7.85 lb/1000-gal hourly

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
							PM2.5 – 7.55 lb/1000-gal hourly VOC – 0.86 lb/hr CO2e – 444 tons/yr 12 month rolling
AR-0163	06/09/2019	11/10/2020	17.110	Emergency Engines	Diesel	Good Operating Practices Limited hours of operation Compliance with NSPS Subpart IIII ULSD	PM/PM10/PM2.5 – 0.2 G/kW-Hr VE – 20% SO2 - 0.0015 % Sulfur Fuel VOC – 1.55 G/kW-Hr CO – 3.5 G/kW-Hr NOx – 4.86 G/kW-Hr CO2 – 163 lb/MMBtu CH4 – 0.0061 lb/MMBtu N2O – 0.0013 lb/MMBtu
LA-0382	04/25/2019	12/16/2021	17.110	Emergency Engines	Diesel	Comply with standards of 40 CFR 60 Subpart IIII	None Listed
TX-0882	01/17/2020	11/12/2020	17.120	Emergency Engine	Diesel	Good combustion practices, Clean fuel ULSD 100 hours per year operating time	NOx – 0.0092 lb/MMBtu VOC – 0.001 lb/MMBtu CO – 0.0057 lb/MMBtu CO2e – 114.5 lb/MMBtu PM/PM10/PM2.5 – 0.0001 lb/MMBtu
AK-0084	06/30/2017	04/16/2020	17.110	Black Start & Emergency Engines	Diesel	Good Combustion Practices	NOx – 8 G/kW-Hr CO – 4.38 G/kW-Hr PM – 0.25 G/kW-Hr PM10 – 0.25 G/kW-Hr PM2.5 – 0.25 G/kW-Hr CO2e – 2781 TPY
AK-0084	06/30/2017	04/16/2020	17.110	Large ULSD/Natural Gas-Fired Internal	Diesel and Natural Gas	Good Combustion Practices	VOC – 0.21 G/kW-Hr (USLD) & 0.09 G/kW-Hr (NG) NOx – 0.53 G/kW-Hr (USLD) & 0.08 G/kW-Hr (NG)

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
				Combustion Engines			CO – 0.18 G/kW-Hr (USLD) & 0.12 G/kW-Hr (NG) PM – 0.29 G/kW-Hr (USLD) & 0.13 G/kW-Hr (NG) PM10 – 0.29 G/kW-Hr (USLD) & 0.13 G/kW-Hr (NG) PM2.5 – 0.29 G/kW-Hr (USLD) & 0.13 G/kW-Hr (NG) FPM – 0.15 G/kW-Hr (USLD) & 0.0 G/kW-Hr (NG) CO2e – 1299630 TPY (USLD) & 869621 TPY (NG)
IL-0130	12/31/2018	04/16/2020	17.110	Emergency Engine	Ultra-Low Sulfur Diesel	None Listed	NOx – 6.4 G/kW-Hr CO – 3.5 G/kW-Hr TPM – 0.2 G/kW-Hr CO2e – 225 TPY
IN-0317	06/11/2019	05/26/2021	17.110	Emergency Generator	Diesel	Tier II diesel engine	NOx – 6.4 G/kW-Hr CO – 3.5 G/kW-Hr TPM – 0.2 G/kW-Hr PM10 – 0.2 G/kW-Hr PM2.5 – 0.2 G/kW-Hr SO2 – 15 ppm VOC – 6.4 G/kW-Hr CO2e – 881 TPY
KY-0109	10/24/2016	01/25/2021	17.110	Emergency Generator	Diesel	The permittee shall prepare and maintain for EU72, EU73, and EU74, within 90 days of startup, a good combustion and operation practices plan (GCOP) that defines, measures and verifies the use of operational and design practices determined as BACT for minimizing CO, VOC, PM, PM10, and PM2.5 emissions.	VOC – 4.77 G/Hp-Hr & 3.5 G/Hp-Hr CO – 2.6 G/Hp-Hr & 3.73 G/Hp-Hr FPM – 0.149 G/Hp-Hr & 0.298 G/Hp-Hr PM10 – 0.149 G/Hp-Hr & 0.298 G/Hp-Hr

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
						Any revisions requested by the Division shall be made, and the plan shall be maintained on site. The permittee shall operate according to the provisions of this plan at all times, including periods of startup, shutdown, and malfunction. The plan shall be incorporated into the plant standard operating procedures (SOP) and shall be made available for the Division's inspection. The plan shall include, but not be limited to: i. A list of combustion optimization practices and a means of verifying the practices have occurred. ii. A list of combustion and operation practices to be used to lower energy consumption and a means of verifying the practices have occurred. iii. A list of the design choices determined to be BACT and verification that designs were implemented in the final construction.	PM2.5 – 0.149 G/Hp-Hr & 0.298 G/Hp-Hr
LA-0331	09/21/2018	6/19/2019	17.110	Large Emergency Engines	Diesel	Good Combustion and Operating Practices.	NOx – 5.6 G/kW-Hr CO – 3.5 G/kW-Hr TPM/PM10 – 0.2 G/kW-Hr PM2.5 – 0.2 G/kW-Hr SO2 – 0.0 Lb/Hp-Hr VOC – 0.79 G/kW-Hr CO2e – 1481 TPY
LA-0364	01/06/2020	08/09/2021	17.110	Emergency Generator	Diesel	Compliance with the limitations imposed by 40 CFR 63 Subpart IIII and operating the engine in accordance with the engine manufacturer's instructions and/or written procedures designed to maximize	None Listed

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
						combustion efficiency and minimize fuel usage.	
MA-0043	06/21/2021	08/09/2021	17.110	Cold Start Engine	ULSD	None Listed	NOx – 35.09 Lb/Hr & 5.3 Tons/C12MP CO – 2.2 Lb/Hr & 0.33 Tons/C12MP CO2e – 163.61 Lb/MMBtu & 3115 Lb/Hr SO2 – 0.029 Lb/Hr & 0.004 Tons/C12MP SA – 0.022 Lb/Hr & 0.003 Tons/C12MP TPM10 – 0.4 Lb/Hr & 0.06 Tons/C12MP TPM2.5 – 0.4 Lb/Hr & 0.06 Tons/C12MP VOC – 0.85 Lb/Hr & 0.13 Tons/C12MP
MD-0042	04/08/2014	08/12/2020	17.110	Emergency Engine	ULSD	Exclusive use of ULSD Good combustion practices Limited hours of operation Designed to achieve emission limits	NOx – 4.8 G/Hp-Hr SO2 – 0.006 G/Hp-Hr CO – 2.6 G/Hp-Hr FPM – 0.15 G/Hp-Hr PM10 – 0.15 G/Hp-Hr PM2.5 – 0.15 G/Hp-Hr
MI-0441	12/21/2018	08/09/2021	17.110	Emergency Engines	Diesel	Good combustion practices NSPS compliant	NOx – 6.4 G/Hp-Hr CO – 3.5 G/Hp-Hr CO2e – 406 TPY PM10 – 0.69 G/Hp-Hr PM2.5 – 0.69 G/Hp-Hr
MI-0441	12/21/2018	08/09/2021	17.110	Emergency Engines	Diesel	Good combustion practices NSPS compliant	NOx – 6.4 G/Hp-Hr CO – 3.5 G/Hp-Hr CO2e – 1590 TPY PM10 – 2.7 G/Hp-Hr PM2.5 – 2.7 G/Hp-Hr

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
OH-0363	11/05/2019	04/01/2019	17.110	Emergency Engines	Diesel	ULSD Purchased certified to the standards in NSPS Subpart IIII	NOx – 13.74 Lb/Hr & 3.44 TPY CO – 8.57 Lb/Hr & 2.14 TPY CO2e – 433.96 TPY & None Listed TPM10 – 0.49 Lb/Hr & 0.12 TPY TPM2.5 – 0.49 Lb/Hr & 0.12 TPY VOC – 1.93 Lb/Hr & 0.12 TPY
OH-0363	11/05/2019	04/01/2019	17.110	Emergency Engines	Diesel	Emergency operation only < 500 hours/year each for maintenance checks and readiness testing Designed to meet NSPS Subpart IIII	NOx – 29.01 Lb/Hr & 7.25 TPY CO – 8.49 Lb/Hr & 2.12 TPY CO2e – 474 TPY TPM – 0.77 Lb/Hr & 0.19 TPY TPM10 – 0.77 Lb/Hr & 0.19 TPY TPM2.5 – 0.77 Lb/Hr & 0.19 TPY
OH-0363	08/25/2015	06/19/2019	17.110	Emergency Engines	Diesel	State-of-the-art combustion design	NOx – 21.6 Lb/Hr & 5.41 TPY CO – 13.5 Lb/Hr & 3.37 TPY CO2e – 683 TPY VOC – 3.1 Lb/Hr & 0.76 TPY TPM10 – 0.77 Lb/Hr & 0.19 TPY TPM2.5 – 0.77 Lb/Hr & 0.19 TPY
OH-0637	09/23/2016	06/19/2019	17.110	Emergency Generator	Diesel	State-of-the-art combustion design	NOx – 27.18 Lb/Hr & 6.8 TPY CO – 16.96 Lb/Hr & 4.24 TPY CO2e – 858 TPY VOC – 3.84 Lb/Hr & 0.96 TPY SO2 – 0.03 Lb/Hr & 0.01 TPY TPM10 – 0.97 Lb/Hr & 0.24 TPY TPM2.5 – 0.97 Lb/Hr & 0.24 TPY
OH-0368	04/19/2017	06/19/2019	17.110	Emergency Generator	Diesel	Good combustion control and operating practices and engines designed to meet the stands of 40 CFR Part 60, Subpart IIII	NOx – 5.5 Lb/Hr & 0.3 TPY CO – 28.8 Lb/Hr & 1.4 TPY CO2e – 1289 TPY VOC – 1.6 Lb/Hr & 0.08 TPY TPM10 – 0.2 Lb/Hr & 0.01 TPY TPM2.5 – 0.2 Lb/Hr & 0.01 TPY

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
OH-0370	09/07/2017	06/19/2019	17.110	Emergency Generator	Diesel	State-of-the-art combustion design	NOx – 16.07 Lb/Hr & 4.02 TPY CO – 8.8 Lb/Hr & 2.2 TPY CO2e – 445 TPY VOC – 2 Lb/Hr & 0.5 TPY SO2 – 0.016 Lb/Hr & 4 x10-3 TPY TPM10 – 0.5 Lb/Hr & 0.13 TPY TPM2.5 – 0.5 Lb/Hr & 0.13 TPY
OH-0372	09/27/2017	06/19/2019	17.110	Emergency Generator	Diesel	ULSD State-of-the-art combustion design Good operating practices (proper maintenance and operation)	NOx – 16.1 Lb/Hr & 4.02 TPY CO – 8.8 Lb/Hr & 2.2 TPY CO2e – 445 TPY VOC – 2 Lb/Hr & 0.5 TPY SO2 – 0.016 Lb/Hr & 4 x10-3 TPY TPM10 – 0.5 Lb/Hr & 0.13 TPY TPM2.5 – 0.5 Lb/Hr & 0.13 TPY
OH-0374	10/12/2017	06/19/2019	17.110	Emergency Generator	Diesel	Certified to the meet the emissions standards in 40 CFR 89.112 and 89.113 pursuant to 40 CFR 60.4205(b) and 60.4202(a)(2). Good combustion practices per the manufacturer's operating manual.	NOx – 23.21 Lb/Hr & 1.16 TPY CO – 12.69 Lb/Hr & 0.63 TPY CO2e – 120 TPY VOC – 23.21 Lb/Hr & 1.16 TPY SO2 – 0.0015 Lb/MMBtu & 0.022 Lb/Hr TPM - 0.73 Lb/Hr & 0.037 TPY TPM10 – 0.73 Lb/Hr & 0.037 TPY TPM2.5 – 0.73 Lb/Hr & 0.037 TPY
OH-0375	11/07/2017	06/19/2019	17.110	Emergency Generator	Diesel	ULSD Good combustion design	NOx – 24.71 Lb/Hr & 1.24 TPY CO – 12.64 Lb/Hr & 0.63 TPY CO2e – 116.8 TPY & None Listed VOC – 24.71 Lb/Hr & 1.24 TPY SO2 – 0.016 Lb/Hr & 4 x10-3 TPY TPM - 0.73 Lb/Hr & 0.037 TPY TPM10 – 0.73 Lb/Hr & 0.037 TPY TPM2.5 – 0.73 Lb/Hr & 0.037 TPY

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
OH-0376	02/09/2018	06/19/2019	17.110	Emergency Generator	Diesel	Comply with NSPS 40 CFR 60 Subpart IIII	NOx – 28.2 Lb/Hr & 7.05 TPY CO – 15.4 Lb/Hr & 3.86 TPY CO2e – 163.6 Lb/MMBtu & 683 TPY TPM10 – 1.01 Lb/Hr & 0.25 TPY TPM2.5 – 1.01 Lb/Hr & 0.25 TPY
OH-0377	04/19/2018	06/19/2019	17.110	Emergency Generator	Diesel	Good combustion practices (ULSD) Compliance with 40 CFR Part 60, Subpart IIII	NOx – 19.68 Lb/Hr & 0.98 TPY CO2e – 109.2 TPY VOC – 19.68 Lb/Hr & 0.98 TPY SO2 – 0.0015 Lb/Hr & 0.0023 Lb/Hr TPM - 0.62 Lb/Hr & 0.031 TPY TPM10 – 0.62 Lb/Hr & 0.031 TPY TPM2.5 – 0.62 Lb/Hr & 0.031 TPY
OH-0378	12/21/2018	06/19/2019	17.110	Emergency Generator	Diesel	Certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII Shall employ good combustion practices per the manufacturer's operating manual	NOx – 37.41 Lb/Hr & 1.87 TPY CO – 19.25 Lb/Hr & 0.96 TPY CO2e – 200 TPY VOC – 37.41 Lb/Hr & 1.87 TPY TPM - 1.1 Lb/Hr & 0.055 TPY TPM10 – 1.1 Lb/Hr & 0.055 TPY TPM2.5 – 1.1 Lb/Hr & 0.055 TPY
OH-0378	12/21/2018	06/19/2019	17.110	Emergency Generator	Diesel	Certified to the meet the emissions standards in Table 4 of 40 CFR Part 60, Subpart IIII Shall employ good combustion practices per the manufacturer's operating manual	NOx – 14.96 Lb/Hr & 0.75 TPY CO – 7.7 Lb/Hr & 0.39 TPY CO2e – 80 TPY VOC – 14.96 Lb/Hr & 0.75 TPY TPM - 0.44 Lb/Hr & 0.022 TPY TPM10 – 0.44 Lb/Hr & 0.022 TPY TPM2.5 – 0.44 Lb/Hr & 0.022 TPY
PA-0291	04/23/2013	03/02/2020	17.110	Emergency Generator	Diesel	ULSD	NOx – 9.89 Lb/Hr & 0.49 TPY CO – 5.79 Lb/Hr & 0.29 TPY CO2e – 80.5 TPY SOx – 0.01 Lb/Hr & 0.0007 TPY

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
							VOC – 0.7 Lb/Hr & 0.03 12-Month Rolling TOT HS – 0.0028 Lb/Hr 7 0.0001 TPY TPM – 0.02 TPY & None Listed
SC-0193	04/15/2016	09/10/2021	17.110	Emergency Generators and Fire Pump	#2 Fuel Oil	Meet emission standards of 40 CFR 60, Subpart IIII	VOC – 100 Hrs/Yr TPM - 100 Hrs/Yr TPM10 – 1100 Hrs/Yr TPM2.5 – 100 Hrs/Yr
TX-0671	12/01/2014	03/06/2019	17.110	Engines	Diesel	ULSD Each emergency generator's emission factor is based on EPA's Tier 2 standards at 40CFR89.112 for NOx	NOx – 5.43 G/kW-Hr & 2.39 TPY SO2 – 0.0649 G/kW-Hr & 0.01 TPY
TX-0728	04/01/2015	01/21/2020	17.110	Emergency Generator	Diesel	Minimized hours of operations Tier II engine	NOx – 0.0218 G/Hp-Hr & 0.35 TPY CO – 0.0126 G/Hp-Hr & 0.2 TPY SO2 – 0.61 Lb/Hr 7 0.02 TPY VOC – 0.7 Lb/Hr & 0.02 TPY TPM - 0.15 Lb/Hr & 0.01 TPY TPM10 – 0.15 Lb/Hr & 0.01 TPY TPM2.5 – 0.15 Lb/Hr & 0.01 TPY
TX-0872	10/31/2019	11/12/2020	17.110	Emergency Generator	Diesel	ULSD Limiting duration and frequency of generator use to 100 hr/yr Good combustion practices will be used to reduce VOC including maintaining proper air-to-fuel ratio.	VOC – 0.12 G/kW-Hr CO – 0.6 G/kW-Hr
TX-0876	02/06/2020	11/12020	17.110	Emergency Generator	Diesel	Tier 4 exhaust emission standards specified in 40 CFR § 1039.101 Limited to 100 hours per year of non-emergency operation	SO2 – 15 PPMW
TX-0904	09/09/2020	12/01/2021	17.110	Emergency Generator	Diesel	ULSD 100 hours of operation	None Listed

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
						Tier 4 exhaust emission standards specified in 40 CFR § 1039.101	
TX-0905	09/16/2020	09/10/2021	17.110	Emergency Generator	Diesel	ULSD Limited to 100 hours per year of non-emergency operation	None Listed
TX-0911	12/15/2020	05/10/2021	17.110	Emergency Generator	Diesel	ULSD	None Listed
VA-0321	03/12/2013	06/19/2019	17.110	Emergency Generator	Diesel	ULSD Good combustion practices	CO - 3.5 G/kW & 4.3 TPY
VA-0325	06/17/2016	06/19/2019	17.110	Emergency Generator	Diesel	Good Combustion Practices/Maintenance	CO2e - 163.6 Lb/MMBtu & 1178 TPY CO2 – 3.5 G/kW & 5.8 TPY NOx - 6.4 G/kW & 10.6 TPY TPM10 – 0.4 G/kW & 1 TPY TPM2.5 – 0.4 G/KR & 0.7 TPY SO2 – 0.0015 Lb/MMBtu SA – 0.0001 Lb/MMBtu VOC – 6.4 G/kW
VA-0328	04/26/2018	06/19/2019	17.110	Emergency Generator	Diesel	ULSD Good combustion practices	CO2e – 981 TPY CO2 – 2.6 G/Hp-Hr & 5.2 TPY NOx - 4.8 G/Hp-hr & 9.6 TPY TPM10 – 0.15 G/Hp-Hr TPM2.5 – 0.15 G/Hp-Hr
VA-0332	06/24/2018	05/19/2021	17.110	Emergency Generator	Diesel	ULSD Good combustion practices High efficiency design	CO2e – 12.3 TPY CO2 – 2.6 G/Hp-Hr & 6.4 TPY NOx – 4.8 G/Hp-Hr & 11.7 TPY FPM – 0.15 G/Hp-Hr TPM10 – 0.15 G/Hp-Hr TPM2.5 – 0.15 G/Hp-Hr SO2 – 0.0015 Lb/MMBtu

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
AR-0084	06/30/2017	04/16/2020	17.110	Black Start and Emergency Internal Combustion Engines	Diesel	Clean Fuel Good Combustion Practices	NOx – 8 G/kW-Hr CO – 4.38 G/kW-Hr TPM – 0.25 G/kW-Hr TPM10 – 0.25 G/kW-Hr TPM2.5 – 0.25 G/kW-Hr CO2e – 2781 TPY
AR-0084	06/30/2017	04/16/2020	17.110	Twelve (12) Large ULSD/ Natural Gas-Fired Internal Combustion Engines	Diesel and Natural Gas	Oxidation Catalyst Good Combustion Practices Clean Fuel	VOC – 0.21 G/kW-Hr & 0.09 G/kW-Hr TPM – 0.29 G/kW-Hr & 0.13 G/kW-Hr FPM – 0.15 G/kW-Hr TPM10 – 0.29 G/kW-Hr & 0.13 G/kW-Hr FPM10 – 0.15 G/kW-Hr TPM2.5 – 0.29 G/kW-Hr & 0.13 G/kW-Hr FPM2.5 – 0.15 G/kW-Hr & NOx – 0.53 G/kW-Hr & 0.08 G/kW-Hr CO – 0.18 G/kW-Hr & 0.12 G/kW-Hr CO2e – 1299630 TPY (ULSD) & 869621 TPY
AK-0085	08/13/2020	03/31/2021	17.110	One (1) Black Start Generator Engine	ULSD	Good combustion practices Limit operation to 500 hours per year	NOx – 3.3 G/kW-Hr CO – 3.3 G/kW-Hr TPM – 0.045 G/kW-Hr TPM10 – 0.045 G/kW-Hr TPM2.5 – 0.045 G/kW-Hr SO2 – 15 G/kW-Hr VOC – 0.18 G/kW-Hr CO2e – 163.6 Lb/MMBtu

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
FL-0363	12/04//2017	11/22/2021	17.110	Two 3300 kW emergency generators	ULSD	Certified engine Clean Fuel	CO – 3.5 G/kW-Hr FPM – 0.2 G/kW-Hr SO2 – 15 PPM Sulfur fuel
FL-0367	07/27/2018	11/22/2021	17.110	1,500 kW Emergency Diesel Generator	ULSD	Operate and maintain the engine according to the manufacturer's written instructions	NOx – 6.4 G/kW-Hr CO – 3.5 G/kW-Hr FPM – 0.2 G/kW-Hr SO2 – 15 PPM Sulfur fuel
FL-0371	06/07/2021	11/22/2021	17.110	1,500 kW Emergency Diesel Generator	ULSD	None Listed	CO – 3.5 G/kW-Hr TPM – 0.2 G/kW-Hr NOx 6.4 - G/kW-Hr SO2 – 15 PPM Sulfur fuel
IL-0130	12/31/2018	04/16/2020	17.110	Emergency Engine	ULSD	None Listed	NOx – 6.4 G/kW-Hr CO – 3.5 G/kW-Hr TPM – 0.2 G/kW-Hr CO2e – 225 TPY
KY-0110	07/23/2020	01/25/2021	17.110	EP 10-02 - North Water System Emergency Generator	Diesel	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	FPM – 0.15 G/kW-Hr TPM10 – 0.15 G/kW-Hr TPM2.5 – 0.15 G/kW-Hr CO – 2.61 G/kW-Hr NOx – 4.77 G/kW-Hr
KY-0110	07/23/2020	01/25/2021	17.110	EP 10-03 - South Water System Emergency Generator	Diesel	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	FPM – 0.15 G/kW-Hr TPM10 – 0.15 G/kW-Hr TPM2.5 – 0.15 G/kW-Hr CO – 2.61 G/kW-Hr NOx – 4.77 G/kW-Hr
KY-0110	07/23/2020	01/25/2021	17.110	EP 10-04 - Emergency Fire Water Pump	Diesel	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	FPM – 0.15 G/kW-Hr TPM10 – 0.15 G/kW-Hr TPM2.5 – 0.15 G/kW-Hr CO – 2.61 G/kW-Hr

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
							NOx – 4.77 G/kW-Hr
KY-0110	07/23/2020	01/25/2021	17.110	EP 11-01 - Melt Shop Emergency Generator	Diesel	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	FPM – 0.15 G/kW-Hr TPM10 – 0.15 G/kW-Hr TPM2.5 – 0.15 G/kW-Hr CO – 2.61 G/kW-Hr NOx – 4.77 G/kW-Hr
KY-0110	07/23/2020	01/25/2021	17.110	EP 11-02 - Reheat Furnace Emergency Generator	Diesel	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	FPM – 0.15 G/kW-Hr TPM10 – 0.15 G/kW-Hr TPM2.5 – 0.15 G/kW-Hr CO – 2.61 G/kW-Hr NOx – 4.77 G/kW-Hr
KY-0110	07/23/2020	01/25/2021	17.110	EP 10-07 - Air Separation Plant Emergency Generator	Diesel	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	FPM – 0.15 G/kW-Hr TPM10 – 0.15 G/kW-Hr TPM2.5 – 0.15 G/kW-Hr CO – 2.61 G/kW-Hr NOx – 4.77 G/kW-Hr
KY-0110	07/23/2020	01/25/2021	17.110	EP 10-01 - Caster Emergency Generator	Diesel	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	FPM – 0.15 G/kW-Hr TPM10 – 0.15 G/kW-Hr TPM2.5 – 0.15 G/kW-Hr CO – 2.61 G/kW-Hr NOx – 4.77 G/kW-Hr
KY-0115	04/19/2021	05/26/2021	17.110	New Pumphouse (XB13) Emergency Generator #1 (EP 08-05)	Diesel	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan.	FPM – 0.15 G/kW-Hr TPM10 – 0.15 G/kW-Hr TPM2.5 – 0.15 G/kW-Hr
KY-0115	04/19/2021	05/26/2021	17.110	Tunnel Furnace	Diesel	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan.	FPM – 0.15 G/kW-Hr TPM10 – 0.15 G/kW-Hr

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
				Emergency Generator (EP 08-06)			TPM2.5 – 0.15 G/kW-Hr
KY-0115	04/19/2021	05/26/2021	17.110	Caster B Emergency Generator (EP 08-07)	Diesel	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan.	FPM – 0.15 G/kW-Hr TPM10 – 0.15 G/kW-Hr TPM2.5 – 0.15 G/kW-Hr
KY-0115	04/19/2021	05/26/2021	17.110	Cold Mill Complex Emergency Generator (EP 09-05)	Diesel	The permittee must develop a Good Combustion and Operating Practices (GCOP) Plan.	FPM – 0.15 G/kW-Hr TPM10 – 0.15 G/kW-Hr TPM2.5 – 0.15 G/kW-Hr

Table 6-5. RBLC Database Updated Review for Small (<500 HP) Engines.

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
MI-0447	01/07/2021	9/10/2021	17.210	Emergency Engine	Diesel	ULSD Good combustion practices NSPS Compliant Catalytic oxidation was the control considered technically feasible. However, it was not considered economically feasible.	CO – 2.6 G/kW-Hr PM10 – 0.12 lb/hr PM2.5 – 0.12 lb/hr CO2e – 20 TPY
MD-0042	04/08/2014	08/12/2020	17.210	Emergency Engine – Fire Water Pump	ULSD	Exclusive use of ULSD Good combustion practices Limited hours of operation Designed to achieve emission limits	NOx – 3 G/Hp-Hr SO2 – 0.0049 G/Hp-Hr CO – 2.6 G/Hp-Hr FPM – 0.15 G/Hp-Hr PM10 – 0.15 G/Hp-Hr

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
							PM2.5 – 0.15 G/Hp-Hr
MI-0441	12/21/2018	08/09/2021	17.210	Emergency Engines	Diesel	Good combustion practices and energy efficiency measures	CO – 2.6 G/Hp-Hr CO2e – 20 TPY PM10 – 0.12 G/Hp-Hr PM2.5 – 0.12 G/Hp-Hr
OH-0376	02/09/2018	06/19/2019	17.210	Emergency Generator	Diesel	Comply with NSPS 40 CFR 60 Subpart IIII	NOx – 1.6 Lb/Hr & 0.41 TPY CO – 1.4 Lb/Hr & 0.36 TPY CO2e – 163.6 Lb/MMBtu & 79 TPY TPM10 – 0.1 Lb/Hr & 0.02 TPY TPM2.5 – 0.1 Lb/Hr & 0.02 TPY
OH-0379	02/06/2019	06/19/2019	17.210	Black Start Generator	Diesel	Tier IV NSPS standards certified by engine manufacturer	NOx – 0.104 Lb/Hr & 5.2 x10-3 TPY CO2e – 181.7 TPY & 9.09 TPY TPM10 – 5.2 x10-3 Lb/Hr & 2.61 x10-4 TPY TPM2.5 – 5.2 x10-3 Lb/Hr & 2.61 x10-4 TPY
OH-0379	02/06/2019	06/19/2019	17.210	Emergency Generator	Diesel	Tier IV engine Good combustion practices	NOx – 3.45 Lb/Hr & 0.17 TPY CO2e – 3632 TPY & 181.6 TPY TPM10 – 0.15 Lb/Hr & 0.01 TPY TPM2.5 – 0.15 Lb/Hr & 0.01 TPY

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
AR-0168	03/17/2021	05/26/2021	17.210	Emergency Engines	Diesel	Good Operating Practices Limited hours of operation Compliance with NSPS Subpart IIII	TPM – 0.2 G/kW-Hr TPM10 – 0.2 G/kW-Hr TPM2.5 – 0.2 G/kW-Hr VE – 20% VOC – 1.55 G/kW-Hr SO2 – 0.0015 % Sulfur Fuel CO – 3.5 G/kW-Hr NOx – 4.86 G/kW-Hr CO2 – 163 Lb/MMBtu CH4 – 0.0061 Lb/MMBtu N2O – 0.0013 Lb/MMBtu
AR-0171	02/14/2019	09/10/2021	17.210	SN-106 Cold Mill 1 Diesel Fired Emergency Generator	Diesel	Good operating practices	TPM – 0.25 G/kW-Hr TPM10 – 0.2 G/kW-Hr TPM2.5 – 02 G/kW-Hr VE – 20% NOx – 2 G/kW-Hr CO – 4 G/kW-Hr CO2e – 163 Lb/MMBtu SO2 – 0.0006 Lb/MMBtu
KY-0110	07/23/2020	01/25/2021	17.210	EP 11-03 - Rolling Mill Emergency Generator	Diesel	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	FPM – 0.15 G/kW-Hr TPM10 – 0.15 G/kW-Hr TPM2.5 – 0.15 G/kW-Hr CO – 2.61 G/kW-Hr NOx – 2.98 G/kW-Hr
KY-0110	07/23/2020	01/25/2021	17.210	EP 11-04 - IT Emergency Generator	Diesel	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	FPM – 0.15 G/kW-Hr TPM10 – 0.15 G/kW-Hr TPM2.5 – 0.15 G/kW-Hr CO – 2.61 G/kW-Hr NOx – 2.98 G/kW-Hr

Determination Number	Permit Date	Date Determination Last Updated	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information
KY-0110	07/23/2020	01/25/2021	17.210	EP 11-05 - Radio Tower Emergency Generator	Diesel	This EP is required to have a Good Combustion and Operating Practices (GCOP) Plan.	FPM – 0.3 G/kW-Hr TPM10 – 0.3 G/kW-Hr TPM2.5 – 0.3 G/kW-Hr CO – 3.73 G/kW-Hr NOx – 3.5 G/kW-Hr
LA-0345	06/13/2018	08/092021	17.210	IC engines (14 units)	Diesel	Comply with requirements of 40 CFR 60 Subpart IIII	None Listed
LA-0349	07/10/2018	08/06/2021	17.210	IC Engines (18)	Diesel	Comply with 40 CFR 60 Subpart IIII Good Combustion Practices	None Listed
LA-0379	05/04/2021	12/07/2021	17.210	PVC Emergency Combustion Equipment A	Diesel	Good combustion practices/gaseous fuel burning	TPM – 0.4 G/Hp-Hr TPM10 – 0.4 G/Hp-Hr NOx – 6.9 G/Hp-Hr CO – 8.5 G/Hp-Hr
LA-0379	05/04/2021	12/07/2021	17.210	PVC Emergency Combustion Equipment 2A and 2B	Diesel	Compliance with 40 CFR 60 Subpart IIII.	TPM – 0.4 G/Hp-Hr TPM10 – 0.4 G/Hp-Hr NOx – 0.4 G/kW-Hr CO – 2.6 G/Hp-Hr VOC – 0.19 G/kW-Hr
LA-0381	12/16/2021	12/16/2021	17.210	Emergency Engines 2-19 and 3-19 (EQT0904 and EQT0905)	Diesel	Comply with standards of 40 CFR 60 Subpart IIII	Not Listed

Based on review of the determinations in **Table 6-4** and **Appendix G**, the NO_x control method requirement for large engines (> 500 hp) are as follows in the order of most to least common:

- Use of certified engine/compliance with NSPS or RICE MACT
- Good combustion practices
- Limited hours of operation
- Use of ULSD
- SCR

Over half of the entries listed use of an EPA-certified engine/compliance with NSPS or RICE MACT. Over a third of the entries listed good combustion practices and about a quarter listed limitation on hours of operation or use of ULSD. The RBLC review contained in **Appendix G** contains only three entries which list use of SCR, and all were for engines operated in non-marine environments. The RBLC review in **Table 6-4** contains two entries which list use of an oxidation catalyst and another entry which lists it as technically feasible but not economically feasible for BACT.

The South Fork permit application also found only 18 relevant determinations for small engines (<500 hp); half of the entries did not list a control technology. The updated review in **Table 6-5** found an additional 16 entries, all of which listed a control method. Over half listed use of an EPA-certified engine/compliance with NSPS or RICE MACT and 16 listed good combustion practices. Fourteen listed the use of ULSD and 12 listed limitations on hours of operation.

The South Fork application also included the results of a search in the CARB and SCAQMB databases for large and small diesel-fired engines. The result tables are included in **Appendix H**. The CARB and SCAQMD databases were reviewed to determine whether additional entries newer than the most recent entry listed in the tables has been added. The review was conducted on January 28, 2022. No additional results were found.

As described in the South Fork permit application, there were eight determinations in the CARB and SCAQMD databases in the last 10 years. All the determinations listed use of an EPA-certified engine. Four entries had hourly or fuel limitations. Four entries deemed SCR not technically feasible because of low exhaust temperature; one entry listed use of SCR.

A search of the TCEQ Current BACT Spreadsheet[32] revealed one entry dated October 1, 2018, for a diesel-fired emergency engine. The NO_x and VOC limits are to meet the requirements of 40 CFR Part 60, Subpart IIII and to fire ULSD.

The EPA Verified Technologies List was reviewed.[33] Four technologies verified to reduce NO_x were identified; two for Caterpillar engines with model years from 1970 to 1995, one SCR system for nonroad, 4-cycle engines rated at 100 to 750 hp certified to EPA Tiers 1, 2, or 3 and one urea-based SCR system for nonroad, 4-cycle, non-EGR diesel engines between 75 to 370 kW power ranges originally manufactured from 1996 through 2008 and originally certified without a catalyst to EPA Tier 1, 2, or 3 standards. All four of these technologies are also verified to reduce HC emissions. Based on this review Ocean Wind found that each technology listed, or an equivalent method, is implemented by manufacturers when certifying engines to Tier 4 standards. Therefore, this source of information for possible control technologies will not be considered further for any pollutant for which LAER or BACT is determined.

An additional three technologies that were verified to reduce VOC but not verified to reduce NO_x were identified. A diesel particulate filter for nonroad, 4-cycle, non-EGR equipped, model year 1996-2005, turbocharged engines with power rates from 174.2 through 301.5 hp, a semi-active electric filter for non-road, model year 1996-2010, wither power rating between 100 and 400 hp and PM certification levels less than 0.25 g/bhp-hr, and a diesel particulate filter for nonroad, Tier 1, 2, or 3 diesel engines certified with a maximum PM level of 0.20 g/bhp-hr with power rating from 100 to 603 hp.

A search of the CARB Verified Technologies List[47] was conducted for diesel nonroad and stationary engines. One Level 3 technology was identified as verified NO_x control, a diesel particulate filter with SCR for stationary prime generators with a PM emission rate of 0.2 g/bhp-hr or less.

Numerous emission control techniques applicable to diesel engines are described in Section 6.1 of this permit application.

6.2.3.2.1 Recent LAER Determinations

Vineyard Wind Offshore Renewable Energy Project

In the Vineyard Wind OCS air permit issued by EPA Region 1 (Permit No. OCS-R1-03), LAER was determined to be:

Diesel-Fired Generating Sets on WTGs – certified by the manufacturer to meet or emit less than the emission standards 40 CFR § 1042.101(a) for new and in-use marine compression-ignition engines with an engine power of approximately 40 kW or less for each engine. The combined emission limit for NO_x + non-methane hydrocarbon (NMHC), and the emission limits for CO and PM, will depend on the Engine's maximum engine power (in kW), the Engine's displacement per cylinder (l/cyl), and the Engine's design displacement (kW/l).

Diesel-Fired Generating Sets on OSSs – certified by the manufacturer to meet or emit less than the emission standards set forth at 40 CFR § 1042.101(a) for new and in-use marine compression-ignition engines: Tier 3 engines for the two approximately 400 kW Engines and Tier 4 engine for the approximately 800 kW engine. For the approximately 400 kW Engines meeting or emitting less than emissions standards for Tier 3 engines, the combined emission limit for NO_x + NMHC, and the emission limits for CO and PM, will depend on the Engine's maximum engine power (in kW), the Engine's displacement per cylinder (l/cyl), and the Engine's design displacement (kW/l). For the approximately 800 kW Engine the emission limits are:

i. NO_x = 1.8 grams/kilowatt-hour (g/kW-hr);
ii. HC = 0.19 g/kW-hr;
iii. CO = 5.0 g/kW-hr;
iv. PM = 0.04 g/kW-hr.

South Fork Offshore Renewable Energy Project

In the South Fork OCS air permit issued by EPA Region 1 (Permit No. OCS-R1-04), LAER was determined to be:

Diesel-Fired Generating Sets on WTGs and OSS – install and operate only engines that are certified by the manufacturer to meet or emit less than the Tier 4 emission standards set forth at 40 CFR § 1039.101(b) for new compression-ignition engines. The emission limits for NO_x, NMHC, CO and PM will depend on the engine's maximum power. For engines proposed for installation on the WTGs and OSS, the emission limits for engines rate 130 ≤ kW ≤ 560 are:

i. NO_x = 0.40 grams/kilowatt-hour (g/kW-hr)
ii. NMHC = 0.19 g/kW-hr
iii. CO = 3.5 g/kW-hr
iv. PM = 0.02 g/kW-hr

[47] California Air Resources Board (CARB). n.d. *Verification Procedure: Currently Verified.* Retrieved from https://ww2.arb.ca.gov/diesel/verdev/vt/cvt.htm.

6.2.3.3 Applicable NSPS or NESHAP Limits

Stationary internal combustion units are subject to 40 CFR Part 60, Subparts IIII and JJJJ as well as 40 CFR Part 63 Subpart ZZZZ. NSPS and NESHAP applicability is presented in Section 4.1.3 and 4.1.4, respectively. NSPS Subpart IIII contains emission limits applicable to CI ICE associated with the Project when the emission units are considered OCS sources. It is not anticipated that the Project will utilize spark ignition engines; therefore, NSPS Subpart JJJJ does not apply to emission units associated with the Project. The applicable emission limit depends on the engine use, model year, size, and displacement per cylinder. NESHAP Subpart ZZZZ applies to RICE associated with the Project when the emission units are considered OCS sources. Per 40 CFR § 63.6590(c)(1), project RICE located at an area source meet the requirements of NESHAP Subpart ZZZZ by meeting the requirements of NSPS Subpart IIII for CI engines. All internal combustion engines utilized by the Project that were constructed or reconstructed before June 12, 2006, and that are considered OCS sources are subject to 40 CFR § 63.6603. NESHAP Subpart ZZZZ contains emissions limits and operating requirements that apply to these engines, including the fuel requirements in 40 CFR § 63.6604.

6.2.3.4 Evaluation of Potential LAER Techniques

LAER determinations may consist of one or more of the following techniques: 1) a change in the raw material processed, 2) a process modification, and 3) add-on controls. Each technique is discussed in this section.

6.2.3.4.1 Change in Raw Materials

The emission units associated with the Project generate emissions when combusting fuel. Therefore, a change in raw materials would be a change in the type of fuel combusted. Fuel combusted by diesel-fired generating sets must be readily available, capable of being stored locally and suitable for current marine engine technology. These constraints limit the potential change in type of fuel combusted by Project vessels to USLD and LPG.

The use of LPG is a safety hazard that makes the use of this fuel technically infeasible. LPG generates flammable and explosive vapors which is a hazard around high-voltage electrical equipment. Additionally, there is a potential for a serious accident if a full tank is dropped while the tank is being lifted.

6.2.3.4.2 Process Modifications

The process that generates emissions is marine engines combusting fuels. A process modification refers to a change in the method engines utilize to accomplish its intended task of providing power or electricity. Process modifications include retrofitting engines to reduce NO_x emissions during combustion. Several sources were reviewed to identify technologies that have demonstrated capabilities of reduce NO_x and/or VOC emissions from marine internal combustion engines. The sources reviewed are described in Section 6.2.1.2.

There are several process modification technologies that can be employed by marine engine manufacturers during initial construction or major reconstruction to reduce NO_x and/or VOC emissions. These technologies were reviewed in detail in Section 6.1.1.

6.2.3.4.3 Add-On Controls

Add-on controls remove emissions after they have been generated by a process. In this case, add-on controls would remove emissions from the internal combustion engine exhaust stream.

The verified technologies identified in a review of the EPA Verified Technologies List and the CARB Verified Technologies list are not considered further because the technology proposed, or an equivalent method, is implemented by manufacturers when certifying engines to Tier 4 standards.

Ocean Wind identified several potential add-on control technologies to reduce NO_x and VOC emissions that could be implemented by marine engine manufacturers during initial construction or major reconstruction. These technologies are described in Section 6.1.3 and include:

<u>NO_x</u>

- SCR
- Selective Non-catalytic Reduction (SNCR)
- LNC
- NO_x Scrubber
- NO_x Adsorber/LNT
- 4-way Catalytic Converter

<u>VOC</u>

- Catalytic Diesel Particulate Filter
- Flow-Through Filter
- Diesel Oxidation Catalyst
- 4-way Catalytic Converter

Many of these technologies impact the design of the generator engine. As EPA states in the Fact Sheet for the OCS Air Permit (Permit No. OCS-R1-03) issued to Vineyard Wind,

> *The EPA has recognized this fact in the new source performance standards (NSPS) for stationary compression ignition internal combustion engines (CI engine) by requiring standards for manufacturers to meet. Therefore, 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 will usually have SCR system to reduce NO_x 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.*

Different engine manufacturers use varying pollution control techniques to meet the NSPS standards and other standards applicable to nonroad or marine engines. A comparison of emission standards for nonroad and marine engines is presented in **Table 6-5, Table 6-6, Table 6-7, Table 6-8, Table 6-9,** and **Table 6-10**. Note that NSPS Subpart IIII emission standards for 2007 model year and later non-emergency CI ICE with a maximum engine power less than 2,237 kW and a displacement less than 10 liters per cylinder references emission standards in 40 CFR § 1039.

Table 6-6. Tier Standards for 209 hp (150 kW) Diesel-Fired Electric Generator on the OSS.

Part	Tier	NO_x (g/kW-hr)	NMHC (g/kW-hr)	NMHC + NO_x (g/kW-hr)	CO (g/kW-hr)	PM (g/kW-hr)
Part 1039	Tier 3	NA	NA	4.0	3.5	0.20
	Tier 4	0.40	0.19	NA	3.5	0.02
Part 1042[a]	Tier 2	NA	NA	7.2	5.0	0.20
	Tier 3	NA	NA	5.6	5.0	0.10

[a] For comparison purposes, it is assumed that the engine has a design of ≤ 35 kW/L and a displacement of 1.2 ≤ disp. < 2.5. The design of the actual engine installed on the OSS may be different and could result in different applicable emission standards.

Table 6-7. Tier Standards for 102 hp (75 kW) Diesel-Fired Electric Generator on the OSS.

Part	Tier	NO_x (g/kW-hr)	NMHC (g/kW-hr)	NMHC + NO_x (g/kW-hr)	CO (g/kW-hr)	PM (g/kW-hr)
Part 1039	Tier 3	NA	NA	4.0	5.0	0.30
	Tier 4	0.40	0.19	NA	5.0	0.02
Part 1042[a]	Tier 2	NA	NA	7.5	5.0	0.40
	Tier 3	NA	NA	5.4	5.0	0.14

[a] For comparison purposes, it is assumed that the engine has a design of ≤ 35 kW/L and a displacement of < 0.9. The design of the actual engine installed on the OSS may be different and could result in different applicable emission standards.

Table 6-8. Tier Standards for 50 hp (40 kW) Diesel-Fired Electric Generator on the WTG.

Part	Tier	NO_x (g/kW-hr)	NMHC (g/kW-hr)	NMHC + NO_x (g/kW-hr)	CO (g/kW-hr)	PM (g/kW-hr)
Part 1039	Tier 3	NA	NA	4.7	5.0	0.40
	Tier 4	NA	NA	4.7	5.0[a]	0.03
Part 1042[b]	Tier 2	NA	NA	7.5	5.0	0.40
	Tier 3	NA	NA	4.7	5.0	0.30

[a] The CO standard is 5.5 g/kW-hr for engines below 37 kW.

[b] For comparison purposes, it is assumed that the engine has a design of ≤ 35 kW/L and a displacement of < 0.9. The design of the actual engine installed on the OSS may be different and could result in different applicable emission standards.

Table 6-9. Tier Standards for 800 hp (600 kW) Diesel-Fired Electric Generator on the OSS.

Part	Tier	NO_x (g/kW-hr)	NMHC (g/kW-hr)	NMHC + NO_x (g/kW-hr)	CO (g/kW-hr)	PM (g/kW-hr)
Part 1039	Tier 2	NA	NA	6.4	3.5	0.20
	Tier 4	0.67	0.19	NA	3.5	0.03
Part 1042[a]	Tier 2	NA	NA	7.2	5.0	0.20
	Tier 3	NA	NA	5.8	5.0	0.12
	Tier 4	1.8	0.19	NA	5.0	0.04

[a] For comparison purposes, it is assumed that the engine has a design of > 35 kW/L and a displacement of 1.2 ≤ disp. < 2.5. The design of the actual engine installed on the OSS may be different and could result in different applicable emission standards.

Table 6-10. Tier Standards for 5 hp (4 kW) Diesel-Fired Electric Generator on the Jack-up Vessel.

Part	Tier	NO_x (g/kW-hr)	NMHC (g/kW-hr)	NMHC + NO_x (g/kW-hr)	CO (g/kW-hr)	PM (g/kW-hr)
Part 1039	Tier 2	NA	NA	7.5	8.0	0.80
	Tier 4	NA	NA	7.5	8.0	0.40[b]
Part 1042[c]	Tier 2	NA	NA	NA	NA	NA
	Tier 3	NA	NA	7.5	5.0	0.40

[a] Part 94 does not apply to engines with a rated power below 37 kW.

[b] There is an optional PM standard for certain engines below 8 kW (see paragraph (c) of § 1039.101).

[c] For comparison purposes, it is assumed that the engine has a design of ≤ 35 kW/L and a displacement of < 0.9. The design of the actual engine installed on the OSS may be different and could result in different applicable emission standards.

Table 6-11. Tier Standards for 90 hp (70 kW) Diesel-Fired Cherry Picker on the Jack-up Vessel.

Part	Tier	NO_x (g/kW-hr)	NMHC (g/kW-hr)	NMHC + NO_x (g/kW-hr)	CO (g/kW-hr)	PM (g/kW-hr)
Part 1039	Tier 3	NA	NA	4.7	5.0	0.40
	Tier 4	0.40	0.19	NA	5.0	0.02
Part 1042[a]	Tier 2	NA	NA	7.5	5.0	0.40
	Tier 3	NA	NA	4.7	5.0	0.30

[a] For comparison purposes, it is assumed that the engine has a design of ≤ 35 kW/L and a displacement of < 0.9. The design of the actual engine installed on the OSS may be different and could result in different applicable emission standards.

6.2.3.5 LAER Determination

For all engine sizes, the lowest emitting engine is the one certified to the highest Tier standard (Tier 4) in 40 CFR Part 1039, as shown in the tables above. Additionally, the LAER determination in the OCS air permit issued to South Fork for engines on the WTGs and OSS was to install and operate only engines certified to meet or emit less than the Tier 4 standards in 40 CFR Part 1039.

However, for the auxiliary equipment onboard the jack-up vessel, and any other vessel that may include auxiliary equipment while operating as an OCS source, it is not technically feasible to require that this equipment be certified to meet Tier 4 standards. As discussed in Section 6.2.1, Ocean Wind does not know exactly which engines will be utilized during construction as the vessels used by the Project will be third-party vessels not owned by Ocean Wind. This extends to the auxiliary equipment onboard the vessels. Since Ocean Wind does not know exactly which vessels will be utilized during construction, Ocean Wind also does not know exactly which auxiliary equipment will be onboard such vessels.

Therefore, Ocean Wind proposes the following as LAER:

<u>Diesel-Fired Generating Sets on WTGs</u>

Ocean Wind proposes that LAER for the approximately 40 kW diesel generator sets that will be used on each WTG during commissioning is to select engines that have been certified by the manufacturer to meet the Tier 4 emission standards of 40 CFR Part 1039.

<u>Diesel-Fired Generating Sets on OSSs</u>

Ocean Wind proposes that LAER for the approximately 150 kW diesel generator sets that will be used on the OSS during commissioning is to select engines that have been certified by the manufacturer to meet the Tier 4 emission standards of 40 CFR Part 1039.

Ocean Wind proposes that LAER for the approximately 75 kW diesel generator sets that will be used on the OSS during commissioning is to select engines that have been certified by the manufacturer to meet the Tier 4 emission standards of 40 CFR Part 1039.

Ocean Wind proposes that LAER for the approximately 600 kW diesel generator sets that will be used on installed on the OSS during commissioning (and left on OSS during O&M to serve as emergency generators) is to select engines that have been certified by the manufacturer to meet the Tier 4 emission standards of 40 CFR Part 1042.

Diesel Fired Equipment Onboard Vessels Considered OCS Sources

Ocean Wind proposes that LAER for any diesel engine powered equipment, such as a diesel generator or cherry picker, used onboard a vessel that becomes an OCS source is to utilize engines that are certified by the manufacturer to meet the highest tier emission standards available at the time of deployment.

6.3 BACT Determination

As described in Section 4.1.1, the construction and commissioning phase of the Project is considered a major PSD source; the O&M phase is not a major PSD source. The PSD program requires that major PSD sources apply BACT for each pollutant that exceeds the SER thresholds. The Project must apply BACT to NO_x, CO, PM, PM_{10}, $PM_{2.5}$ and GHG emissions in the construction and commissioning phase. BACT is defined in 40 CFR § 52.21(b)(12) in part as *an emissions limitation… based on the maximum degree of reduction for each pollutant… 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, including fuel treatment or innovative fuel combustion techniques for control of such pollutant*…. BACT must be determined for each emission unit considered an OCS source.

In accordance with EPA guidance, BACT is determined using a five-step 'top-down' approach. The five steps are:

1. Identify all control technologies
2. Eliminate technically infeasible options
3. Rank remaining control technologies by control effectiveness
4. Evaluate most cost-effective controls
5. Select BACT

As discussed in Section 2.3, certain vessels are anticipated to meet the definition of an OCS source during both the construction and commissioning phase and the O&M phases. This section presents the BACT determination for the marine diesel engines powering such vessels. All vessels anticipated to be considered OCS sources will be supplied by third-party contractors and so the exact specifications of each vessel engine are not available to Ocean Wind. Additionally, vessel selection is subject to change on short notice based on global and local vessel availability and Jones Act limitations.

As described in Section 2.3, the diesel generators that will be used on WTG and OSS during construction and commissioning must comply with BACT. There will be up to 6 generators used on the OSS (2 per OSS) during commissioning with engines rated up to 209 horsepower (hp), up to 3 generators used on the OSS (1 per OSS) during commissioning with engines rated up to 102 hp, and up to 98 generators used on the WTG (1 per WTG) during commissioning with engines rated up to 50 hp. There will be up to 3 generators used on the OSS (1 per OSS) installed permanently that will begin operation during commissioning with engines rated up to 800 hp.

Additionally, as described in Section 2.3, any diesel engine powering equipment, such as a diesel generator or cherry picker, used onboard a vessel that becomes an OCS source must also comply with BACT while the vessel is considered an OCS source. Additional emission units onboard the jack-up vessel include a generator with an engine rated up to 5 hp and a cherry picker rated up to 90 hp.

The same resources reviewed to evaluate LAER were reviewed to evaluate BACT. These resources are described in Section 6.2.

6.3.1 Engines Powering Vessels Meeting the Definition of an OCS Source – NO_x

Because the Project must comply with LAER for NO_x (see Section 6.2.1), the Project meets BACT for NO_x.

6.3.2 Engines Powering Vessels Meeting the Definition of an OCS Source – CO

Control options for CO are the same as identified for VOC in Section 6.2.2.4. Because these technologies were determined to be infeasible in the VOC LAER determination, they are also considered infeasible for CO BACT. Ocean Wind proposes the use of good combustion practices on all vessels and compliance with LAER for NO_x and VOC as BACT for CO. Refer to Section 6.2.1.5 for the LAER determination.

6.3.3 Engines Powering Vessels Meeting the Definition of an OCS Source – PM, PM_{10}, and $PM_{2.5}$

Step 1: Identify all control technologies.

PM emissions are a product of incomplete combustion. Pollution control technologies were reviewed in Section 6.1. Design and retrofit technologies that reduce PM emissions include:

1. Common Rail Fuel Injection Systems
2. Reduced Oil Consumption
3. Fuel-Water Emulsions
4. Turbocharger Improvements
5. Crankcase Ventilation Systems
6. Good Combustion Practices

Additionally, the following add-on controls identified in Section 6.1 reduce PM emissions:

1. SO_x Scrubber
2. NO_x Scrubber
3. Diesel Particulate Filter
4. Flow-Through Filter
5. Diesel Oxidation Catalyst
6. 4-way Catalytic Converter

Finally, as described in Section 6.2.1.2, EPA's Verified Technologies List identifies ten Marine Engine Emissions Upgrade Kits as verified control technologies for marine engines; nine of them are verified to reduce PM emissions. The upgrade kits are for specific models of Caterpillar engines used in marine applications with a model year between 1994-2006 or Caterpillar engines used in marine applications with a model year 1994 and newer.

Step 2: Eliminate technically infeasible options.

Other than use of good combustion practices, use of these control technologies would require Ocean Wind to wait for a vessel with design and retrofit technologies or add-on controls installed or require third-party contractors to replace old engines or retrofit existing engines with control technologies. None of these options are feasible for reasons described in Section 6.2.1.4.2.

Additionally, as described in Section 6.2.1.4.2, the use of Marine Engine Emissions Upgrade Kits is not technically feasible because Ocean Wind does not know exactly which engines will be utilized during construction as the vessels used by the Project will be third-party vessels not owned by Ocean Wind. Additionally, construction plans and schedules are subject to change on short notice and the Jones Act imposes limitations on vessel usage. Finally, there will be several other offshore wind farms being built concurrently with the Project; this will impact the availability of specific vessels for the Project's use.

Therefore, only the use of good combustion practices is technically feasible. The vessels used by the Project may employ one or more of the control technologies identified to meet LAER as proposed in Section 6.2.

Step 3: Rank remaining control technologies by control effectiveness.

The Project will comply with LAER as proposed in Section 6.2, which ensures that all vessel engines will meet Tier 1 or better emission standards, at a minimum. Additionally, Ocean Wind will utilize good combustion practices, as defined in Section 6.1.1.13, at all times.

There are no other remaining feasible control technologies, so there is no need to rank remaining control technologies.

Step 4 and 5: Evaluate most effective controls considering economic, energy, and environmental impacts of the control technology and select BACT.

Ocean Wind proposes the use of good combustion practices on all vessels and compliance with LAER for NO_x and VOC as BACT for PM, PM_{10}, and $PM_{2.5}$. Refer to Section 6.2.1.5 for the LAER determination.

6.3.4 Engines Powering Vessels Meeting the Definition of an OCS Source – GHG

GHG emissions emitted by the project include the following products of combustion: carbon dioxide (CO_2), N_2O, and CH_4. Since N_2O is a subset of NO_x, the Project will meet BACT for N_2O by meeting LAER for NO_x and will meet BACT for CH_4 by meeting LAER for VOC.

Step 1: Identify all control technologies.

Of the design and retrofit technologies reviewed in Section 6.1, Ocean Wind identified that good combustion practices will reduce CO_2 emissions. Additionally, the following add-on control identified in Section 6.1 reduces CO_2 emissions:

1. 4-way Catalytic Converter

Step 2: Eliminate technically infeasible options.

One of the 4-way catalytic converter designs identified in Section 6.1.3.10 controls CO_2 by reducing CO, HCs, nitrogen oxides to CO_2, water, oxygen gas and nitrogen gas and then adsorbing and capturing the CO_2 for storage. The 4-way catalytic converter is still in research and development; Ocean Wind is not aware of any commercially available 4-way catalytic converters that capture CO_2 for storage. Additionally, even if such technology were available, it would not be feasible to store CO_2 onboard vessels to be transported for eventual sequestration onshore due to lack of space on the vessels. If the Project were required to capture and store CO_2 for sequestration, the Project would likely have to make additional vessel trips to transport the CO_2 to land. This would cause an increase in emissions of GHG as well as other criteria pollutants.

Therefore, the only technically feasible option is the use of good combustion practices.

Step 3: Rank remaining control technologies by control effectiveness.

The Project will comply with LAER as proposed in Section 6.2, which ensures that all vessel engines will meet Tier 1 or better emission standards, at a minimum. Additionally, Ocean Wind will utilize good combustion practices, as defined in Section 6.1.1.13, at all times.

There are no other remaining feasible control technologies, so there is no need to rank remaining control technologies.

Step 4 and 5: Evaluate most effective controls considering economic, energy, and environmental impacts of the control technology and select the BACT.

Ocean Wind proposes the use of good combustion practices on all vessels and compliance with LAER for NO_x and VOC as BACT for GHG.

6.3.5 Engines Powering Electric Generators on WTG and OSS and Engines Powering Auxiliary Equipment Onboard Vessels Considered OCS Sources – NO_x

Because the Project must comply with LAER for NO_x (see Section 6.2.3), the Project meets BACT for NO_x.

6.3.6 Engines Powering Electric Generators on WTGs and OSSs and Engines Powering Auxiliary Equipment Onboard Vessels Considered OCS Sources – CO

Control options for CO are the same as identified for VOC in Section 6.2.3.4. Because these technologies were determined to be infeasible in the VOC LAER determination, they are also considered infeasible for CO BACT. Ocean Wind proposes the use of good combustion practices and compliance with LAER for NO_x and VOC as BACT for CO. Refer to Section 6.2.3.5 for the LAER determination.

6.3.7 Engines Powering Electric Generators on WTG and OSS and Engines Powering Auxiliary Equipment Onboard Vessels Considered OCS Sources – PM, PM_{10}, and $PM_{2.5}$

Step 1: Identify all control technologies.

PM emissions are a product of incomplete combustion. Pollution control technologies were reviewed in Section 6.1. Design and retrofit technologies that reduce PM emissions include:

1. Common Rail Fuel Injection Systems
2. Reduced Oil Consumption
3. Fuel-Water Emulsions
4. Turbocharger Improvements
5. Crankcase Ventilation Systems
6. Good Combustion Practices

Additionally, the following add-on controls identified in Section 6.1 reduce PM emissions:

1. SO_x Scrubber
2. NO_x Scrubber
3. Diesel Particulate Filter
4. Flow-Through Filter
5. Diesel Oxidation Catalyst
6. 4-way Catalytic Converter

Finally, as described in Section 6.2.3.2, EPA's Verified Technologies List identifies four control technologies for nonroad or stationary engines verified to reduce NOx and an additional three control technologies verified to reduce VOC; six of them are verified to reduce PM emissions. These technologies are not applicable because they either achieve a lower emissions rate than the LAER determination described in Section 6.2.3.5 or because the technology proposed, or an equivalent method, is implemented by manufacturers when certifying engines to Tier 4 standards.

A search of the CARB Verified Technologies List[48] was conducted for diesel nonroad or stationary engines. There are many technologies verified to reduce PM emissions from nonroad or stationary engines. All the listed technologies are diesel particulate filters.

Step 2: Eliminate technically infeasible options.

A 4-way catalytic converter operates best at steady state loads and exhaust temperatures. The electric generators and auxiliary equipment used during construction and commissioning is not anticipated to be

[48] California Air Resources Board (CARB). n.d. *Verification Procedure: Currently Verified.* Retrieved from https://ww2.arb.ca.gov/diesel/verdev/vt/cvt.htm.

operated at steady state loads and exhaust temperatures. Additionally, non-combustible elements present in engine lube oils may collect over time and damage the catalyst. Finally, this technology is still in the development stage and is not available for marine diesel engines.[45]

All other technologies are technically feasible for marine diesel engines.

Step 3: Rank remaining control technologies by control effectiveness.

To meet LAER, as described in Section 6.2.3, the Project must select engines that meet Tier 4 emission standards in 40 CFR Part 1042. Tier 4 emission standards in 40 CFR Part 1042 include stringent PM emission standards. Engines designed and certified to meet Tier 4 emission standards typically include add-on controls such as particulate filters or a diesel oxidation catalyst. Therefore, the requirement to select engines that meet the highest applicable Tier emission standard is the best available control technology because the engine manufacturer will generally utilize both engine design and add-on controls to meet the stringent Tier 4 PM emission standards.

Step 4 and 5: Evaluate most effective controls considering economic, energy, and environmental impacts of the control technology and select the BACT.

Ocean Wind proposes the use of good combustion practices and compliance with LAER for NO_x and VOC as BACT for PM, PM_{10}, and $PM_{2.5}$. Refer to Section 6.2.3.5 for the LAER determination.

6.3.8 Engines Powering Electric Generators on WTG and OSS and Engines Powering Auxiliary Equipment Onboard Vessels Considered OCS Sources – GHG

GHG emissions emitted by the project include the following products of combustion: CO_2, N_2O, and CH_4. Since N_2O is a subset of NO_x, the Project will meet BACT for N_2O by meeting LAER for NO_x.

The same control options identified in Section 6.3.4 for vessel engines apply to generators and auxiliary equipment. These technologies are infeasible for generators and auxiliary equipment for the same reasons the technologies were determined to be infeasible for marine engines. Ocean Wind proposes the use of good combustion practices and compliance with LAER for NO_x and VOC as BACT for GHG. Refer to Section 6.2.3.5 for the LAER determination.

6.4 SOTA Determination

Per N.J.A.C. 7:27-8.12(a), if an application proposes construction, installation, reconstruction, or modification of equipment and control apparatus that is a significant source meeting the following criteria, the applicant shall document SOTA for the source:

1. The equipment and control apparatus has a PTE HAP at a rate equal to or greater than the SOTA Threshold at N.J.A.C. 7:27-17.9(b); or
2. The equipment and control apparatus has a PTE any other air contaminant or category of air contaminant, except carbon dioxide (CO_2), at a rate equal to or greater than the SOTA threshold in N.J.A.C. 7:27-8, Appendix 1, Table A.

6.4.1 Construction and Commissioning Phase

In the construction and commissioning phase, the diesel-fired generators on the OSS are considered significant sources under N.J.A.C. 7:27-8.12(a). The diesel-fired generators on the OSS will be installed during the construction and commissioning phase and will remain on the OSS to serve as emergency generators during the O&M phase, so the generators will be located on site for longer than one year. The potential emissions from each of the 800 horsepower diesel-fired generators do not exceed the SOTA thresholds in N.J.A.C. 7:27-17.9(b) or in N.J.A.C. 7:27-8, Appendix 1, Table A.

All other sources, including marine vessels, auxiliary equipment onboard vessels, and temporary generators, meet the exemption for significant source in N.J.A.C. 7:27-8.2(d)15 which describes exempt equipment as

> *Equipment used to conduct construction, repair, or maintenance (CRM) activities, provided that the equipment is portable and is located on site for no longer than one year*.

No individual vessel, auxiliary equipment, or generator (other than the generators installed on the OSS) is anticipated to be located on site for longer than one year. Additionally, this equipment is portable and will be used to conduct construction activities. Only significant sources are required to document SOTA.

Therefore, no emission units in the construction and commissioning phase are required to document SOTA.

6.4.2 O&M Phase

In the O&M phase, only the diesel-fired generators on the OSS are considered significant sources under N.J.A.C. 7:27-8.12(a). All other sources, such as marine vessels, meet the exemption in N.J.A.C. 7:27-8.2(d)15 which describes exempt equipment as

> *Equipment used to conduct construction, repair, or maintenance (CRM) activities, provided that the equipment is portable and is located on site for no longer than one year.*

The potential emissions from each of the 800 horsepower diesel-fired generators do not exceed the SOTA thresholds in N.J.A.C. 7:27-17.9(b) or in Appendix 1, Table A. Therefore, no emission units in the O&M phase are required to document SOTA.

7. Proposed Permit Conditions

7.1 Construction and Commissioning Phase

Proposed emission limits which satisfy BACT and LAER for the Project's OCS sources during construction are discussed in Section 6.

No additional emission limits are proposed.

7.2 O&M Phase

Ocean Wind proposes a 1000-hour per year limit for all operating scenarios, including emergency use, routine testing and maintenance, on each generator located on the OSS.

No additional emission limits are proposed.

8. Emissions Offsets

N.J.A.C. 7:27-18.3(c) requires that any person subject to Subchapter 18 pursuant to N.J.A.C. 7:27-18.2(a) and 18.2(b)(1) secure emission offsets, in accordance with N.J.A.C. 7:27-18.5, for each air contaminant having a significant net emission increase at the facility.

The construction and commissioning phase potential emissions are subject to Subchapter 18. However, as described in the Supplemental Fact Sheet to South Fork Wind, LLC, dated October 20, 2021, EPA Regional Offices and Headquarters determined that emission offset requirements under the CAA and NNSR regulations do not apply to construction emissions on the OCS.[49] EPA stated:

[49] Supplemental Fact Sheet to OCS Permit Number OCS-R1-04. Retrieved from https://www.epa.gov/system/files/documents/2021-10/sfw-supplemental-fs-10-20-2021.pdf.

"Section 173(a)(1)(A) of the CAA ties actual emissions reductions from offsetting measures to the operation phase of a project, stating that the NNSR program 'shall provide that permits to construct and operate may be issued if… the permitting agency determines that by the time the source is to ***commence operation****, sufficient offsetting emissions reductions have been obtained…" (emphasis added).*[49]

This determination is consistent with EPA determinations in other situations where emissions from the construction phase of a project have been considered.

In addition, New Jersey regulations specifically exclude temporary emission increases from the emissions offset requirements. Pursuant to N.J.A.C. 7:27-18.3(h), no person is required to secure emission offsets for temporary emission increases that occur during and result directly from the construction of newly constructed equipment or control apparatus.

For these reasons, it is Ocean Wind's understanding that obtaining emissions offsets for construction and commissioning phase emissions will not be required.

The O&M phase emissions do not exceed the thresholds listed in N.J.A.C. 7:27-18.2(a)(1). Therefore, the emissions offset requirement does not apply. Ocean Wind has evaluated the PTE of the O&M phase against relevant thresholds (e.g. PSD and NNSR) separately from the PTE of the construction and commissioning phase consistent with typical NSR procedures. **Appendix B** includes an evaluation of the O&M phase for PSD and NNSR when using the PTE of the construction and commissioning phase to determine applicability of the O&M phase.

9. Additional Impact Analysis

Per 40 CFR § 52.21(o), the Project owner or operator must assess potential impacts of the Project's emissions on visibility, soil, and vegetation, and the air quality impacts from growth associated with the Project. The additional impact analysis is included in this permit application in **Appendix E**.

10. Source Impact Analysis

A modeling report is included in this permit application in **Appendix E.**

11. AQRV Analysis

The AQRV modeling protocol submitted to the appropriate reviewing authorities on July 6, 2022 is included in this permit application in **Appendix I**. An AQRV modeling report is included in this permit application in **Appendix E**.

12. Environmental Justice

There are Environmental Justice requirements under New Jersey's Environmental Justice legislation, as codified in N.J.S.A. 13:1D-157, et seq., and Executive Order 12898 entitled "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," which apply to certain projects.

12.1 New Jersey's Environmental Justice Law

New Jersey's Environmental Justice legislation, as codified in N.J.S.A. 13:1D-157, et seq., was established to protect overburdened communities which have been historically subject to a disproportionately high number of environmental and public health stressors. A facility is only subject to Environmental Justice review if an applicant is a major source of air pollution (i.e., a Title V source) or a specific source type listed in the rule. Additionally, the project must be in an overburdened community, which is defined as any census block group

that is: (1) at least 35 percent of the households qualify as low-income households; (2) at least 40 percent of the residents identify as minority or as members of a State recognized tribal community; or (3) at least 40 percent of the households have limited English proficiency.

The Project is not subject to the New Jersey Environmental Justice requirements. The Project is not a major source of air pollution in the O&M phase and offshore wind power projects are not a source type listed in the rule. Furthermore, the portion of the Project subject to the OCS air permit is located entirely offshore and so is not located in an overburdened community.

Ocean Wind acknowledges that a portion of the Project (not subject to the OCS air permit) is located onshore. However, the onshore portion of the Project is not a major source of air pollution under N.J.A.C. Chapter 27 and is therefore not subject to Environmental Justice review under New Jersey's Environmental Justice legislation.

12.2 EPA Executive Orders on Environmental Justice

Executive Order 12898 entitled "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" requires that federal agencies consider if impacts on human health or the environment would be disproportionately high and adverse for minorities and low-income populations, and appreciably exceed impacts on the general population or other comparison group.

Executive Order 13985, Advancing Racial Equity and Support for Underserved Communities Through the Federal Government, strongly encourages independent agencies to "consult with members of communities that have been historically underrepresented in the Federal Government and underserved by, or subject to discrimination in, federal policies and programs."

Executive Order 13990, Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis calls for advancing environmental justice and states that U.S. policy is to improve public health and protect our environment; to ensure access to clean air and water; to limit exposure to dangerous chemicals and pesticides; to hold polluters accountable, including those who disproportionately harm communities of color and low-income communities; to reduce greenhouse gas emissions; to bolster resilience to the impacts of climate change; to restore and expand our national treasures and monuments; and to prioritize both environmental justice and the creation of the well-paying union jobs necessary to deliver on these goals.

Executive Order 14008, Tackling the Climate Crisis at Home and Abroad, prioritizes climate change considerations in national security and requires explorations of energy-generating resources that create a sustainable climate pathway. The Executive Order requires that the United States organize and deploy the full capacity of its agencies to combat the climate crisis and implement a Government-wide approach that reduces climate pollution in every sector of the economy; increases resilience to the impacts of climate change; protects public health; conserves our lands, waters, and biodiversity; delivers environmental justice; and spurs well-paying union jobs and economic growth, especially through innovation, commercialization, and deployment of clean energy technologies and infrastructure. The Federal Government, consistent with applicable law, is required to take steps to ensure that Federal infrastructure investment reduces climate pollution and that Federal permitting decisions consider the effects of greenhouse gas emissions and climate change. Executive Order 14008 specifies that "The Secretary of the Interior shall review siting and permitting processes on public lands and in offshore waters to identify to the Task Force steps that can be taken, consistent with applicable law, to increase renewable energy production on those lands and in those waters, with the goal of doubling offshore wind by 2030 while ensuring robust protection for our lands, waters, and biodiversity and creating good jobs."

The Project will demonstrate that issuance of an OCS permit will not cause or contribute to an exceedance of the NAAQS or potentially adversely impact ambient air quality. The Environmental Appeals Board has recognized that compliance with the NAAQS is "emblematic of achieving a level of public health protection that, based on the level of protection afforded by a primary NAAQS, demonstrates that minority or low-income populations will not experience disproportionately high and adverse human health or environmental effects due to the exposure to relevant criteria pollutants."[50]

The Project anticipates that the air permit public notice documents will be translated into languages most commonly spoken by nearby communities, other than English, and made available on the Project docket at Regulations.gov.

Ocean Wind has evaluated the onshore Project areas (BL England and Oyster Creek corridors) for potential affected environmental justice communities. The environmental justice study is described in Section 2.3.2.1.2 of Volume II of the COP[1]. The study found that the Project would not cause a disproportionate share of high and adverse environmental or socioeconomic impacts on any racial, ethnic, or socioeconomic group.

When considering portions of the Project outside of the study area evaluated in the Section 2.3.2.1.2 of Volume II of the COP, the Project has conducted an extensive stakeholder and public outreach program dating back to the early stages of the Project. The stakeholder and public outreach program is described in Section 2.3 of Volume I of the COP and summarized below.

The Project has developed a systematic and strategic approach to bringing the Project to local communities for their feedback and input. The key stakeholder groups include the coastal communities in the Project Area. The Ocean Wind team has engaged numerous mayors and representatives in coastal communities including:

- Ocean City
- Upper Township
- Lacey Township
- Ocean Township
- Margate
- Longport
- Brigantine
- Atlantic City
- Avalon
- Stone Harbor
- Sea Isle City
- Cape May
- North Wildwood
- City of Wildwood
- Ventnor
- Wildwood Crest

Ocean Wind has been engaging in its home communities since acquiring the Lease in May 2016. This includes participation in panels, networking events, conferences, symposiums, and receptions. Ocean Wind has also extended invitations for pre-survey meetings and project updates to representatives of four federally recognized Native American tribes:

- Lenape Tribe of Delaware
- Shinnecock Indian Nation

[50] Environmental Appeals Board order In re Shell Gulf of Mexico, Inc. & in re Shell Offshore, Inc., 15 E.A.D. 103, 156 (December 30, 2010).

- Narragansett Indian Tribe
- Delaware Tribe of Indians

Ocean Wind's stakeholder outreach is ongoing. Proper noticing and advertising for these outreach meetings will take place in order to make sure all interested parties have been notified and given the opportunity to comment on the Project. The following list includes, but is not limited to, the groups that will be consulted throughout the process:

- Residents Against Giant Electric
- NJ Audubon Society
- ReClam the Bay
- Lund's Fisheries
- Ocean City Fishing and Cruising Fleet
- Atlantic Cape Fisheries, Inc.
- Atlantic Offshore Lobsterman Association
- Oceanside Marine LLC
- Seawatch International
- The Nature Conservancy
- American Waterways Operators
- Mariners Advisory Committee (MAC) for the Bay and River Delaware
- The New Jersey Boatmen
- The Area Maritime Safety Committee
- Recreational Fisherman's Alliance
- Responsible Offshore Development Alliance (RODA)

Ocean Wind is committed to maintaining a strong working relationship with all commercial and recreational fishermen who may be affected by the Project. Ocean Wind has retained a Mid-Atlantic Fisheries Liaison and is actively participating in a variety of research initiatives. Ocean Wind has and will continue to conduct outreach to various fishing interests fishing within and transiting through the Project area. Over 270 interviews were conducted with commercial and recreational fishermen between July 2019 and September 2020. Outcomes and takeaways from these engagements can be summarized as follows:

- There is a wide variety of interest and a range of attitudes towards the Project;
- There is a strong interest in safe navigation and preserving the ability to fish within the Project area;
- The commercial fishing that does occur in the Project vicinity primarily includes squid and groundfish trawls, conch and lobster pots, and clam and scallop dredging;
- The limited number of mobile gear fishermen identified by outreach have indicated a preference for a layout which maximizes space between WTGs and;
- Fishermen desire to be as informed as possible in this process.

Ocean Wind developed a Fisheries Communication and Outreach Plan (Appendix O of Volume III of the COP) in accordance with BOEM Guidelines; this plan outlines key strategies that Ocean Wind will use to communicate with fishermen and fishing industry representatives associated with the Project. The plan includes the appointment of a dedicated fisheries liaison as well as fisheries representatives who will serve as conduits for providing information to, and gathering feedback from, the fishing industry.

12.2.1 EJSCREEN 2.0 Analysis

In addition, because of the overlap between climate change and environmental justice in Executive Order 14008 Ocean Wind has used the EJScreen 2.0 tool, which includes new layers for climate change. The analysis using EJScreen is provided to address USEPA's goal to reduce climate pollution, increase resilience

to the impacts of climate change, protect public health, deliver environmental justice, and deploy clean energy technology initiatives.

EJScreen is an environmental justice mapping and screening tool that provides USEPA with a nationally consistent dataset and approach for combining environmental and demographic indicators. EJScreen provides demographic and environmental information for a chosen geographic area (up to a maximum of 20 miles). An EJScreen 2.0 analysis was performed using a 20-mile radius around the midpoint of the WTA (Latitude 39.117947, Longitude -74.239472).

The EJScreen tool combines demographic information with 12 environmental indicators to create 11 Environmental Justice (EJ) Indexes:

1. Particulate Matter 2.5
2. Ozone
3. Diesel Particulate Matter
4. Air Toxics Cancer Risk
5. Air Toxics Respiratory Hazard Index
6. Traffic Proximity
7. Lead Paint
8. Risk Management Plan Facility Proximity
9. Hazardous Waste Proximity
10. Superfund Proximity
11. Underground Storage Tanks (UST) and Leaking UST
12. Wastewater Discharge

The EJScreen report shows the state, regional and national EJ Indexes for the selected area in tabular form and in a bar chart. "Percentiles" are an important part of EJScreen. Every indicator in EJScreen is put into perspective by showing its associated percentiles. The percentiles allow the user to compare a community to the rest of the state, EPA region and nation. For example, the national percentile indicates what percent of the US population has an equal or lower value, meaning less potential for exposure/ risk/ proximity to certain facilities, or a lower percent minority.

The EJScreen report for the 20-mile ring surrounding the midpoint of the WTA indicates that although some socioeconomic indicators in the buffer area are higher than the state, regional, or national percentiles, most environmental indicators are lower. For example, 78 percent of the population within the 20-mile ring are people of color, which is higher than the state average of 45 percent, and 57 percent of the population within the 20-mile ring are low-income, which is higher than the state average of 23 percent. The percentage of the population within the 20-mile ring that is linguistically isolated is 16 percent, higher than the state average of 7 percent. In comparison, for the 12 EJ indexes listed above, the 20-mile buffer is higher than the state average for only 3 indexes: Traffic Proximity (81st percentile), Lead Paint (60th percentile), and Underground Storage Tanks (80th percentile).

Some of the outreach described above was conducted in communities that EJScreen indicated may have socioeconomic indicators higher than the state, regional, or national percentiles. For example, Ocean Wind conducted outreach in August 2019 and February 2020 within the EJScreen study area in communities that include low-income or less-than-high school education populations. See the COP Table 2.3-1 for additional details on this outreach.

The full EJScreen Report is included in **Appendix J**.

Subsistence Fishing

Although USEPA's EJSCREEN 2.0 does not include data on subsistence fishing, USEPA has found that "Communities of color, low-income communities, tribes, and other indigenous peoples depend on healthy aquatic ecosystems and the fish, aquatic plants, and wildlife that these ecosystems support. While there are important differences among these various affected groups, their members generally depend on the fish, aquatic plants, and wildlife to a greater extent and in different ways than does the general population. These resources are consumed and used to meet nutritional and economic needs. For some groups, they are also consumed or used for cultural, traditional, or religious purposes" (USEPA 2002).

The State of New Jersey does not have any Federally recognized tribes, nor does the State of New Jersey have any agreements with State-recognized tribes regarding subsistence fishing (ASMFC undated).

Appendix A, O&M OCS Source Determination Supporting Documentation

Ocean Wind OCS Air Permit Application

1.0 Overview

Ocean Wind LLC ("Ocean Wind"), a joint venture between Orsted Wind Power North America, LLC ("Orsted") and Public Service Enterprise Group Renewable Generation LLC ("PSEG"), will submit an Outer Continental Shelf (OCS) air permit application to support the construction and operation of the Ocean Wind Offshore Wind Farm Project ("Ocean Wind" or the "Project"). The air permit application has been prepared by Ocean Wind in accordance with OCS air permit regulations promulgated by the Environmental Protection Agency (EPA) in 40 CFR Part 55.

Ocean Wind is proposing to install up to 98 wind turbine generators (WTGs) and the associated offshore infrastructure required to transmit power generated by the WTGs to onshore interconnection point(s), which includes the installation of offshore substations installed on platforms (OSSs), array cabling connecting WTGs, interconnection cabling connecting OSSs to other OSSs, and offshore export cabling connecting OSSs to land. The commissioning activities during the construction and commissioning phase will potentially require the use of generators on the WTGs and OSSs.

The Project will be located approximately 13 nautical miles (nm) southeast of the Atlantic City, New Jersey shoreline. Construction will begin contingent upon required regulatory approvals; it is anticipated the Project will be installed from 2023 through 2024 and will be commissioned and operational in 2024. During the construction and commissioning phase, the WTGs, OSSs and some associated vessels will constitute an OCS source.

This memorandum is prepared to document the Project's air quality permitting approach and justification of the definition of the OCS source during operations and maintenance ("O&M") used in preparation of the application. This determination is integral to proper permitting of the project and includes defining the area within which vessel operations must be accounted for in emissions calculations and a determination of which vessel operations must be included.

In each of two recent permitting actions (Vineyard Wind and South Fork), EPA determined that the entire group of WTG and OSS associated with the project constituted a single OCS source, during both the construction and commissioning phase and the O&M phase. Both referenced projects assumed the use of permanently-installed backup diesel generators at each WTG during the O&M phase. This memorandum will review EPA's proposed approach as it applies to O&M phase of the project.

Based on the South Fork and Vineyard Wind permitting actions, EPA has preliminarily informed the Project that the same approach may be applied to this permit application. Furthermore, during a preapplication meeting with EPA on March 10, 2022, EPA indicated that it believed the WTGs are part of the OCS source during operation because of the remote possibility of the use of diesel-fired emergency generators on the WTGs and the possibility of fugitive emissions of the greenhouse gas ("GHG") sulfur hexafluoride ("SF6") from the switchgear.

In addition, EPA asserted that it prefers to maintain a single OCS source determination for the life of a project (i.e., a "once-in-always-in" policy to the determination of an OCS source).

This memorandum reviews the relevant regulatory and interpretive background and evaluates the distinguishing characteristics of the Project that are determinative in defining the Project (or portions of the Project) as an OCS source. As explained further below, the Project is distinguishable from the Vineyard Wind and South Fork projects in that the Project does not assume the use of permanent diesel generators on the WTGs during the operational life of the project. As such, the WTGs are not sources of emissions during O&M

and are therefore not part of the OCS source. The WTGs should not be included in the OCS source once the O&M phase has commenced. As such, only the individual OSS—which has a permanent emergency diesel generator—and an occasional jack-up vessel are the OCS sources for purposes of O&M.

2.0 Regulatory Background

OCS permitting involves the interaction of Clean Air Act ("CAA") requirements specific to the OCS with other CAA permitting requirements, including both EPA's New Source Review ("NSR") pre-construction and Title V operating permitting programs. Determining what regulatory requirements apply requires defining the scope of these programs with respect to a given collection of air pollutant emitting activities.

The first step in determining the applicable air permitting requirements is to define the OCS source. New Jersey in NJAC 7:27-30.4 has adopted the EPA definition for OCS source in 40 CFR § 55.2, as follows:

> "OCS source means any equipment, activity, or facility which:
>
> (1) Emits or has the potential to emit any air pollutant;
>
> (2) Is regulated or authorized under the Outer Continental Shelf Lands Act ("OCSLA") (43 U.S.C. §1331 *et seq.*); and
>
> (3) Is located on the OCS or in or on the waters above the OCS.
>
> This definition shall include vessels only 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.

2.1 Relevant EPA Interpretations of the Term "OCS Source"

Subsequent guidance from EPA has clarified this definition, confirming that OCS sources may be temporary in nature and can be distinguished between construction and operational phases where emissions activities differ.

Letter from US EPA Region 2, Steven Riva, Chief Permitting Section Air Programs Branch to Robert Gibbs, Vice President Garden State Offshore Energy, October 15, 2010

In 2010, EPA Region 2 evaluated OCS permit applicability as it related to the installation of a meteorological monitoring station buoy to support development of a wind farm for Garden State Offshore Energy (GSOE). GSOE proposed installation of the buoy to collect meteorological data to support a planned windfarm. EPA Region 2 evaluated the applicability of 40 CFR Part 55 as it related to the installation and operation of the buoy. The memorandum determined that during construction the activities have a potential to emit and would therefore come under the definition of OCS source. However, once operational the buoy would not be considered an OCS source because once attached to the seafloor the buoy does not have the potential to emit air pollutants.

This letter stated:

> "In light of the regulatory definition of an OCS source, the spar buoy itself, once constructed (i.e., during its operational phase) will not be an OCS source because even though attached to the seafloor, it has no potential to emit any air pollutant. The crew boat that will provide service and

> maintenance for the spar buoy, during the buoy project's operational phase [will attach to the seafloor or to the buoy itself and will result in emissions. Even while attached to the spar buoy] the crew boat is not an OCS source because the spar buoy by itself is not an OCS source." (See Garden State Letter at Page 3).

Letter from US EPA OAR, Karl Moor, Deputy Assistant Administrator for the Office of Air and Radiation, to Walid Masri, Program Director, West Coast Decommission Program, Chevron USA, Inc., January 19, 2021

More recently, EPA responded to a request from Chevron USA, Inc (Chevron) requesting a determination of whether drilling platforms cease to be an OCS source during decommissioning, once they have all pollutant emitting activities removed (hereinafter Chevron Letter). Chevron contended that during the abandonment phase, once all pollutant-emitting equipment and all potential emission sources on the platforms were removed it could surrender its existing operating permits because the platforms would have no emissions or potential to emit, and therefore no longer satisfy the necessary criteria to be considered an OCS source in the definitions of the CAA Section 328(a)(4)(C) and 40 CFR § 55.2.

In addition, relying on several Environmental Appeals Board (EAB) decisions, Chevron contended that the support vessels associated with the platforms would not be considered OCS sources, or cause the platforms to continue to be considered an OCS source, because the support vessels are only direct emissions of an OCS source when there is an OCS source to which they can be attributed.

EPA concurred with Chevron's conclusions in both instances: (1) the platforms ceased to be OCS sources once they no longer had any activities with the potential to emit any air pollutant and (2) that support vessels would also not be considered direct sources of emissions because there would be no OCS sources to which they could be attributed.

EPA concluded that a facility that previously was considered an OCS source can cease to be an OCS source when the definitional criteria are no longer met. The EPA relied on a previously established concept that once a definitional criterion in 40 CFR 55.2 is no longer met an OCS source no longer exists. In the Chevron case once the potential to emit facet of the OCS source definition was no longer met the facility was no longer an OCS source and would no longer be treated as such. (Chevron Letter at Page 5). By extension, EPA further concluded that the local definitions of stationary source that govern permitting of NSR, or Title V requirements only apply where there is an OCS source as defined by 40 CFR § 55.2. Since there was no OCS source, permitting regulations would also not apply.

Furthermore, EPA addressed the question of whether support vessels would continue to be considered sources of potential emissions of the platforms once the OCS source no longer existed.

> Section 328(a)(4)(C) identifies three criteria each of which must be met for "any equipment, activity, or facility" to be considered an OCS source. The last criterion is clearly satisfied with regard to the Platforms because they continue to be located on the OCS…The criterion in Section 328(a)(4)(C) germane to this determination is whether the Platforms "emit[] or ha[ve] the potential to emit any air pollutant." Section 328(a)(4)(C) of the CAA further states that "[f]or the purposes of this subsection, emissions from any vessel servicing or associated with an OCS source, including emissions while at the OCS source or en route to or from the OCS source within 25 miles of the OCS source, shall be considered direct emissions from the OCS source." (EPA's added emphasis retained). This sentence in the definition of OCS source draws a clear distinction between the OCS source and any vessel

> servicing or associated with that source. Thus, the vessels in this context are not the OCS source, and the emissions from these types of vessels are not deemed to be emissions from an OCS source if there is no longer an OCS source present. For a vessel to service or associate with an OCS source, there must be equipment, an activity, or a facility that meets the three established defined OCS source criteria independent of such vessel." (Chevron Letter at Page 4)

Note that EPA modified the January 19, 2021 letter in a follow-up on April 20, 2021 to clarify that under the facts of that situation there was the possibility that future activity might be classified as an OCS source under certain conditions. However, the April 20, 2021 letter did not change the EPA's interpretation of the OCS source definition in the January 2021 letter.

2.2 Relevant Interpretations regarding definition of "air pollutant" within 40 CFR §55.2

In 1992, EPA interpreted its regulatory authority under section 328 of the CAA to be restricted to federal and state criteria pollutants, and pollutants regulated pursuant to PSD, and has limited the OCS rule to these pollutants. 57 Fed. Reg. 40804 (September 4, 1992).

In *Utility Air Regulatory Group v EPA*, 134 S. Ct. 2427 (2014), the United States Supreme Court severely limited the EPA's ability to interpret "air pollutant" to include GHG. The decision is based on the concept that the term "air pollutant" is narrowly interpreted and given context-appropriate meaning. The Supreme Court stated that a broader interpretation of "air pollutant" to include GHG would radically transform the PSD and Title V programs to make them unworkable.

2.3 Aggregation

Separate from the definition and duration of OCS Source but related is EPA's policy on source aggregation. Under EPA regulations, the agency considers three factors when determining what "pollutant-emitting activities" constitute a major stationary source: 1) whether the activities share the same industrial grouping (SIC code), 2) whether they are located on one or more contiguous or adjacent properties, and 3) whether they are under the control of the same person (or person under common control). *See* 40 CFR 52.2 l(b)(5); 40 CFR 5 l.165(a)(l)(i); 40 CFR 5 l.166(b)(5). For the purposes of this analysis, we assume the WTGs share the same SIC code and are under common control.

In determining whether activities on are one or more contiguous or adjacent properties, EPA's adjacency guidance stresses that there is no bright line outside of the oil and gas context, and that adjacency may vary depending on the nature of the industry. *See* U.S. EPA, "Interpreting 'Adjacent' for New Source Review and Title V Source Determinations in All Industries Other Than Oil and Gas" (Nov. 26, 2019) ("Adjacent Guidance"). More specifically, "EPA will consider properties that do not share a common boundary or border, or are otherwise not physically touching each other, to be "adjacent" only if the properties are nevertheless nearby, side-by-side, or neighboring (with allowance being made for some limited separation by, for example, a right of way)." Adjacent Guidance at 8. The guidance acknowledged the concern that sources should not be "over-aggregated in a manner inconsistent with the 'common sense notion of a plant' if adjacency were determined based on physical proximity alone. *Id*.

3.0 Analysis

The first step in defining an OCS source is to identify any equipment, activity, or facility which emits or has the potential to emit any air pollutant. This mirrors the NSR regulatory structure which includes all "pollutant-emitting activities" as being part of the "stationary source" that is subject to permitting. See 40 CFR 52.21(b)(6).

Based on the CAA, implementing regulations, and interpretive guidance referenced above, the Project envisions that during the O&M phase, only the OSSs (with accompanying permanent emergency generators) and any jack-up vessels would be OCS sources during operations. Individual WTGs, because they have no permanent source of criteria pollutants, would not properly be considered OCS sources, and thus would not be aggregated with other OCS sources. The WTGs would use battery backup systems instead of emergency diesel generators. As discussed earlier, a WTG may use a temporary diesel generator only in the rare event there were to be a grid outage, the WTGs were unable to produce power, and the integrated battery backup system was affected by a fault or otherwise lacked sufficient power.

3.1 Diesel Fired Emergency Generators

The remote possibility that diesel fired emergency generators might be used on the WTG(s) does not cause the WTGs to be part of the OCS source.

As discussed previously, EPA stated its preliminary position that the remote possibility of diesel emergency engines temporarily installed on a WTG(s) during O&M is an equipment or activity that emits or has the potential to emit any air pollutant would cause the WTG to be considered part of the OCS source.

Part 55 defined "potential emissions" as "the maximum emissions of a pollutant from an OCS source operating at its design capacity...". This definition mirrors 40 CFR §52.21 where EPA defined potential to emit (PTE) as "the maximum capacity of a stationary source to emit a pollutant under its physical and operational design." These definitions make clear that EPA intended PTE to only reflect the design of the process.

The remote possibility of grid outage is not part of operational design and is therefore outside the definition of PTE. A temporary diesel generator would only be necessary if there were to be a grid outage, the WTGs were unable to produce power, and the integrated battery backup system was affected by a fault or otherwise lacked sufficient power. All conditions happening simultaneously is an unlikely scenario and not considered a typical operating scenario by the Project. A similar scenario would be if a hurricane or other significant storm caused irreparable damage to multiple turbines, resulting in the need to remove and replace these turbines. This is not a scenario that is part of its operational design although there is a remote possibility something like this could occur. Neither scenario is something that is required to be permitted because these conditions are not inherently part of the design of the WTG. Therefore, for EPA to consider the emergency diesel fired generators as reason to find the WTG to be part of the OCS source is inconsistent with the definition of PTE.

3.2 SF6 is not included within the definition of "air pollutant".

Because SF6 is not an "air pollutant" within the context of the OCS rule based on both EPA determinations and decisions by the US Supreme Court limiting the definition of "air pollutant," the Project assumes its possible presence in the switchgear is not sufficient to cause the WTGs to be classified as part of the OCS source.

The OCS rules do not define the term "air pollutant," so the Project looked to how "air pollutant" has been defined in other contexts. In the preamble for publication of 40 CFR Part 55, EPA addressed whether the EPA's authority to regulate under Part 55 included non-criteria pollutants. EPA stated that it "interprets its regulatory authority under section 328 to be restricted to federal and state criteria pollutants, precursors to those pollutants, and pollutants regulated pursuant to PSD, and has accordingly limited its rule to these pollutants." See 57 FR 40792, 40804 (September 4, 1992).

This statement by EPA makes clear that it did not intend the term "air pollutant" within the OCS source context to include GHG. SF6 is not a federal or state criteria pollutant. Therefore, this criterion is not satisfied, and the Project looked to whether or not SF6 is a pollutant regulated pursuant to PSD.

The United States Supreme Court held in *Utility Air Regulatory Group v EPA*, 573 US 302 (2014) that the Clean Air Act did not permit EPA's interpretation that the term "air pollutant" could be broadly construed to include

GHG. The Court stated that a broader interpretation of "air pollutant" to include GHG would radically transform the PSD and Title V programs to make them unworkable. Only within the confines of sources that were already determined to be PSD major sources was the EPA allowed to include PSD requirements applicable to GHG.

In response to the Utility Air Group decision, EPA revised the NSR provisions under which the PSD program is established to modify how GHG are regulated. See 81 FR 68110 (October 3, 2016). The definition of "Subject to regulation" for GHG was revised to state that GHG would not be subject to regulation except "as provided in paragraph (b)(49)(iv) of this section and shall not be subject to regulation if the stationary source maintains its total source-wide emissions below the GHG PAL level, meets the requirements in paragraphs (aa)(1) through (15) of this section, and complies with the PAL permit containing the GHG PAL."

Inclusion of SF6 as an "air pollutant" in the OCS context would be inconsistent with EPA's own narrow interpretation of "air pollutant" because it would be inconsistent with the *Utility Air Group* holding that EPA exceeded its discretion in attempting to treat GHG as an "air pollutant" under the CAA. Such an attempt to expand the definition of GHG to be considered an air pollutant in the OCS source context is analogous to EPA's prior attempt to do the same in the context of PSD. As a result, GHG cannot be considered an air pollutant for the purpose of the OCS source determination.

3.3 Changing the definition of an OCS source over the lifespan of a project is consistent with prior EPA interpretations.

EPA can and should consider that the OCS source(s) during the construction and commissioning phase of the project may differ from the OCS source(s) in the O&M phase. The regulations envision that some OCS sources may be temporary, if they are "temporarily attached to the seabed…." 40 C.F.R. §55.2. EPA has as recently as 2021 found that an activity that was considered an OCS source at one phase of a project may cease being an OCS source at a later phase of the project if the activity no longer meets the definitions of OCS source at 40 C.F.R. §55.2. The same concept should apply to the Project's WTGs.

Exclusion of the non-emitting WTGs from the OCS source during O&M is consistent with the Region 2 GSOE determination and the EPA 2021 Chevron determination. These determinations clearly indicate that there must be an air pollutant emitting activity present for a source to be classified as an OCS source. Once the emergency engines are removed from the WTG there are no air pollutant emitting activities. As noted above, any fugitive emissions from switchgear are not in themselves sufficient to trigger PSD.

Once the commissioning diesel engines are removed and the O&M phase commences, Ocean Wind will not have any pollutant emitting activities at the WTG. Furthermore, as indicated by the Garden State letter, if there is no OCS source, no emissions from the support vessels associated with the WTG will be included in the potential emissions of the Project, as the presence of an OCS source is a condition precedent for inclusion of the support vessels. EPA clearly stated, "For a vessel to service or associate with an OCS source, there must be equipment, an activity, or facility that meets the three defined OCS source criteria independent of such vessel." Chevron Letter at Page 5.

The focus of the OCS determination is on the emissions of the equipment, activity, or facility. If the activity does not generate emissions, it cannot be aggregated as part of the OCS source and none of the vessels associated with such activity can be included in the potential emissions of the Project.

Nothing in the Vineyard Wind or South Fork OCS determinations contradicts the approach in the Garden State Letter and Chevron Letter. Instead, the Vineyard Wind and South Fork determinations are distinguishable because in both of those projects the WTG themselves had the potential to emit during the operational phase as a result of the permanent presence of emergency generators at the WTG.

Similarly, in those cases where EPA has made a single source determination for sources separated by more than 1/4 mile, EPA was aggregating each “emitting unit”, not portions of a facility under common control that did not generate emissions. See, e.g., Letter from Richard R. Long, Region VIII Director, Air and Radiation Program, to Jack Vaughn EnerVest San Juan Operating Co. (July 8, 1999) (“each compressor station with its associated emitting units…would be considered a single source for purposes of determining Title V applicability.”). But see Letter from Richard R. Long, Region VII Director, Air and Radiation Program, to Jeffer L. Ingerson, Senior Environmental Specialist, Questar Gas Management Company (August 7, 1998 (“EPA does not intend for a ‘source’ to include activities along a long-line operation; such as, pumping stations along a multi-state pipeline would not be considered a single stationary source.” (quoting 45 Fed. Reg. 52695) (August 7, 1980)).

4.0 Conclusion

In conclusion, during construction and commissioning, the Project will consider the WTG an OCS source (in addition to other aspects of the Project that meet the definition of an OCS source) and account for emissions as such. However, during O&M, the WTG will cease to be an OCS source. The OSS and a jack-up vessel are the only activities to be included in the OCS source during the O&M phase. Therefore, potential emissions of the Project during O&M should be limited to emissions from the generators on the OSS, the jack-up vessel, and emissions from vessels en route to and from the OSS or jack-up vessel when within 25 nautical miles of the OSS or jack-up vessel.

Appendix B, O&M OCS Source – Alternate Approach

Ocean Wind OCS Air Permit Application

1. Introduction

Ocean Wind believes the approach to OCS source determination in the O&M phase that is most consistent with the OCS rules, prior OCS air permit source determinations, and formal policy determinations is to exclude the WTGs from the OCS source in O&M (See Appendix A for discussion of this issue). Additionally, please note that Ocean Wind believes that the PTE of the short-term construction and commissioning phase should not be used to determine whether or not activities in the three-decade long O&M phase are subject to regulations, including PSD and NNSR. Ocean Wind suggests that considering the PTE of the O&M phase independently of the construction and commissioning phase is consistent with the OCS rules, prior OCS air permit source determinations, PSD and NNSR rules and formal policy determinations. Separating the emissions analysis between construction/commissioning and O&M seems particularly appropriate where significantly different equipment is used during the two periods, and where the same piece of equipment may meet the regulatory definition of an OCS source in one period but not the other.

However, EPA has indicated in preliminary discussions that the WTGs should be included in the OCS source in O&M and that the construction and commissioning PTE should be used to determine whether O&M phase activities are subject to PSD and NNSR. Ocean Wind prepared this appendix with information reflecting an alternate approach where WTGs are included in the OCS source and/or the construction and commissioning phase PTE is used to determine whether O&M phase activities are subject to PSD and NNSR because these issues have not been resolved at the time of submittal of the air permit application. If EPA determines based on OCS rules, prior OCS air permit source determinations, and formal policy determinations that WTGs must be included in the OCS source at the O&M phase, the Project would then include emissions from all vessel traffic to and from the WTGs while within 25 nm of the WTA.

The implications of the alternate approach are discussed in this appendix in the following sections:

- Increase in PTE of the O&M phase
- PSD applicability
- NNSR applicability
- Operating permit applicability
- Pre-construction permit modeling requirements

2. Potential Emissions of O&M Phase Under Alternate Approach

Potential air emissions during the O&M phase which are subject to permitting under 40 CFR Part 55 when including WTGs as part of the OCS source are summarized in **Table 2-1**. The estimate of the Project's potential emissions during O&M differ from the estimates presented in Table 3-4 of the main application text due to the following:

- 1 additional crew transfer vessel servicing the WTGs (and not the OSS)
- Increased number of trips and duration of all other vessels to account for trips to the WTGs in addition to the OSS

Table 2-1. PTE During O&M – Alternate Approach.

Pollutant	CO_2	CH_4	N_2O	CO_2e	CO	NO_x	PM	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC	HAP
		Tons/year											
Vessels	9,534	0.06	0.5	9,671	34.2	151	4.9	4.6	4.4	0.2	0.0007	2.1	0.8

Pollutant	CO_2	CH_4	N_2O	CO_2e	CO	NO_x	PM	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC	HAP
	Tons/year												
Auxiliary Equipment	1,241	0.05	0.01	1,246	17.0	75.3	2.8	2.8	2.8	0.04	NA	2.8	0.01
Generators	497	0.02	0.004	499	6.9	1.3	0.06	0.06	0.08	0.01	NA	0.8	0.005
Fugitive	NA	NA	NA	1,381	NA	NA	NA	NA	NA	NA	NA	0.05	0.01
Total	**11,272**	**0.13**	**0.5**	**12,797**	**58.1**	**227.3**	**8.8**	**7.4**	**7.3**	**0.2**	**0.0007**	**5.8**	**0.9**

3. PSD Applicability

3.1 Policy Issue #1 – Whether WTGs should be included in the OCS Source in O&M

As discussed above, Ocean Wind believes the correct approach to OCS source determination in the O&M phase is to exclude the WTGs from the OCS source because the WTGs no longer have a PTE. This change in factual assumptions warrants revisiting the source determination basis from the Vineyard Wind and South Fork Wind Farm permits, which assumed WTGs would have emergency generators. However, EPA has indicated in preliminary discussions that the WTGs should be included in the OCS source in O&M. The combined potential emissions of all OCS sources, when including WTGs in the OCS source, during O&M are presented and compared to PSD major source thresholds in **Table 3-1**.

Table 3-1. PTE During O&M Compared to PSD Major Source Thresholds.

Pollutant	Potential to Emit tons/year	PSD Threshold tons/year	PSD Major Source
Carbon Monoxide (CO)	58.1	250	No
Nitrogen Oxides (NO_x)	227.3	250	No
Particulate Matter (PM)	8.8	250	No
Particulate Matter (PM_{10})	7.4	250	No
Particulate Matter ($PM_{2.5}$)	7.3	250	No
Sulfur Dioxide (SO_2)	0.2	250	No
Volatile Organic Compounds (VOC)	5.8	NA [1]	No [1]
Lead (Pb)	0.0007	250	No

[1] In accordance with 40 CFR 52.21(i)(2), the substantive PSD requirements [paragraphs (j) through (r)] shall not apply to a major stationary source with respect to a particular pollutant if the source is in an area designated as nonattainment under section 107 of the Act. Such areas are subject to nonattainment new source review (NNSR) if emissions are major under that program. Because the presumed COA is designated nonattainment for ozone, 40 CFR 52.21 paragraphs (j) through (r) do not apply to NO_x or VOC as ozone precursor emissions. However, NO_x emissions need to be treated as both PSD-regulated emissions for purposes of NO_2 impacts, and as NNSR-regulated emissions for purposes of ozone impacts.

Table 3-1 demonstrates that the O&M phase is not subject to PSD permitting, even when including the WTGs in the OCS source.

3.2 Policy Issue #2 – Whether the PTE of the Construction and Commissioning Phase Should be Used for NNSR/PSD Applicability Evaluations for the O&M Phase

Ocean Wind asserts that the O&M phase should be not subject to PSD just because the temporary construction and commissioning phase is over one or more PSD threshold(s). While both phases are part of the same Project, they are distinct in time and in emission quantities. The O&M phase will not commence until the construction and commissioning phase is complete. At that time, the PTE of the construction phase will cease to be the PTE of the Project. This is analogous to a PSD source on land removing most of its emission sources such that the PTE of the facility is no longer over the PSD thresholds. A source is not required to remain a PSD source in perpetuity simply because it was once a PSD source. This would be another version of EPA's 'once in always in' policy that was rescinded for major sources of HAP[1]. Ocean Wind is not aware of a similar 'once in always in' policy that EPA has applied to PSD major sources and is aware of multiple facilities that have ceased to be PSD major sources because of equipment changes or the acceptance of permit limits that reduced emissions to non-PSD major levels. However, if the PTE of the construction and commissioning phase is used to evaluate the applicability of PSD to the O&M phase, the O&M phase is subject to PSD permitting as shown in **Table 3-2**.

Table 3-2. PTE During Construction and Commissioning Compared to PSD SER Thresholds.

Pollutant	PTE	SER	PSD Review Required [1]
	tons/year	tons/year	
CO	576.3	100	**YES**
NO_x	2,160.7	40	**YES** [1]
PM	69.6	25	**YES**
PM_{10}	69.6	15	**YES**
$PM_{2.5}$	67.0	10	**YES**
SO_2	13.8	40	No
VOC	81.4 [1]	NA [1]	No [1]
Sulfuric Acid (H_2SO_4)	0.6	7	No
Lead (Pb)	0.008	0.6	No
GHG (as CO_2e) [2]	135,329	75,000	**YES**

[1] In accordance with 40 CFR 52.21(i)(2), the substantive PSD requirements [paragraphs (j) through (r)] shall not apply to a major stationary source with respect to a particular pollutant if the source is in an area designated as nonattainment under section 107 of the Act. Such areas are subject to nonattainment new source review (NNSR) if emissions are major under that program. Because the presumed COA is designated nonattainment for ozone, 40 CFR 52.21 paragraphs (j) through (r) do not apply to NO_x or VOC as ozone precursor emissions. However, NO_x emissions need to be treated as both PSD-regulated emissions for purposes of NO_2 impacts, and as NNSR-regulated emissions for purposes of ozone impacts.

[2] The SER for GHG applies to sources subject to PSD for another pollutant, also known as "anyway sources".

PSD review elements are described in 40 CFR § 52.21(j) through (s). PSD review elements specific to the O&M phase of the Project include a BACT analysis, a source impact analysis, an air quality analysis, and an additional impact analysis. The BACT analysis for the O&M phase is presented in Section 3.3. As described in the Ocean Wind Modeling Protocol dated June 17, 2022, the PTE during O&M is significantly lower than the PTE during the construction phase (regardless of EPA's final decision on Policy Issue #1 and Policy Issue #2). Therefore, since the Project has demonstrated compliance with all applicable NAAQS and PSD Class I and

[1] The recission of the 'once in always in' policy was codified at 40 CFR Part 63 on November 19, 2020 (see https://www.federalregister.gov/documents/2020/11/19/2020-22044/reclassification-of-major-sources-as-area-sources-under-section-112-of-the-clean-air-act).

Class II increment during the construction phase (see the Ocean Wind Modeling Report in **Appendix E** of this revised OCS air permit application package), and the types of sources modeled in both phases are the same, it is reasonable to assume that the Project will also demonstrate compliance with all applicable standards during the O&M phase.

Similarly, the AQRV analysis conducted for the construction and commissioning phase of the Project, in consultation with the Federal Land Manager (FLM), United States Fish and Wildlife Services (USFWS), of Brigantine Wilderness, is considered a conservative representation of the O&M phase. The AQRV modeling report is presented in **Appendix I** of this revised OCS air permit application package.

3.3 BACT Determination

As discussed in Section 2.3 of the main application text, certain vessels are anticipated to meet the definition of an OCS source during the O&M phase. This section presents the BACT determination for the marine diesel engines powering such vessels. All vessels anticipated to be considered OCS sources will be supplied by third-party contractors and so the exact specifications of each vessel engine are not available to Ocean Wind. Additionally, vessel selection is subject to change on short notice based on global and local vessel availability and Jones Act limitations.

As described in Section 2.3, the diesel generators that will be used on the OSS during O&M will meet the definition of an OCS source. The diesel generators will be installed on the OSS during commissioning and left on the OSS. Each generator will have an engine rated up to 800 hp.

Additionally, any diesel-powered equipment, such as a diesel generator, used onboard a vessel that meets the definition of an OCS source must also comply with BACT. Anticipated additional emission units onboard the jack-up vessel include a generator with an engine rated up to 5 hp, a generator with an engine rated up to 100 hp, and a cherry picker with an engine rated up to hp.

3.3.1 Engines Powering Vessels Meeting the Definition of an OCS Source – NO_x

Because the Project must comply with LAER for NO_x (see Section 4.2.1), the Project meets BACT for NO_x.

3.3.2 Engines Powering Vessels Meeting the Definition of an OCS Source – CO

Control options for CO are the same as identified for VOC in Section 4.2.2. Because these technologies were determined to be infeasible in the VOC LAER determination, they are also considered infeasible for CO BACT. Ocean Wind proposes the use of good combustion practices on all vessels and compliance with LAER for NO_x and VOC as BACT for CO. Refer to Section 4.2.2 for the LAER determination.

3.3.3 Engines Powering Vessels Meeting the Definition of an OCS Source – PM, PM_{10}, and $PM_{2.5}$

Control options for PM, PM_{10} and $PM_{2.5}$ for vessel engines in the O&M phase are the same as identified for vessel engines associated with the construction and commissioning phase in Section 6.3.3. These technologies are considered to be infeasible for O&M vessel engines for the same reasons described in Section 6.3.3. Ocean Wind proposes the use of good combustion practices on all vessels and compliance with LAER for NO_x and VOC as BACT for PM, PM_{10}, and $PM_{2.5}$.

3.3.4 Engines Powering Vessels Meeting the Definition of an OCS Source – GHG

GHG emissions emitted by the Project include the following products of combustion: carbon dioxide (CO_2), N_2O, and CH_4. Since N_2O is a subset of NO_x, the Project will meet BACT for N_2O by meeting LAER for NO_x and will meet BACT for CH_4 by meeting LAER for VOC.

Control options for CO_2 for vessel engines in the O&M phase are the same as identified for vessel engines associated with the construction and commissioning phase in Section 6.3.4. These technologies are

considered to be infeasible for O&M vessel engines for the same reasons described in Section 6.3.4. Ocean Wind proposes the use of good combustion practices on all vessels and compliance with LAER for NO_x and VOC as BACT for GHG.

3.3.5 Engines Powering Electric Generators on OSS and Engines Powering Auxiliary Equipment Onboard Vessels Considered OCS Sources – NO_x

Because the Project must comply with LAER for NO_x (see Section 4.2.3), the Project meets BACT for NO_x.

3.3.6 Engines Powering Electric Generators on OSS and Engines Powering Auxiliary Equipment Onboard Vessels Considered OCS Sources – CO

Control options for CO are the same as identified for CO in Section 6.2.3.4. Because these technologies were determined to be infeasible in the VOC LAER determination, they are also considered infeasible for CO BACT. Ocean Wind proposes the use of good combustion practices and compliance with LAER for NO_x and VOC as BACT for CO. Refer to Section 4.2.1 for the LAER determination.

3.3.7 Engines Powering Electric Generators on OSS and Engines Powering Auxiliary Equipment Onboard Vessels Considered OCS Sources – PM, PM_{10}, and $PM_{2.5}$

Control options for PM, PM_{10} and $PM_{2.5}$ for vessel engines in the O&M phase are the same as identified for generator and auxiliary equipment engines associated with the construction and commissioning phase in Section 6.3.7. These technologies are considered to be infeasible for O&M generator and auxiliary equipment engines for the same reasons described in Section 6.3.7. Ocean Wind proposes the use of good combustion practices and compliance with LAER for NO_x and VOC as BACT for PM, PM_{10}, and $PM_{2.5}$.

3.3.8 Engines Powering Electric Generators on OSS and Engines Powering Auxiliary Equipment Onboard Vessels Considered OCS Sources – GHG

GHG emissions emitted by the project include the following products of combustion: CO_2, N_2O, and CH_4. Since N_2O is a subset of NO_x, the Project will meet BACT for N_2O by meeting LAER for NO_x.

The same control options identified in Section 6.3.4 for vessel engines apply to generators and auxiliary equipment. These technologies are infeasible for generators and auxiliary equipment for the same reasons the technologies were determined to be infeasible for marine engines. Ocean Wind proposes the use of good combustion practices and compliance with LAER for NO_x and VOC as BACT for GHG. Refer to Section 4.2.1 for the LAER determination.

3.3.9 Electrical Equipment Fugitive Leaks – SF_6

The Project will include electrical equipment containing SF_6, which is a regulated GHG and a high GWP gas. This equipment will be associated with the electrical equipment (circuit breakers and switches) for the WTGs and OSS. The anticipated inventory of SF_6 in the electrical equipment is provided in the SF_6 spreadsheet incorporated in the emission calculations in Attachment 1 to this Appendix B.

Step 1: Identify all control technologies.

Because SF_6 emissions from circuit breakers and switches are fugitive, it is not practical to capture and control emissions of this gas from these sources. The only feasible control option is to minimize the fugitive emissions of SF_6 by following manufacturer recommendations for limiting leaks, and when significant leaks are detected, performing prompt repairs. Pressure sensors in the breakers and switches can be used to trigger an alarm so maintenance can be initiated to eliminate significant leakage points. Also, any SF_6 removed from breakers and switches during maintenance can be captured and recycled.

Another approach to eliminating or reducing fugitive SF_6 emissions is to replace all or some of the proposed SF_6-containing circuit breakers and switches with equipment using an alternate technology, such as vacuum circuit breakers with air as the insulating medium. This technology is available from some WTG manufacturers, such as Siemens 8VM1 high-voltage switchgear.

Step 2: Eliminate technically infeasible options.

The use of SF_6-free switchgear is not feasible for the WTGs that will be installed by the Project because the manufacturer providing WTGs for Ocean Wind, GE, will not have SF_6-free switchgear until 2024 at the earliest, which is too late based on the proposed schedule and purpose and need, to be used by Ocean Wind. Therefore, the only feasible control option left is to minimize the fugitive emissions of SF_6 by following manufacturer recommendations for limiting leaks, and when significant leaks are detected, performing prompt repairs.

Step 3: Rank remaining control technologies by control effectiveness.

There is only one remaining feasible control technologies, so there is no need to rank remaining control technologies.

Step 4 and 5: Evaluate most effective controls considering economic, energy, and environmental impacts of the control technology and select BACT.

Given that SF_6-containing circuit breakers and switches are the selected technology for the Project, the means of controlling SF_6 emissions from these sources is to minimize leakage via leak detection and prompt repairs if leaks are detected. The switchgears are designed to be maintenance-free so it is not expected that SF_6 will need to be removed from the equipment during the equipment life as part of regularly scheduled maintenance procedures.

Considering the extremely small amount of CO_2e emissions attributed to fugitive SF_6 and the fact that emissions are fugitive and difficult to measure or limit, it is impractical to establish a numerical BACT limitation with respect to SF_6-containing equipment.

While a 0.5% per year or lower leakage rate is a reasonable average target from all SF_6-containing circuit breakers and switches, a significant leak on one unit could cause this level to be exceeded in any given year. However, over the life of the Project, it is anticipated the average leak rates would be below the 0.5% level.

Review of EPA's RBLC database shows numerous SF_6 breaker/switch BACT entries in the last 10 years. Many of the determination entries require maintenance and recordkeeping procedures for fugitive emissions of SF_6. but many other determination entries specify a limit of 0.5% per year as an SF_6 loss rate. As explained, the SF_6 loss rate may exceed the conservative average 0.5% loss rate if there is a significant leak in one component. Therefore, the BACT proposed for GHG emissions from Electrical Equipment – Fugitive Leaks are the work practices that are in accordance with PSD rules as summarized below.

- Follow manufacturer recommendations for service and repair of the affected breakers and switches.
- Conduct visual inspections of the switchgear and monitoring equipment according to manufacturer recommendations.
- Create alarms based on the pressure readings in the breakers/switches, so leaks can be detected when substantial SF_6 leakage occurs. Upon a detectable pressure drop that is >10% of the original pressure (accounting for ambient air conditions), perform maintenance to fix seals as soon as feasible. If an event requires removal of SF_6, the affected major component(s) will be replaced with new component(s).
- Keep a log of all detected leaks and maintenance procedures potentially affecting SF_6 emissions from circuit breakers/switches.

4. NNSR Applicability

The O&M phase is not subject to NNSR when evaluating the PTE of the O&M phase separately from the PTE of the construction and commissioning phase and when excluding WTGs from the OCS source in O&M. However, if EPA adopts either, or both, of these two approaches (the PTE of the construction and commissioning phase is used to evaluate the applicability of the O&M phase or the WTGs are included in the OCS Source in O&M), the O&M phase is subject to NNSR as described in this section.

N.J.A.C. Chapter 27, Subchapter 18 establishes the ambient air quality requirements that a project must meet for the Department to issue an air quality preconstruction permit. An application must comply with this subchapter if it meets the following criteria:

1. the facility has the potential to emit any of the air contaminants equal to or exceeding the NJDEP major source thresholds; and
2. any allowable emissions proposed in the application would result in a significant net emission increase of any contaminant listed in Table 3 of N.J.A.C. 7:27-18.7, and
3. the facility is located at an area which is nonattainment for the respective criteria pollutant(s) corresponding to that air contaminant.

The COA of the Project is designated nonattainment for ozone. When including WTGs in the OCS source, the O&M phase exceeds the NJDEP major source thresholds for one or more pollutants and exceeds the listed significant net emission increase thresholds for NO_x, as shown in **Table 4-1**. Therefore, the O&M phase of the Project is subject to NNSR for the ozone precursor pollutant NO_x.

Table 4-1. NJDEP Significant Net Emission Increase Thresholds and O&M PTE (Alternative Approach).

Pollutant	O&M PTE	Threshold	Exceeds Threshold?
	tons/year	tons/year	
SO_2	0.2	40	No
SO_2 (as $PM_{2.5}$ precursor)	0.2	40	No
TSP [1]	8.8	25	No
PM	8.8		
PM_{10}	7.4	15	No
$PM_{2.5}$	7.3	10	No
CO	58.1	100	No
NO_x	227.3	25	**YES**
NO_x as $PM_{2.5}$ precursor	227.3	40	**YES**
VOC	5.8	25	No
Pb	0.0007	0.6	No

[1] It is assumed TSP is equivalent to PM.

Pursuant to N.J.A.C. 7:27-18.4(a), ozone is excluded from the requirement to conduct an air quality impact analysis. Therefore, there is no required air quality impact analysis specific to NNSR requirements.

4.1 Emissions Offsets

The O&M phase of the Project must comply with N.J.A.C. 7:27-18.3(b) which requires that air emissions from the equipment proposed to be constructed will be controlled to the degree which represents the LAER and certify, in accordance with N.J.A.C. 7:27-1.39, that all existing facilities in New Jersey, which are owned or operated by the person applying for the permit, or by any entity controlling, controlled by, or under common control with such person, are operating:

1. In compliance with the provisions of [Subchapter 18] and with all applicable emission limitations and standards promulgated pursuant to the Federal Clean Air Act; or
2. In conformance with an enforceable compliance schedule approved by the Department.

Finally, N.J.A.C. 7:27-18.3(c) requires that any person subject to Subchapter 18 pursuant to N.J.A.C. 7:27-18.2(a) and 18.2(b)(1) secure emission offsets, in accordance with N.J.A.C. 7:27-18.5, for each air contaminant having a significant net emission increase at the facility.

The O&M phase potential emissions are subject to Subchapter 18 and the Project must obtain emission reductions for the O&M phase in accordance with Subchapter 18. Table 2 of Subchapter 18 identifies an applicable offset ratio of 1.3-to-1 when obtaining offsets from sources within 100 miles of the Project and an offset ratio of 2.6-to-1 when obtaining offsets from sources greater than 100 miles from the Project but less than 250 miles. When the annual NO_x PTE for the O&M phase shown in **Table 2-1** is multiplied by the applicable offset ratio of 1.3-to-1, the resulting emission offset requirements is 296 tons per year of NO_x offsets. If the annual NO_x PTE for the O&M phase shown in **Table 2-1** is multiplied by an offset ratio of 2.6-to-1, the resulting worst case emission offset requirement is 591 tons per year of NO_x offsets.

If the WTG are not included in the OCS source in O&M but the O&M phase is still subject to NNSR because the construction and commissioning phase is subject to NNSR, then the Project must obtain offsets for the annual NO_x PTE for the O&M phase shown in Table 3-4 of the revised permit application submitted with this revised Appendix B. When multiplied by the applicable offset ratio of 1.3-to-1, the resulting emission offset requirement is 15 tons per year of NO_x offsets. If the annual NO_x PTE for the O&M phase shown in Table 3-4 of the revised permit application submitted with this revised Appendix B is multiplied by an offset ratio of 2.6-to-1, the resulting worst case emission offset requirement is 30 tons per year of NO_x offsets.

N.J.A.C. 7:27-18.3(e) requires that an emission offset demonstration be submitted with the application which specifies:

1. The sources of the air contaminant emission reductions to be applied as emission offsets;

   PSEG, part owner of the Project, has banked offsets from the permanent retirement of the PSEG Fossil Hudson and Mercer Generating Stations. The offsets were entered into New Jersey's Banked Emission Credits on August 30, 2017.

   The Fossil Hudson Generating Station is 112.59 miles from the centroid of the Project array and 105.35 miles from the boundary of the array area. PSEG has a total of 494.2 tons per year of NO_x banked from the permanent retirement of the Fossil Hudson Generating Station.

   The Mercer Generating Station is 77.81 miles from the centroid of the Project array and 71.09 miles from the boundary of the array area. PSEG has a total of 210.96 tons per year of NO_x banked from the permanent retirement of the Mercer Generating Station.

   The banked emission offsets from the Fossil Generating Station and the Mercer Generating Station will be discounted by fifty percent on August 30, 2022 per N.J.A.C. 7:27-18.8(f). The total banked offsets owned by PSEG from the Fossil Hudson Generating Station after August 30, 2022 will be 247.1 tons per year NO_x. The total banked offsets owned by PSEG from the Mercer Generating Station after August 30, 2022 will be 105.48 tons per year NO_x. The Project application submittal date is prior to August 30, 2022; therefore, 494.2 tons per year of NO_x is available from the Fossil Hudson Generating Station and 210.96 tons per year of NO_x from the Mercer Generating Station is available for the Project.

   For the case where the Project needs to offset 227 tons per year of NO_x (when WTGs are included in the OCS source for O&M), the Project will obtain 210.96 tons per year of NO_x from the Mercer

Generating Station, which will offset 162.2 tons per year. The remaining 64.8 tons per year of NO_x will be offset from the Fossil Hudson Generating Station. At a ratio of 2.6-to-1, offsetting 64.8 tons per year will require 168.48 tons per year of the 494.2 tons per year available.

For the case where the Project needs to offset 11.6 tons per year of NO_x (when WTGs are not included in the OCS source for O&M), the Project will obtain 15.1 tons per year of NO_x from the Mercer Generating Station.

Please see the printout of New Jersey's Banked Emission Credits included in Attachment 2 to this Appendix B.

2. How the emission reductions shall be effected;

   The emission reductions were effected at the time they were banked by PSEG, August 30, 2017.

3. How the owner or operator of the facility generating the emissions offsets will make the permanent reduction of the emissions to be used as emission offsets Federally enforceable on or before the date that the Department will issue to the applicant the authorization required under N.J.A.C. 7:27-8 or 22;

   PSEG is the owner and operator of the facilities generating the emissions offsets. The emissions reductions were made permanent and Federally enforceable at the time they were banked by PSEG, August 30, 2017.

4. How the applicant shall 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; and

   The emissions reductions were made permanent at the time they were banked by PSEG, on August 30, 2017.

5. How the emission offsets to be secured will comply with N.J.A.C. 7:27-18.5.

   The emission offsets comply with N.J.A.C. 7:27-18.5 because they have been banked in accordance with N.J.A.C. 7:27-18.8.

4.2 LAER Review

4.2.1 Engines Powering Vessels Meeting the Definition of an OCS Source – NO_x

Compression-ignition internal combustion engines power vessels utilized during O&M will be subject to LAER while the vessels meet the definition of an OCS source. Ocean Wind anticipates that a jack-up vessel used for unplanned O&M for the major components will meet the definition of an OCS source. Other vessels that may meet the definition of an OCS source include any vessels physically attached to an OCS source. The Project will use vessel engines that comply with the most stringent NO_x emission limit identified in any SIP, the most stringent limit achieved in practice, or the most stringent limit identified in any applicable NSPS or NESHAP.

Section 6.2.1 of the main application text contains a review of SIPs, limits achieved in practice, and limits identified in any applicable NSPS or NESHAP. The review presented in Section 6.2.1 for vessels associated with the construction and commissioning phase also applies to vessels associated with O&M.

The evaluation of potential LAER techniques for NO_x described in Section 6.2.1.4 for vessels associated with the construction and commissioning phase also applies to vessels associated with the O&M phase. The following discussion provides additional relevant information of how LAER will apply to vessels associated with the O&M phase.

Although there are two jack-up vessels worldwide capable of combusting LNG and one being built capable of combusting methanol, it is not feasible for the Project to restrict the pool of vessels for O&M for several reasons, including:

- Jack-up vessels must meet Project specifications regarding size, power, and other characteristics. There are only a few jack-up vessels worldwide that meet these specifications.
- There are dozens of other offshore wind projects scheduled to be constructed over the next 10-15 years off the East Coast alone, all of which will require jack-up vessels for construction and for O&M purposes.
- Restrictions to limit vessel pool to two, or potentially three, vessels would likely result in higher overall NO_x emissions because:
    - Delaying O&M activities until the lower NO_x-emitting vessel is available could result in a failure of one or more components or systems of the Project, jeopardizing its ability to produce clean energy.
    - The lower NO_x-emitting vessel would likely need to travel significant distances to reach the Project because Ocean Wind is aware of only two jack-up vessels that combust LNG available in the world and one vessel capable of combusting methanol that is anticipated to be built by 2024.
    - The Project's other construction equipment would idle during the delay caused by waiting for the lower NO_x-emitting vessel to arrive on-site.

Therefore, Ocean Wind will not be able to conduct O&M activities in accordance with the schedule required by the Project without the flexibility to use jack-up vessels with engines combusting traditional marine vessel fuels. For similar reasons, it is not feasible to limit the pool of potential jack-up vessels to those with engines meeting specific Tier standards.

It is not feasible for Ocean Wind to require that third-party contractors replace or retrofit vessel engines to reduce NO_x emissions for reasons like those discussed above. Ocean Wind does not know specifically which vessels will be utilized during O&M and vessel availability is subject to change on short notice. Because several other offshore wind projects will be under construction or in operation at the same time as Ocean Wind, vessel availability is anticipated to be constrained, in addition to limitations imposed by the Jones Act. Additionally, the vessels that will be utilized during O&M are not under Ocean Wind's control since all vessels that will be OCS sources will be third-party vessels. Requiring the replacement or retrofit of specific vessel would prevent Ocean Wind from being able to substitute vessels on short notice due to unplanned maintenance or repair events, or schedule changes to planned maintenance events. For reasons discussed above, it is not feasible for Ocean Wind to wait for specific vessels to be available. Finally, the third-party contractor and/or Ocean Wind would not be able to recoup the high costs of retrofit or replacement. Requiring such process modifications would impose control costs so great that no major offshore wind farm could be built.

For the reasons described in Section 6.2.1, as well as the additional clarifying information provided above, Ocean Wind proposes LAER for NO_x for vessels considered OCS sources in O&M is the same as what was proposed in Section 6.2.1.5.

4.2.2 Engines Powering Vessels Meeting the Definition of an OCS Source – VOC

Section 6.2.2 of the main application text contains a review of SIPs, limits achieved in practice, and limits identified in any applicable NSPS or NESHAP. The review presented in Section 6.2.2 for vessels associated with the construction and commissioning phase also applies to vessels associated with O&M.

The evaluation of potential LAER techniques for VOC described in Section 6.2.2.4 for vessels associated with the construction and commissioning phase also applies to vessels associated with the O&M phase. Ocean

Wind proposes LAER for VOC for vessels considered OCS sources in O&M is the same as what was proposed in Section 6.2.2.5, for the same reasons discussed in Section 6.2.2.

4.2.3 Engines Powering Electric Generators on OSS and Engines Powering Auxiliary Equipment Onboard Vessels Considered OCS Sources – NO_x

The diesel generators installed on the OSS during O&M are subject to NNSR and must comply with LAER. There will be 3 generators installed on the OSS (1 per OSS) with engines rated up to 800 hp. Additionally, any diesel engine powering equipment, such as a diesel generator, or cherry picker, used onboard a vessel that becomes an OCS source is also subject to NNSR while the vessel is considered an OCS source. Additional emission units onboard the jack-up vessel include a generator with an engine rated up to 5 hp, a generator with an engine rated up to 100 hp, and a cherry picker rated up to 6 hp. The Project will use engines that comply with the most stringent NO_x emission limit(s) identified in any SIP, the most stringent limit achieved in practice, or the most stringent limit identified in any applicable NSPS or NESHAP.

Please see Section 6.2.3 for a review of SIPs, limits achieved in practice, and limits identified in any applicable NSPS or NESHAP; the review conducted in Section 6.2.3 for engines powering electric generators and engines powering auxiliary equipment onboard vessels considered OCS sources associated with the construction and commissioning phase also applies to these types of engines associated with O&M.

The LAER review conducted in Section 6.2.3 applies to the engines powering electric generators and engines powering auxiliary equipment onboard vessels considered OCS sources associated with the O&M phase. As a result, Ocean Wind proposed the following as LAER:

<u>Diesel-Fired Generating Sets on Offshore Substations</u>

Ocean Wind proposes that LAER for the approximately 600 kW diesel generator sets that will be installed on the OSS during commissioning and left on OSS during O&M is to select engines that have been certified by the manufacturer to meet the Tier 4 emission standards of 40 CFR Part 1042.

<u>Diesel Fired Equipment Onboard Vessels Considered OCS Sources</u>

Ocean Wind proposes that LAER for any diesel engine powered equipment, such as a diesel generator or cherry picker, used onboard a vessel that becomes an OCS source is to utilize engines that are certified by the manufacturer to meet the highest tier emission standards available at the time of deployment.

5. N.J.A.C. Chapter 27, Subchapter 22

N.J.A.C. Chapter 27, Subchapter 22 establishes the Major Source Operating Permit Requirements. This applies to any facility that is major for HAP, including fugitive emissions, or exceeds the thresholds presented in **Table 5-1**. When comparing facility emissions to thresholds in **Table 5-1** fugitive emissions are not included unless the facility falls into one of 28 listed source categories. The Project does not fall into one of the listed 28 source categories; therefore, fugitive emissions are not included when comparing to the thresholds.

Table 5-1. Operating Permit Facility Thresholds.

Air Contaminant	Threshold Level
CO	100 tons per year
PM_{10}	100 tons per year
$PM_{2.5}$	100 tons per year

Air Contaminant	Threshold Level
TSP	100 tons per year
SO_2	100 tons per year
SO_2 (as $PM_{2.5}$ precursor)	100 tons per year
NO_x	25 tons per year
NO_x (as $PM_{2.5}$ precursor)	100 tons per year
VOC	25 tons per year
Lead	10 tons per year
Any other air contaminant, except CO_2	100 tons per year

Potential emissions from the O&M phase exceed the thresholds listed in **Table 5-1** for NO_x and NO_x as $PM_{2.5}$ precursor. Therefore, the Project is required to obtain an operating permit under Subchapter 22.

6. N.J.A.C. Chapter 27, Subchapter 8

Pursuant to N.J.A.C. 7:27-8.5(a)(2) an application for a preconstruction permit must include an air quality impact analysis if the facility for which the application is submitted is a major facility as defined as N.J.A.C. 8:27-8.1 and the proposed maximum allowable increases of an air contaminant would result in a significant net emission increase.

The threshold for a major facility is presented in **Table 6-1**, along with the PTE of the O&M phase when including WTGs in the OCS source. The Project exceeds major facility thresholds in the O&M phase for at least one pollutant and is therefore considered a major source.

Table 6-1. PTE During O&M Compared to NJDEP Major Source Thresholds.

Air Contaminant	Threshold Level Tons per year	Potential to Emit Tons per year	Exceeds Threshold?
CO	100	52.0	No
PM_{10}	100	6.8	No
$PM_{2.5}$	100	6.6	No
TSP	100	6.8	No
SO_2	100	0.3	No
SO_2 (as $PM_{2.5}$ precursor)	100	0.3	No
NO_x	25	220.9	**YES**
NO_x (as $PM_{2.5}$ precursor)	100	220.9	**YES**
VOC	25	3.4	No
Lead	10	0.001	No

The significant net emission increase thresholds are presented in **Table 6-2**. The O&M phase exceeds significant net emission increase thresholds for the pollutants indicated in **Table 6-2**.

Table 6-2. PTE During O&M Compared to NJDEP Significant Net Emission Increase Thresholds.

Air Contaminant	Threshold Level Tons per year	Potential to Emit Tons per year	Exceeds Threshold?
CO	100	52.0	No
PM_{10}	15	6.8	No
$PM_{2.5}$	10	6.6	No
TSP	25	6.8	No
SO_2	40	0.3	No
SO_2 (as $PM_{2.5}$ precursor)	40	0.3	No
NO_x	25	220.9	**YES**
NO_x (as $PM_{2.5}$ precursor)	40	220.9	**YES**
VOC	25	3.4	No
Lead	0.6	0.001	No

NJDEP modeling guidance[2] states that applications for a new major source must conduct an air quality impact analysis for each pollutant whose proposed net emissions increases exceed the significant net emissions increase thresholds shown above in **Table 6-1**. Therefore, the Project must conduct a NAAQS analysis for $PM_{2.5}$ and NO_2 in the O&M phase.

[2] New Jersey Department of Environmental Protection. May 2021. *Guidance on Preparing an Air Quality Modeling Protocol.* Retrieved from https://www.state.nj.us/dep/aqpp/downloads/techman/1002.PDF.

Vessel Transit Distances: Construction Phase [1] [2]	Distance Within OCS nautical miles	Distance Outside OCS nautical miles	Total Trip Distance (One-Way) nautical miles
Atlantic City, NJ	21.2	0	21.2
Charleston, SC	25	513.6	538.6
Europe	25	168.1	193.1
Hope Creek, NJ	25	67.9	92.9
Norfolk, VA	25	166.0	191.0
Paulsboro, NJ	25	101.8	126.8
Port Elizabeth, NJ	25	57.2	82.2
Repauno, NJ	25	118.3	124.5

[1] The ports listed are the expected list of ports Ocean Wind may use; this table displays distances to each port and breaks it down into distances occuring within the 25 nautical mile radius from the centroid of the array area and those outside that circle. When calculating time spent in transit for the purpose of estimating emissions, the longest route was selected among the list of expected possible ports for each vessel as a conservative assumption.

[2] It is assumed all crew transfer vessels utilize Atlantic City port.

Vessel Transit Distances: Operations Phase	Distance Within OCS nautical miles	Distance Outside OCS nautical miles	Total Trip Distance (One-Way) nautical miles
Atlantic City, NJ	21.2	0	21.2
Europe	25	168.1	193.1

Project Information - Bureau of Ocean Energy Management (BOEM) Default Vessel Parameters [1]

Vessel Type [1]	Vessel Speed [1] Knots			Main Engine Power Rating [1] kW			Auxiliary Engine Power Rating [1] kW		
	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
Anchor Handling Tugs	12.37	12.37	12.37	5,732.71	5,732.71	5,732.71	1,237.10	1,237.10	1,237.10
Barge	19.99	19.99	19.99	22,424.22	22,424.22	22,424.22	3,020.00	3,020.00	3,020.00
Cable Laying	12.24	12.24	12.24	6,657.62	6,657.62	6,657.62	3,025.77	3,025.77	3,025.77
Crew	22.13	22.13	22.13	3,013.01	3,013.01	3,013.01	201.05	201.05	201.05
Dredging	10.92	10.92	10.92	3,233.66	3,233.66	3,233.66	963.82	963.82	963.82
Jackup	7.00	7.00	7.00	3,214.91	3,214.91	3,214.91	895.08	895.08	895.08
Research/Survey	12.46	12.46	12.46	2,996.75	2,996.75	2,996.75	1,362.92	1,362.92	1,362.92
Shuttle Tanker	14.76	14.76	14.76	17,484.02	17,484.02	17,484.02	30,769.22	30,769.22	30,769.22
Supply Ship	12.12	12.12	12.12	3,842.65	3,842.65	3,842.65	873.99	873.99	873.99
Tug	11.53	11.53	11.53	2,053.16	2,053.16	2,053.16	238.13	238.13	238.13

[1] Chang, R., B. Do, and R. Billings. 2017. Technical Summary for the Offshore Wind Energy Facilities Emission Estimating Tool. US Dept. of the Interior, Bureau of Ocean Energy Management, Sterling, VA. OCS Study BOEM 2017. 9 pp.

Engine	Type [1]	Units	Emission Factors									
			CO_2	CH_4	N_2O	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Main	Anchor Handling Tugs	g/kW-hr	636.09	4.00E-03	3.10E-02	2.16	9.26	0.34	0.33	7.87E-02	4.03E-05	0.24
Main	Barge	g/kW-hr	588.90	4.00E-03	3.10E-02	1.40	13.61	0.45	0.42	0.36	1.18E-05	0.63
Main	Cable Laying	g/kW-hr	635.02	4.00E-03	3.10E-02	2.20	9.49	0.34	0.33	8.51E-02	3.88E-05	0.25
Main	Crew	g/kW-hr	648.16	4.00E-03	3.10E-02	2.30	5.51	0.15	0.15	6.24E-03	4.65E-05	0.14
Main	Dredging	g/kW-hr	630.62	4.00E-03	3.10E-02	2.13	9.60	0.36	0.34	0.11	3.70E-05	0.28
Main	Jackup	g/kW-hr	647.08	4.00E-03	3.10E-02	2.30	10.03	0.31	0.30	1.27E-02	4.51E-05	0.14
Main	Research/Survey	g/kW-hr	638.26	4.00E-03	3.10E-02	2.25	9.86	0.34	0.33	6.57E-02	4.15E-05	0.22
Main	Shuttle Tanker	g/kW-hr	588.90	4.00E-03	3.10E-02	1.40	9.05	0.45	0.42	0.36	1.18E-05	0.63
Main	Supply Ship	g/kW-hr	644.58	4.00E-03	3.10E-02	2.29	9.44	0.32	0.31	2.77E-02	4.45E-05	0.17
Main	Tug	g/kW-hr	643.66	4.00E-03	3.10E-02	2.29	9.52	0.33	0.32	3.33E-02	4.48E-05	0.18
Main	Feeder Barge Tug	g/kW-hr	643.66	4.00E-03	3.10E-02	2.29	9.52	0.33	0.32	0.03	0.00	0.18
Main	Multi-Purpose Service Vessel	g/kW-hr	630.62	4.00E-03	3.10E-02	2.13	9.60	0.36	0.34	0.11	0.00	0.28
Main	Noise Monitoring Vessel	g/kW-hr	643.66	4.00E-03	3.10E-02	2.29	9.52	0.33	0.32	0.03	0.00	0.18
Main	Guard Vessel	g/kW-hr	638.26	4.00E-03	3.10E-02	2.25	9.86	0.34	0.33	6.57E-02	4.15E-05	0.22
Main	Heavy Lift Installation Vessel	g/kW-hr	647.08	4.00E-03	3.10E-02	2.30	10.03	0.31	0.30	1.27E-02	4.51E-05	0.14
Main	Platform Support Vessel	g/kW-hr	644.58	4.00E-03	3.10E-02	2.29	9.44	0.32	0.31	2.77E-02	4.45E-05	0.17
Main	Compressor	g/kW-hr	647.08	4.00E-03	3.10E-02	2.30	10.03	0.31	0.30	1.27E-02	4.51E-05	0.14
Main	Heavy Transport Vessel	g/kW-hr	647.08	4.00E-03	3.10E-02	2.30	10.03	0.31	0.30	1.27E-02	4.51E-05	0.14
Main	Support Vessel - Small	g/kW-hr	644.58	4.00E-03	3.10E-02	2.29	9.44	0.32	0.31	0.03	0.00	0.17
Main	Support Vessel - Large	g/kW-hr	638.26	4.00E-03	3.10E-02	2.25	9.86	0.34	0.33	0.07	0.00	0.22
Auxiliary	Anchor Handling Tugs	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	9.88	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Barge	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	12.57	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Cable Laying	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	9.89	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Crew	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	5.51	0.15	0.15	6.00E-03	4.80E-05	0.14
Auxiliary	Dredging	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	9.85	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Jackup	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	11.55	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Research/Survey	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.21	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Shuttle Tanker	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	9.80	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Supply Ship	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.43	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Tug	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.10	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Feeder Barge Tug	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.10	0.32	0.31	0.01	0.00	0.14
Auxiliary	Multi-Purpose Service Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	9.85	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Noise Monitoring Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.10	0.32	0.31	0.01	0.00	0.14
Auxiliary	Guard Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.21	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Heavy Lift Installation Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	11.55	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Platform Support Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.43	0.32	0.31	0.01	0.00	0.14
Auxiliary	Compressor	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	11.55	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Heavy Transport Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	11.55	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Support Vessel - Small	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.43	0.32	0.31	0.01	0.00	0.14
Auxiliary	Support Vessel - Large	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.21	0.32	0.31	0.01	0.00	0.14

[1] Emission factors for project-specific vessels are assumed to be equivalent to BOEM Wind Tool emission factors for the vessel that is closest in engine rating, except for crew vessels. The NO_x, PM_{10}, and $PM_{2.5}$ emission facors correspond to the lowest (resulting in highest emissions) Tier emission standard in 40 CFR § 1042 that this vessel type may be certified by the manufacturer as meeting.

Vessel Type [1]	Equivalent Vessel Type in BOEM WindTool	Maneuvering Time per Roundtrip [1] [2] (hours)
Misc.	All others	1
Tanker	Shuttle Tanker	1
Tug	Tug	1.7
Vehicle Carrier	Barge	1

[1] U.S.EPA. (2018). 2014 National Emissions Inventory, Version 2 Technical Support Document.

[2] Manuevering time at port and vessel type obtained from Table 4-111 of 2014 NEI Technical Support Document. The types of vessels the Project will use was aligned with the vessel types given in the NEI table as shown in column 'Equivalent Vessel Type in BOEM WindTool'. The time Project vessels spend maneuvering at port is subtracted, along with other activities, from the total time the vessel is used to obtain time spent in on-site maneuvering.

Propulsion Engines Load Factor [1]				
Vessel Type	Transit	On-site Maneuvering	Port Maneuvering	Hoteling [2]
All	0.82	0.2	0.2	0
Jackup [3]	0.82	0	0.2	0

[1] Load factors for the propulsion engines are the default BOEM WindTool load factors, as a worst case assumption. The default BOEM load factors for propulsion engines are consistent with other available sources of marine vessel load factors, including USEPA (2000), 2009 USEPA, and 2014 NEI (EPA, 2018). Note that the terms propulsion engine and main engine are used interchangeably throughout workbook.

[2] It is assumed only auxiliary engines are used for hoteling for all vessel types, based on 2014 NEI (EPA, 2018).

[3] Jack-up vessels plant their legs on the seafloor to remain in place, so it is assumed the propulsion engines of jack-up vessels will not engage in on-site maneuvering.

Auxiliary Engines Load Factor				
Table 4-120 of 2014 NEI				Table 2-7 of 2009 USEPA [1]
Vessel Type	Type in BOEM WindTool	Maneuvering	Hotel [2]	Transit
Drilling	Dredging	0.45	0.22	0.32
Jackup [3]	Jackup	0	0.22	0.32
Pipelaying	Cable Laying	0.45	0.22	0.32
Research	Research/Survey	0.45	0.22	0.32
Supply	Supply Ship	0.45	0.22	0.32
Support	Crew	0.45	0.22	0.32
Tanker	Shuttle Tanker	0.33	0.26	0.32
Tug	Tug	0.45	0.22	0.32
Vehicle Carrier	Barge	0.45	0.22	0.32

[1] Load factors for auxiliary engines in transit are from 2009 USEPA, which based load factors on a study conducted for the 2005 emissions inventory for the Port of Los Angeles. Excluding cruise ships, the highest load factor among cruise load factors and Reduced Speed Zone (RSZ) load factors is assumed to represent transit load factors for all vessels used for Ocean Wind, as a conservative assumption.

[2] It is assumed vessels equipped with Category 1 or 2 propulsion engines do not engage propulsion or auxiliary engines while hoteling based on 2014 NEI (EPA, 2018) and assume to engage in cold ironing. Category 1, 2 and 3 marine vessel engines are defined in 40 CFR 1042.901 based on engine displacement. Because engine displacement information is unknown, it was assumed that Category 1 and 2 engines are typically smaller than 3,000 kW (Browning and Bailey). If the propulsion engine is greater than 3,000 kW then the load factor displayed is utilized in emissions calculations for hoteling for auxiliary engines.

[3] Jack-up vessels plant their legs on the seafloor to remain in place, so it is assumed the auxiliary engines of jack-up vessels will not engage in on-site maneuvering.

Sources:

2014 NEI: U.S.EPA. (2018). 2014 National Emissions Inventory, Version 2 Technical Support Document.

Browning and Bailey: Browning, ICF Consulting and Bailey, USEPA. Current Methodologies and Best Practice for Preparing Port Emission Inventories. https://www3.epa.gov/ttnchie1/conference/ei15/session1/browning.pdf

U.S.EPA. (2000). Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data. https://nepis.epa.gov/Exe/ZyPDF.cgi/P1009Z2K.PDF?Dockey=P1009Z2K.PDF

2009 USEPA: U.S.EPA. (2009). Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories. https://www.epa.gov/sites/production/files/2016-06/documents/2009-port-inventory-guidance.pdf

Phase	Activity	Vessel Description	Project-Specific Vessel Type	BOEM Wind Tool Vessel Type	Vessel Type [1]	Number of Vessels	Port	Longest Overall Route Distance	Main Engine Rating (kW)	Auxiliary Engine Rating (kW)	Average Speed of Vessel (nm/hr) 1 knot = 1 nm/hr	Number of One Way Trips Per Vessel Between Array and Port	Installation Duration Not Including Transit (Days)	Transit & Installation Duration (Days)	Propulsion Engines Load Factor: Transit	Propulsion Engine Load Factor: Maneuvering	Propulsion Engine Load Factor: Hoteling	Auxiliary Engine Load Factor: Transit	Auxiliary Engine Load Factor: Maneuvering	Auxiliary Engine Load Factor: Hoteling
Construction	Array Cable Installation	Pre-lay Survey Vessel	Not Given	Crew	Crew	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,060.00	201.05	10.00	3	60	67	0.82	0.2	0	0.32	0.45	0
Construction		Pre-lay Grapnel Run (PLGR) Vessel	Not Given	Dredging	Dredging	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,233.66	963.82	10.00	3	35	42	0.82	0.2	0	0.32	0.45	0.22
Construction		Boulder Clearance Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,131.92	1,006.68	10.00	3	50	57	0.82	0.2	0	0.32	0.45	0.22
Construction		Sandwave Clearance Vessel	Not Given	Dredging	Dredging	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,233.66	963.82	10.00	3	35	42	0.82	0.2	0	0.32	0.45	0.22
Construction		Cable Laying Vessel	Not Given	Cable Laying	Cable Laying	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	6,657.62	3,025.77	10.00	14	100	131	0.82	0.2	0	0.32	0.45	0.22
Construction		Cable Burial Vessel	Not Given	Cable Laying	Cable Laying	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	6,657.62	3,025.77	10.00	14	150	181	0.82	0.2	0	0.32	0.45	0.22
Construction		Crew Transport Vessel	Not Given	Crew	Crew	2	Atlantic City, NJ	Atlantic City, NJ	2,060.00	201.05	22.13	99	75	79	0.82	0.2	0	0.32	0.45	0
Construction		Walk to Work Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,131.92	1,006.68	10.00	99	120	342	0.82	0.2	0	0.32	0.45	0.22
Construction		Post-Lay Inspection Survey Vessel	Not Given	Crew	Crew	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,060.00	201.05	10.00	50	110	222	0.82	0.2	0	0.32	0.45	0
Construction		DP2 Construction Vessel - Jack of All Trades	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,131.92	1,006.68	10.00	51	71	186	0.82	0.2	0	0.32	0.45	0.22
Construction	Offshore Export Cable & Interconnection Cable Installation	Cable Lay and Burial Vessel	Not Given	Cable Laying	Cable Laying	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	6,657.62	3,025.77	10.00	20	200	245	0.82	0.2	0	0.32	0.45	0.22
Construction		Cable Burial Vessel	Not Given	Cable Laying	Cable Laying	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	6,657.62	3,025.77	10.00	21	15	62	0.82	0.2	0	0.32	0.45	0.22
Construction		Anchor Handling Tug	Not Given	Tug	Tug	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,053.16	238.13	10.00	30	60	127	0.82	0.2	0	0.32	0.45	0
Construction		Pull tug to move barges	Not Given	Tug	Tug	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,053.16	238.13	10.00	100	200	424	0.82	0.2	0	0.32	0.45	0
Construction		Pull ahead export cable tug for assist CLV	Anchor Tug	NA	Anchor Tug	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	1,230.00	357.00	10.00	70	135	292	0.82	0.2	0	0.32	0.45	0
Construction		Pre-lay Grapnel Run (PLGR) Vessel	Not Given	Dredging	Dredging	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,233.66	963.82	10.00	11	60	85	0.82	0.2	0	0.32	0.45	0.22
Construction		Boulder Clearance Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,131.92	1,006.68	10.00	5	30	41	0.82	0.2	0	0.32	0.45	0.22
Construction		Crew Transport Vessel	Not Given	Crew	Crew	2	Atlantic City, NJ	Atlantic City, NJ	2,060.00	201.05	22.13	11	68	68	0.82	0.2	0	0.32	0.45	0
Construction		Guard Vessel	Guard Vessel	NA	Guard Vessel	5	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,460.00	357.00	10.00	30	200	267	0.82	0.2	0	0.32	0.45	0
Construction		Post-Lay Inspection Survey Vessel	Not Given	Crew	Crew	2	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,060.00	201.05	10.00	11	18	43	0.82	0.2	0	0.32	0.45	0
Construction		General Work Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,131.92	1,006.68	10.00	15	67	101	0.82	0.2	0	0.32	0.45	0.22
Construction	OSS Topside	Heavy Transport Vessel	Heavy Transport Vessel	NA	Heavy Transport Vessel	2	Atlantic City, NJ	Atlantic City, NJ	10,022.00	0.00	10.00	12	3	4	0.82	0.2	0	0.32	0.45	0.22
Construction	WTG & OSS Platform Foundation Installation	Heavy Lift Installation Vessel	Heavy Transport Vessel	NA	Heavy Transport Vessel	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	10,022.00	0.00	10.00	99	210	290	0.82	0.2	0	0.32	0.45	0.22
Construction		Secondary Steel Installation	Not Given	Jackup	Jackup	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	3,214.91	895.08	10.00	99	210	290	0.82	0	0	0.32	0	0.22
Construction		Feeder Barge Tug	Feeder Barge Tug	Tug	Feeder Barge Tug	2	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	8,113.00	340.00	10.00	99	90	170	0.82	0.2	0	0.32	0.45	0.22
Construction		Rock Dumping Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	3,131.92	1,006.68	10.00	99	105	185	0.82	0.2	0	0.32	0.45	0.22
Construction		Bubble Curtain Vessel	Platform Support Vessel	NA	Platform Support Vessel	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	4,516.00	1,618.00	10.00	99	150	230	0.82	0.2	0	0.32	0.45	0.22
Construction		Heavy Transport Vessel	Heavy Transport Vessel	NA	Heavy Transport Vessel	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	10,022.00	0.00	10.00	99	180	260	0.82	0.2	0	0.32	0.45	0.22
Construction		Crew Transport Vessel	Not Given	Crew	Crew	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	2,060.00	201.05	22.13	99	210	246	0.82	0.2	0	0.32	0.45	0
Construction		Noise Monitoring Vessel	Noise Monitoring Vessel	NA	Noise Monitoring Vessel	2	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	970.00	0.00	10.00	99	105	185	0.82	0.2	0	0.32	0.45	0
Construction		Platform Support Vessel	Platform Support Vessel	NA	Platform Support Vessel	2	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	4,516.00	1,618.00	10.00	99	105	185	0.82	0.2	0	0.32	0.45	0.22
Construction	WTG Construction	Installation Vessel	Not Given	Jackup	Jackup	1	Norfolk, VA or Hope Creek, NJ	Norfolk, VA	3,214.91	895.08	10.00	17	100	114	0.82	0	0	0.32	0	0.22
Construction		Towing Tug	Not Given	Tug	Tug	2	Norfolk, VA or Hope Creek, NJ	Norfolk, VA	2,053.16	238.13	10.00	17	50	63	0.82	0.2	0	0.32	0.45	0
Construction	Construction Package	Safety Vessel	Not Given	Supply Ship	Supply Ship	1	Atlantic City, NJ	Atlantic City, NJ	3,842.65	873.99	10.00	140	650	662	0.82	0.2	0	0.32	0.45	0.22
Construction		Crew Transport Vessel	Not Given	Crew	Crew	6	Atlantic City, NJ	Atlantic City, NJ	2,060.00	201.05	22.13	2300	539	631	0.82	0.2	0	0.32	0.45	0
Construction		Service Operation Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Atlantic City, NJ	Atlantic City, NJ	3,131.92	1,006.68	10.00	70	491	497	0.82	0.2	0	0.32	0.45	0.22
Operations	Annual O&M	Crew Transport Vessel - Minor Repairs	Not Given	Crew	Crew	2	Atlantic City, NJ	Atlantic City, NJ	2,060.00	201.05	22.13	0	0	0	0.82	0.2	0	0.32	0.45	0
Operations		Crew Transport Vessel	Not Given	Crew	Crew	1	Atlantic City, NJ	Atlantic City, NJ	2,060.00	201.05	22.13	5	1	1	0.82	0.2	0	0.32	0.45	0
Operations		Jackup - Major Repairs	Not Given	Jackup	Jackup	1	Paulsboro, NJ	Europe	3,214.91	895.08	7.00	1	17	18	0.82	0	0	0.32	0	0.22
Operations		Feeder Barge Tug	Not Given	Tug	Tug	1	Paulsboro, NJ	Paulsboro, NJ	2,053.16	238.13	11.53	10	14	18	0.82	0.2	0	0.32	0.45	0
Operations		Crew Transport Vessel	Not Given	Crew	Crew	3	Atlantic City, NJ	Atlantic City, NJ	2,060.00	201.05	22.13	30	6	7	0.82	0.2	0	0.32	0.45	0

[1] Vessel specifications are from vessel specificiation sheets, where possible; otherwise, vessel specifications are BOEM defaults.

Project-Specific Information - Activity Hours for Each Marine Vessel

Phase	Activity	Vessel Description	Vessel Type	Number of Vessels	Average Speed of Vessel (nm/hr) 1 knot = 1 nm/hr	Number of One Way Trips Per Vessel Between Array and Port	Duration (Total Days)	Year 1 Hours of Transit within OCS	Year 1 Hours of Transit Outside OCS	Year 1 Hours of Maneuvering at Port	Year 1 Hours of Hoteling [1]	Year 1 Total Hours of Onsite Maneuvering [2]
Construction	Array Cable Installation	Pre-lay Survey Vessel	Crew	1	10.00	3.0	67	8	154	1.50	0	1,422
Construction		Pre-lay Grapnel Run (PLGR) Vessel	Dredging	1	10.00	3.0	42	8	154	1.50	10	828
Construction		Boulder Clearance Vessel	Multi-Purpose Service Vessel	1	10.00	3.0	57	8	154	1.50	14	1,185
Construction		Sandwave Clearance Vessel	Dredging	1	10.00	3.0	42	8	154	1.50	10	828
Construction		Cable Laying Vessel	Cable Laying	1	10.00	14.0	131	35	719	7.00	32	2,361
Construction		Cable Burial Vessel	Cable Laying	1	10.00	14.0	181	35	719	7.00	44	3,549
Construction		Crew Transport Vessel	Crew	2	22.13	99.0	79	95	0	49.50	0	1,732
Construction		Walk to Work Vessel	Multi-Purpose Service Vessel	1	10.00	99.0	342	248	5,085	49.50	82	2,748
Construction		Post-Lay Inspection Survey Vessel	Crew	1	10.00	50.0	222	125	2,568	25.00	0	2,562
Construction		DP2 Construction Vessel - Jack of All Trades	Multi-Purpose Service Vessel	1	10.00	51.0	186	128	2,619	25.50	45	1,641
Construction	Offshore Export Cable & Interconnection Cable Installation	Cable Lay and Burial Vessel	Cable Laying	1	10.00	20.0	245	50	1,027	10.00	59	4,731
Construction		Cable Burial Vessel	Cable Laying	1	10.00	21.0	62	53	1,079	10.50	15	335
Construction		Anchor Handling Tug	Tug	1	10.00	30.0	127	75	1,541	15.00	0	1,394
Construction		Pull tug to move barges	Tug	1	10.00	100.0	424	215	4,417	43.00	0	3,997
Construction		Pull ahead export cable tug for assist CLV	Anchor Tug	1	10.00	70.0	292	175	3,595	35.00	0	3,135
Construction		Pre-lay Grapnel Run (PLGR) Vessel	Dredging	1	10.00	11.0	85	28	565	5.50	20	1,414
Construction		Boulder Clearance Vessel	Multi-Purpose Service Vessel	1	10.00	5.0	41	13	257	2.50	10	708
Construction		Crew Transport Vessel	Crew	2	22.13	11.0	68	11	0	5.50	0	1,598
Construction		Guard Vessel	Guard Vessel	5	10.00	30.0	267	75	1,541	15.00	0	4,721
Construction		Post-Lay Inspection Survey Vessel	Crew	2	10.00	11.2	43	28	575	5.60	0	404
Construction		General Work Vessel	Multi-Purpose Service Vessel	1	10.00	15.0	101	38	770	7.50	24	1,576
Construction	OSS Topside	Heavy Transport Vessel	Heavy Transport Vessel	2	10.00	12.0	4	25	0	6.00	1	65
Construction	WTG & OSS Platform Foundation Installation	Heavy Lift Installation Vessel	Heavy Transport Vessel	1	10.00	99.0	290	248	1,664	49.50	70	4,921
Construction		Secondary Steel Installation	Jackup	1	10.00	99.0	290	248	1,664	49.50	70	4,921
Construction		Feeder Barge Tug	Feeder Barge Tug	2	10.00	99.0	170	248	1,664	49.50	41	2,070
Construction		Rock Dumping Vessel	Multi-Purpose Service Vessel	1	10.00	99.0	185	248	1,664	49.50	44	2,426
Construction		Bubble Curtain Vessel	Platform Support Vessel	1	10.00	99.0	230	248	1,664	49.50	55	3,495
Construction		Heavy Transport Vessel	Heavy Transport Vessel	1	10.00	99.0	260	248	1,664	49.50	62	0
Construction		Crew Transport Vessel	Crew	1	22.13	99.0	246	112	752	49.50	0	4,931
Construction		Noise Monitoring Vessel	Noise Monitoring Vessel	2	10.00	99.0	185	248	1,664	49.50	0	2,426
Construction		Platform Support Vessel	Platform Support Vessel	2	10.00	99.0	185	248	1,664	49.50	44	2,426
Construction	WTG Construction	Installation Vessel	Jackup	1	10.00	17.0	114	43	282	8.50	27	2,364
Construction		Towing Tug	Tug	2	10.00	16.5	63	41	274	8.25	0	1,177
Construction	Construction Package	Safety Vessel	Supply Ship	1	10.00	140.0	662	297	0	70.00	159	15,371
Construction		Crew Transport Vessel	Crew	6	22.13	2300.0	631	2,204	0	1,150.00	0	11,639
Construction		Service Operation Vessel	Multi-Purpose Service Vessel	1	10.00	70.0	497	148	0	35.00	119	11,630
Operations	Annual O&M	Crew Transport Vessel - Minor Repairs	Crew	2	22.13	0.0	0	0	0	0.00	0	0
Operations		Crew Transport Vessel	Crew	1	22.13	5.0	1	5	0	2.50	0	22
Operations		Jackup - Major Repairs	Jackup	1	7.00	1.0	18	4	24	0.50	4	406
Operations		Feeder Barge Tug	Tug	1	11.53	9.8	18	21	87	4.90	0	321
Operations		Crew Transport Vessel	Crew	3	22.13	30.0	7	29	0	15.00	0	133

[1] Hoteling is the amount of time vessels spend at port. To estimate hours vessels spend hoteling, Ocean Wind assumes that vessels spend 1% of time hoteling, based on time the ratio of time spent at port vs. underway for Deepwater Vessel Type from Table 3 of USEPA. (2015) Category 1 / Category 2 Vessel Port Underway Split for 2011 National Emission Inventory. https://www3.epa.gov/ttn/chief/conference/ei21/session7/billings.pdf. It is also assumed vessels equipped with Category 1 or 2 propulsion engines do not engage propulsion or auxiliary engines while hoteling based on 2014 NEI (2017) because it is assumed vessels engage in cold ironing. Category 1 and 2 engines are typically smaller than 3,000 kW (Browning and Bailey).

[2] As a worst-case assumption, it is assumed that marine vessel engines are being utilized 24 hours per day for the expected duration of the construction activity. It is assumed that vessel engines are engaged in on-site maneuvering every hour the vessel is not at port and not in transit. Based on the definition of potential emissions in 40 CFR Part 55.2, emissions from vessel engines while they are at port are not included in the *potential emissions* of the OCS source even if the port is within 25 miles of the OCS source because vessels at port are not 'enroute to or from the source'.

Construction Emissions from Vessel Engines - Transit within OCS Area [1]

Main Engine:											
tons/year=	hrs/year x kW, main engine x load factor, propulsion engine x EF x 1.1X10^-6 g/ton x # of Vessels										
	CO_2	CH_4	N_2O	CO	NO_X	PM [2]	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Construction	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	9.03	5.57E-05	0.00	0.03	0.08	0.00	0.00	0.00	0.00	6.47E-07	0.00
Dredging	13.80	8.75E-05	0.00	0.05	0.21	0.01	0.01	0.01	0.00	8.10E-07	0.01
Multi-Purpose Service Vessel	13.36	8.47E-05	0.00	0.05	0.20	0.01	0.01	0.01	0.00	7.85E-07	0.01
Dredging	13.80	8.75E-05	0.00	0.05	0.21	0.01	0.01	0.01	0.00	8.10E-07	0.01
Cable Laying	133.47	8.41E-04	0.01	0.46	2.00	0.07	0.07	0.07	0.02	8.15E-06	0.05
Cable Laying	133.47	8.41E-04	0.01	0.46	2.00	0.07	0.07	0.07	0.02	8.15E-06	0.05
Crew	228.47	1.41E-03	0.01	0.81	1.94	0.06	0.05	0.05	0.00	1.64E-05	0.05
Multi-Purpose Service Vessel	440.92	2.80E-03	0.02	1.49	6.71	0.26	0.25	0.24	0.08	2.59E-05	0.20
Crew	150.54	9.29E-04	0.01	0.53	1.28	0.04	0.04	0.04	0.00	1.08E-05	0.03
Multi-Purpose Service Vessel	227.14	1.44E-03	0.01	0.77	3.46	0.13	0.13	0.12	0.04	1.33E-05	0.10
Cable Laying	190.67	1.20E-03	0.01	0.66	2.85	0.11	0.10	0.10	0.03	1.16E-05	0.07
Cable Laying	200.20	1.26E-03	0.01	0.69	2.99	0.11	0.11	0.10	0.03	1.22E-05	0.08
Tug	89.40	5.56E-04	0.00	0.32	1.32	0.05	0.05	0.04	0.00	6.22E-06	0.02
Tug	256.29	1.59E-03	0.01	0.91	3.79	0.13	0.13	0.13	0.01	1.78E-05	0.07
Anchor Tug	124.97	7.77E-04	0.01	0.44	1.85	0.07	0.06	0.06	0.01	8.70E-06	0.03
Dredging	50.58	3.21E-04	0.00	0.17	0.77	0.03	0.03	0.03	0.01	2.97E-06	0.02
Multi-Purpose Service Vessel	22.27	1.41E-04	0.00	0.08	0.34	0.01	0.01	0.01	0.00	1.31E-06	0.01
Crew	25.39	1.57E-04	0.00	0.09	0.22	0.01	0.01	0.01	0.00	1.82E-06	0.01
Guard Vessel	531.09	3.33E-03	0.03	1.87	8.21	0.29	0.28	0.27	0.05	3.46E-05	0.18
Crew	67.44	4.16E-04	0.00	0.24	0.57	0.02	0.02	0.02	0.00	4.83E-06	0.01
Multi-Purpose Service Vessel	66.81	4.24E-04	0.00	0.23	1.02	0.04	0.04	0.04	0.01	3.92E-06	0.03
Heavy Transport Vessel	297.62	1.84E-03	0.01	1.06	4.61	0.15	0.14	0.14	0.01	2.07E-05	0.07
Heavy Transport Vessel	1,447.75	8.95E-03	0.07	5.14	22.43	0.71	0.69	0.67	0.03	1.01E-04	0.32
Jackup	464.42	2.87E-03	0.02	1.65	7.20	0.23	0.22	0.21	0.01	3.24E-05	0.10
Feeder Barge Tug	2,331.57	1.45E-02	0.11	8.29	34.49	1.22	1.19	1.14	0.12	1.62E-04	0.64
Multi-Purpose Service Vessel	440.92	2.80E-03	0.02	1.49	6.71	0.26	0.25	0.24	0.08	2.59E-05	0.20
Platform Support Vessel	649.85	4.03E-03	0.03	2.31	9.52	0.33	0.32	0.31	0.03	4.49E-05	0.17
Heavy Transport Vessel	1,447.75	8.95E-03	0.07	5.14	22.43	0.71	0.69	0.67	0.03	1.01E-04	0.32
Crew	134.71	8.31E-04	0.01	0.48	1.15	0.03	0.03	0.03	0.00	9.66E-06	0.03
Noise Monitoring Vessel	278.76	1.73E-03	0.01	0.99	4.12	0.15	0.14	0.14	0.01	1.94E-05	0.08
Platform Support Vessel	1,299.71	8.07E-03	0.06	4.61	19.04	0.66	0.64	0.62	0.06	8.98E-05	0.34
Jackup	79.75	4.93E-04	0.00	0.28	1.24	0.04	0.04	0.04	0.00	5.56E-06	0.02
Tug	98.34	6.11E-04	0.00	0.35	1.45	0.05	0.05	0.05	0.01	6.85E-06	0.03
Supply Ship	663.10	4.11E-03	0.03	2.35	9.71	0.34	0.33	0.32	0.03	4.58E-05	0.17
Crew	15,923.41	9.83E-02	0.76	56.45	135.36	3.87	3.76	3.76	0.15	1.14E-03	3.36
Multi-Purpose Service Vessel	264.37	1.68E-03	0.01	0.89	4.02	0.15	0.15	0.14	0.05	1.55E-05	0.12

[1] OCS Area is the area within the OCS circle, which is a circle with a radius of 25 nautical miles measured from the centroid of the array area.

[2] BOEM emission factors for PM are not provided. It is assumed that PM emissions from main engines are 103% of PM_{10} emissions, based on page 3-35 of US Environmental Protection Agency (EPA). 2009. Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines. (EPA-420-R-09-019)

Construction Emissions from Vessel Engines - Transit within OCS Area [1]

Auxiliary Engine:											
tons/year=	hrs/year x kW, aux engine x load factor, aux engine x EF x 1.1X10^-6 g/ton x # of Vessels										
	CO_2	CH_4	N_2O	CO	NO_X	PM [3]	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Construction	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	0.34	2.12E-06	1.65E-05	0.00	0.00	0.00	0.00	0.00	3.18E-06	2.55E-08	0.00
Dredging	1.65	1.02E-05	7.89E-05	0.01	0.03	0.00	0.00	0.00	1.53E-05	1.22E-07	0.00
Multi-Purpose Service Vessel	1.72	1.06E-05	8.24E-05	0.01	0.03	0.00	0.00	0.00	1.59E-05	1.28E-07	0.00
Dredging	1.65	1.02E-05	7.89E-05	0.01	0.03	0.00	0.00	0.00	1.53E-05	1.22E-07	0.00
Cable Laying	24.16	1.49E-04	1.16E-03	0.09	0.37	0.02	0.01	0.01	2.24E-04	1.79E-06	0.01
Cable Laying	24.16	1.49E-04	1.16E-03	0.09	0.37	0.02	0.01	0.01	2.24E-04	1.79E-06	0.01
Crew	8.70	5.37E-05	4.16E-04	0.03	0.07	0.00	0.00	0.00	8.05E-05	6.44E-07	0.00
Multi-Purpose Service Vessel	56.85	3.51E-04	2.72E-03	0.22	0.86	0.04	0.03	0.03	5.26E-04	4.21E-06	0.01
Crew	5.73	3.54E-05	2.74E-04	0.02	0.05	0.00	0.00	0.00	5.31E-05	4.25E-07	0.00
Multi-Purpose Service Vessel	29.29	1.81E-04	1.40E-03	0.11	0.45	0.02	0.01	0.01	2.71E-04	2.17E-06	0.01
Cable Laying	34.52	2.13E-04	1.65E-03	0.13	0.53	0.02	0.02	0.02	3.20E-04	2.56E-06	0.01
Cable Laying	36.24	2.24E-04	1.73E-03	0.14	0.55	0.02	0.02	0.02	3.35E-04	2.68E-06	0.01
Tug	4.08	2.51E-05	1.95E-04	0.02	0.06	0.00	0.00	0.00	3.77E-05	3.02E-07	0.00
Tug	11.68	7.21E-05	5.59E-04	0.04	0.18	0.01	0.01	0.01	1.08E-04	8.65E-07	0.00
Anchor Tug	14.25	8.80E-05	6.82E-04	0.05	0.22	0.01	0.01	0.01	1.32E-04	1.06E-06	0.00
Dredging	6.05	3.73E-05	2.89E-04	0.02	0.09	0.00	0.00	0.00	5.60E-05	4.48E-07	0.00
Multi-Purpose Service Vessel	2.87	1.77E-05	1.37E-04	0.01	0.04	0.00	0.00	0.00	2.66E-05	2.13E-07	0.00
Crew	0.97	5.97E-06	4.62E-05	0.00	0.01	0.00	0.00	0.00	8.95E-06	7.16E-08	0.00
Guard Vessel	30.55	1.88E-04	1.46E-03	0.12	0.48	0.02	0.02	0.01	2.83E-04	2.26E-06	0.01
Crew	2.57	1.59E-05	1.23E-04	0.01	0.02	0.00	0.00	0.00	2.38E-05	1.90E-07	0.00
Multi-Purpose Service Vessel	8.61	5.32E-05	4.12E-04	0.03	0.13	0.01	0.00	0.00	7.97E-05	6.38E-07	0.00
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Jackup	50.55	3.12E-04	2.42E-03	0.19	0.90	0.03	0.02	0.02	4.68E-04	3.74E-06	0.01
Feeder Barge Tug	38.40	2.37E-04	1.84E-03	0.15	0.60	0.02	0.02	0.02	3.55E-04	2.84E-06	0.01
Multi-Purpose Service Vessel	56.85	3.51E-04	2.72E-03	0.22	0.86	0.04	0.03	0.03	5.26E-04	4.21E-06	0.01
Platform Support Vessel	91.37	5.64E-04	4.37E-03	0.35	1.47	0.06	0.05	0.04	8.46E-04	6.77E-06	0.02
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Crew	5.13	3.17E-05	2.45E-04	0.02	0.04	0.00	0.00	0.00	4.75E-05	3.80E-07	0.00
Noise Monitoring Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Platform Support Vessel	182.74	1.13E-03	8.74E-03	0.70	2.94	0.12	0.09	0.09	1.69E-03	1.35E-05	0.04
Jackup	8.68	5.36E-05	4.15E-04	0.03	0.15	0.01	0.00	0.00	8.03E-05	6.43E-07	0.00
Tug	4.48	2.77E-05	2.14E-04	0.02	0.07	0.00	0.00	0.00	4.15E-05	3.32E-07	0.00
Supply Ship	59.19	3.65E-04	2.83E-03	0.23	0.95	0.04	0.03	0.03	5.48E-04	4.38E-06	0.01
Crew	606.50	3.74E-03	2.90E-02	2.32	5.16	0.19	0.14	0.14	5.61E-03	4.49E-05	0.13
Multi-Purpose Service Vessel	34.09	2.10E-04	1.63E-03	0.13	0.52	0.02	0.02	0.02	3.16E-04	2.52E-06	0.01

[1] OCS Area is the area within the OCS circle, which is a circle with a radius of 25 nautical miles measured from the centroid of the array area.

[3] BOEM emission factors for PM are not provided. It is assumed that PM emissions from auxiliary engines are 131% of PM_{10} emissions, based on page 3-35 of US Environmental Protection Agency (EPA). 2009. Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines. (EPA-420-R-09-019)

	CO_2	CH_4	N_2O	CO	NO_X	PM	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Summary	30,255.77	0.19	1.45	107.40	343.75	11.13	10.66	10.43	0.94	0.00	7.33

Construction Emissions from Vessel Engines - Onsite Maneuvering

Main Engine:											
tons/year=	hrs/year x kW, main engine x load factor, propulsion engine x EF x 1.1X10^-6 g/ton x # of Vessels										
	CO_2	CH_4	N_2O	CO	NO_X	PM [1]	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Construction	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	417.85	2.58E-03	0.02	1.48	3.55	0.10	0.10	0.10	0.00	3.00E-05	0.09
Dredging	371.68	2.36E-03	0.02	1.25	5.66	0.22	0.21	0.20	0.07	2.18E-05	0.17
Multi-Purpose Service Vessel	514.85	3.27E-03	0.03	1.74	7.84	0.30	0.29	0.28	0.09	3.02E-05	0.23
Dredging	371.68	2.36E-03	0.02	1.25	5.66	0.22	0.21	0.20	0.07	2.18E-05	0.17
Cable Laying	2,196.40	1.38E-02	0.11	7.60	32.84	1.22	1.18	1.13	0.29	1.34E-04	0.85
Cable Laying	3,301.36	2.08E-02	0.16	11.43	49.36	1.83	1.77	1.70	0.44	2.02E-04	1.28
Crew	1,017.27	6.28E-03	0.05	3.61	8.65	0.25	0.24	0.24	0.01	7.29E-05	0.21
Multi-Purpose Service Vessel	1,194.20	7.57E-03	0.06	4.03	18.18	0.70	0.68	0.65	0.21	7.01E-05	0.54
Crew	752.48	4.64E-03	0.04	2.67	6.40	0.18	0.18	0.18	0.01	5.39E-05	0.16
Multi-Purpose Service Vessel	713.08	4.52E-03	0.04	2.41	10.85	0.42	0.40	0.39	0.13	4.19E-05	0.32
Cable Laying	4,400.52	2.77E-02	0.21	15.24	65.79	2.43	2.36	2.27	0.59	2.69E-04	1.71
Cable Laying	311.20	1.96E-03	0.02	1.08	4.65	0.17	0.17	0.16	0.04	1.90E-05	0.12
Tug	405.42	2.52E-03	0.02	1.44	6.00	0.21	0.21	0.20	0.02	2.82E-05	0.11
Tug	1,162.21	7.22E-03	0.06	4.13	17.19	0.61	0.59	0.57	0.06	8.09E-05	0.32
Anchor Tug	546.02	3.39E-03	0.03	1.94	8.08	0.29	0.28	0.27	0.03	3.80E-05	0.15
Dredging	634.44	4.02E-03	0.03	2.14	9.66	0.37	0.36	0.34	0.11	3.73E-05	0.29
Multi-Purpose Service Vessel	307.46	1.95E-03	0.02	1.04	4.68	0.18	0.17	0.17	0.05	1.81E-05	0.14
Crew	938.93	5.79E-03	0.04	3.33	7.98	0.23	0.22	0.22	0.01	6.73E-05	0.20
Guard Vessel	8,153.49	5.11E-02	0.40	28.72	126.00	4.46	4.33	4.16	0.84	5.30E-04	2.83
Crew	237.45	1.47E-03	0.01	0.84	2.02	0.06	0.06	0.06	0.00	1.70E-05	0.05
Multi-Purpose Service Vessel	684.94	4.34E-03	0.03	2.31	10.43	0.40	0.39	0.37	0.12	4.02E-05	0.31
Heavy Transport Vessel	185.55	1.15E-03	0.01	0.66	2.88	0.09	0.09	0.09	0.00	1.29E-05	0.04
Heavy Transport Vessel	7,020.82	4.34E-02	0.34	24.92	108.79	3.44	3.34	3.23	0.14	4.89E-04	1.57
Jackup	0.00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00
Feeder Barge Tug	4,755.69	2.96E-02	0.23	16.91	70.35	2.49	2.42	2.33	0.25	3.31E-04	1.30
Multi-Purpose Service Vessel	1,054.20	6.69E-03	0.05	3.56	16.05	0.61	0.60	0.57	0.19	6.19E-05	0.48
Platform Support Vessel	2,238.47	1.39E-02	0.11	7.95	32.79	1.14	1.11	1.07	0.10	1.55E-04	0.58
Heavy Transport Vessel	0.00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00
Crew	1,448.60	8.94E-03	0.07	5.14	12.31	0.35	0.34	0.34	0.01	1.04E-04	0.31
Noise Monitoring Vessel	666.50	4.14E-03	0.03	2.37	9.86	0.35	0.34	0.33	0.03	4.64E-05	0.18
Platform Support Vessel	3,107.49	1.93E-02	0.15	11.03	45.53	1.59	1.54	1.49	0.13	2.15E-04	0.81
Jackup	0.00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00
Tug	684.16	4.25E-03	0.03	2.43	10.12	0.36	0.35	0.34	0.04	4.76E-05	0.19
Supply Ship	8,375.99	5.20E-02	0.40	29.74	122.71	4.28	4.15	4.01	0.36	5.79E-04	2.17
Crew	20,512.71	1.27E-01	0.98	72.72	174.38	4.99	4.84	4.84	0.20	1.47E-03	4.33
Multi-Purpose Service Vessel	5,053.22	3.21E-02	0.25	17.06	76.91	2.95	2.86	2.73	0.89	2.97E-04	2.28

[1] BOEM emission factors for PM are not provided. It is assumed that PM emissions from main engines are 103% of PM_{10} emissions, based on page 3-35 of US Environmental Protection Agency (EPA). 2009. Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines. (EPA-420-R-09-019)

Auxiliary Engine:											
tons/year=	hrs/year x kW, aux engine x load factor, aux engine x EF x 1.1X10^-6 g/ton x # of Vessels										
	CO_2	CH_4	N_2O	CO	NO_X	PM [2]	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Construction	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	40.78	2.52E-04	1.95E-03	0.16	0.35	0.01	0.01	0.01	3.78E-04	3.02E-06	0.01
Dredging	113.87	7.03E-04	5.45E-03	0.44	1.73	0.07	0.06	0.05	1.05E-03	8.43E-06	0.02
Multi-Purpose Service Vessel	170.10	1.05E-03	8.13E-03	0.65	2.59	0.11	0.08	0.08	1.57E-03	1.26E-05	0.04
Dredging	113.87	7.03E-04	5.45E-03	0.44	1.73	0.07	0.06	0.05	1.05E-03	8.43E-06	0.02
Cable Laying	1,018.94	6.29E-03	4.87E-02	3.90	15.54	0.66	0.50	0.49	9.43E-03	7.55E-05	0.22
Cable Laying	1,531.55	9.45E-03	7.32E-02	5.86	23.36	0.99	0.76	0.73	1.42E-02	1.13E-04	0.33
Crew	99.29	6.13E-04	4.75E-03	0.38	0.84	0.03	0.02	0.02	9.19E-04	7.35E-06	0.02
Multi-Purpose Service Vessel	394.55	2.43E-03	1.89E-02	1.51	6.00	0.26	0.19	0.19	3.65E-03	2.92E-05	0.09
Crew	73.44	4.53E-04	3.51E-03	0.28	0.62	0.02	0.02	0.02	6.80E-04	5.44E-06	0.02
Multi-Purpose Service Vessel	235.59	1.45E-03	1.13E-02	0.90	3.58	0.15	0.12	0.11	2.18E-03	1.74E-05	0.05
Cable Laying	2,041.46	1.26E-02	9.76E-02	7.81	31.14	1.32	1.01	0.98	1.89E-02	1.51E-04	0.44
Cable Laying	144.37	8.91E-04	6.90E-03	0.55	2.20	0.09	0.07	0.07	1.34E-03	1.07E-05	0.03
Tug	47.35	2.92E-04	2.26E-03	0.18	0.74	0.03	0.02	0.02	4.38E-04	3.51E-06	0.01
Tug	135.75	8.38E-04	6.49E-03	0.52	2.12	0.09	0.07	0.06	1.26E-03	1.01E-05	0.03
Anchor Tug	159.60	9.85E-04	7.63E-03	0.61	2.49	0.10	0.08	0.08	1.48E-03	1.18E-05	0.03
Dredging	194.37	1.20E-03	9.30E-03	0.74	2.96	0.13	0.10	0.09	1.80E-03	1.44E-05	0.04
Multi-Purpose Service Vessel	101.58	6.27E-04	4.86E-03	0.39	1.54	0.07	0.05	0.05	9.40E-04	7.52E-06	0.02
Crew	91.64	5.66E-04	4.38E-03	0.35	0.78	0.03	0.02	0.02	8.48E-04	6.79E-06	0.02
Guard Vessel	1,201.68	7.42E-03	5.75E-02	4.60	18.92	0.78	0.59	0.57	1.11E-02	8.90E-05	0.26
Crew	23.18	1.43E-04	1.11E-03	0.09	0.20	0.01	0.01	0.01	2.15E-04	1.72E-06	0.01
Multi-Purpose Service Vessel	226.29	1.40E-03	1.08E-02	0.87	3.44	0.15	0.11	0.11	2.09E-03	1.68E-05	0.05
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Jackup	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Feeder Barge Tug	200.71	1.24E-03	9.60E-03	0.77	3.13	0.13	0.10	0.10	1.86E-03	1.49E-05	0.04
Multi-Purpose Service Vessel	348.29	2.15E-03	1.67E-02	1.33	5.30	0.23	0.17	0.17	3.22E-03	2.58E-05	0.08
Platform Support Vessel	806.50	4.98E-03	3.86E-02	3.09	12.98	0.52	0.40	0.39	7.47E-03	5.97E-05	0.17
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Crew	141.39	8.72E-04	6.76E-03	0.54	1.20	0.04	0.03	0.03	1.31E-03	1.05E-05	0.03
Noise Monitoring Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Platform Support Vessel	1,119.60	6.91E-03	5.35E-02	4.28	18.02	0.72	0.55	0.54	1.04E-02	8.29E-05	0.24
Jackup	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Tug	79.91	4.93E-04	3.82E-03	0.31	1.25	0.05	0.04	0.04	7.40E-04	5.92E-06	0.02
Supply Ship	1,915.77	1.18E-02	9.16E-02	7.33	30.83	1.24	0.95	0.92	1.77E-02	1.42E-04	0.41
Crew	2,002.07	1.24E-02	9.57E-02	7.66	17.02	0.62	0.47	0.47	1.85E-02	1.48E-04	0.43
Multi-Purpose Service Vessel	1,669.52	1.03E-02	7.98E-02	6.39	25.38	1.08	0.82	0.80	1.55E-02	1.24E-04	0.36

[2] BOEM emission factors for PM are not provided. It is assumed that PM emissions from auxiliary engines are 131% of PM_{10} emissions, based on page 3-35 of US Environmental Protection Agency (EPA). 2009. Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines. (EPA-420-R-09-019)

	CO_2	CH_4	N_2O	CO	NO_X	PM	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Summary	100,179.34	0.62	4.83	357.08	1,332.09	47.26	43.85	42.48	5.69	0.01	28.03

Activity	Emission Unit	Number of Units	Engine Capacity	Load Factor[1]	Number of Hours Each Unit Used	Rate Each Engine Used	Applicable Emission Standard[2]				CO_2	CH_4	N_2O	CO	NO_X[3]	PM	PM_{10} [4]	$PM_{2.5}$ [4]	SO_2	VOC	Total HAP
							NO_X + NMHC	NO_x	PM	CO											
			hp		hours/year	hp-hr/year	g/kW-hr	g/kW-hr	g/kW-hr	g/kW-hr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Foundation Installation	Heavy Lift Installation Vessel Generator	5	5	0.43	5040	10,836	7.5	NA	0.4	8	11.23	4.56E-04	9.11E-05	0.36	0.32	1.78E-02	1.81E-02	1.81E-02	3.29E-04	6.81E-02	2.67E-04
	Heavy Lift Installation Vessel Power Pack	1	1000	0.43	5040	2,167,200	NA	3.5	0.04	3.5	449.22	1.82E-02	3.64E-03	6.23	6.23	7.13E-02	0.13	0.13	1.31E-02	0.70	4.34E-03
	Secondary Steel Generator	3	5	0.43	5040	10,836	7.5	NA	0.4	8	6.74	2.73E-04	5.47E-05	0.21	0.19	1.07E-02	1.10E-02	1.10E-02	1.97E-04	4.09E-02	1.60E-04
	Bubble Curtain Vessel Generator	46	480	0.43	1800	371,520	NA	0.4	0.02	3.5	3,542.43	0.14	2.87E-02	49.17	5.62	0.28	0.29	0.29	0.10	21.48	0.08
	Heavy Transport Vessel Generator	1	5	0.43	4320	9,288	7.5	NA	0.4	8	1.93	7.81E-05	1.56E-05	6.11E-02	5.44E-02	3.05E-03	3.30E-03	3.30E-03	5.64E-05	1.17E-02	4.57E-05
OSS Topside	Heavy Lift Installation Vessel Generator	5	5	0.43	72	155	7.5	NA	0.4	8	0.16	6.51E-06	1.30E-06	5.09E-03	4.53E-03	2.54E-04	2.59E-04	2.59E-04	4.70E-06	9.73E-04	3.81E-06
WTG Construction	Jack-up Vessel Generator	5	5	0.43	2400	5,160	7.5	NA	0.4	8	5.35	2.17E-04	4.34E-05	0.17	0.15	8.48E-03	8.62E-03	8.62E-03	1.57E-04	3.24E-02	1.27E-04
	Jack-up Vessel Cherry Picker	2	90	0.43	2400	92,880	NA	0.4	0.02	5	38.50	1.56E-03	3.12E-04	0.76	0.06	3.05E-03	5.56E-03	5.56E-03	1.13E-03	0.23	9.15E-04
	Feeder Barge Generator	2	40	0.43	2400	41,280	4.7	NA	0.03	5.5	17.11	6.94E-04	1.39E-04	0.37	0.30	2.04E-03	3.15E-03	3.15E-03	5.01E-04	0.10	4.07E-04
	SOV Generator	6	5	0.43	2400	5,160	7.5	NA	0.4	8	6.42	2.60E-04	5.21E-05	0.20	0.18	1.02E-02	1.03E-02	1.03E-02	1.88E-04	0.04	1.52E-04
Offshore Export Cable	Cable Laying Vessel Generator	2	100	0.43	4800	206,400	NA	0.4	0.02	5	85.57	3.47E-03	6.94E-04	1.70	0.14	6.79E-03	1.23E-02	1.23E-02	2.50E-03	0.52	2.03E-03
	Cable Laying Vessel Generator	7	250	0.43	4800	516,000	NA	0.4	0.02	3.5	748.70	3.04E-02	6.07E-03	10.39	1.19	0.06	7.33E-02	7.33E-02	2.19E-02	4.54	1.78E-02
	Cable Laying Vessel Power Pack	1	500	0.43	4800	1,032,000	NA	0.4	0.02	3.5	213.92	8.68E-03	1.74E-03	2.97	0.34	1.70E-02	4.48E-02	4.48E-02	6.26E-03	1.30	5.08E-03
	Barge Generator	2	60.5	0.43	2208	57,441	4.7	NA	0.03	5	23.81	9.66E-04	1.93E-04	0.47	0.42	2.83E-03	4.38E-03	4.38E-03	6.97E-04	0.14	5.66E-04
	Barge Cherry Picker	1	760	0.43	2208	721,574	NA	3.5	0.04	3.5	149.57	6.07E-03	1.21E-03	2.08	2.08	2.37E-02	4.32E-02	4.32E-02	4.38E-03	0.23	1.44E-03
										Total:	**5,300.66**	**0.22**	**0.04**	**75.15**	**17.28**	**0.52**	**0.66**	**0.66**	**0.16**	**29.44**	**0.12**

[1] Load factor obtained from MOVES and applied to estimate emissions since this eqiupment will operate at varying loads during the construction process.

[2] Applicable emission standard based on LAER determination, which is Tier 4 emission standards from 40 CFR 1039.101. The Tier 4 emission standard was used to estimate PTE for the following pollutants: NO_x, PM, PM_{10}, $PM_{2.5}$ and CO. All other pollutants (CO_2, CH_4, N_2O, SO_2, and VOC) were estimated using AP-42 emission factors from Tables 3.4-1 and 3.3-1. See footnote [3] for an explanation of how NO_x emissions were estimated when the applicable standard is in terms of NO_x + NMHC. See footenote [4] for an explanation of how PM_{10} and $PM_{2.5}$ emissions were estimated from the PM standard.

[3] NO_x emissions are estimated to comprise 95% of NO_x + NMHC emissions in accordance with CARB guidance. California Air Resources Board (CARB). 2004. Policy: CARB Emission Factors for CI Diesel Engines – Percent HC in Relation to NMHC + NO_x. Retrieved from https://www.baaqmd.gov/~/media/files/engineering/policy_and_procedures/engines/emissionfactorsfordieselengines.pdf?la=en

[4] It is conservatively assumed that the PM emission standard is equal to the filterable portion of PM_{10} and $PM_{2.5}$. The condensable portion of PM_{10} and $PM_{2.5}$ was added using the AP-42 emission factor of 0.0077 lb/MMBtu from AP-42 Table 3.4-2 and converting to lb/hp-hr using the conversion factor 7,000 Btu/hp-hr from footnote 'e' of AP-42 Table 3.4-1, resulting in a condensable emission factor of 0.0000539 lb/hp-hr.

Pollutant	EF	Unit	Source
Engines 600 hp or Greater			
CO_2	163.05	lb/MMBtu	40 CFR Part 98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
CO	5.50E-03	lb/hp-hr	AP-42 Table 3.4-1
NO_X	2.40E-02	lb/hp-hr	AP-42 Table 3.4-1
PM_{10}	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
$PM_{2.5}$	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.4-1
VOC	6.42E-04	lb/hp-hr	AP-42 Table 3.4-1
Acetaldehyde	2.52E-05	lb/MMBtu	AP-42 Table 3.4-3
Acrolein	7.88E-06	lb/MMBtu	AP-42 Table 3.4-3
Benzene	7.76E-04	lb/MMBtu	AP-42 Table 3.4-3
Formaldehyde	7.89E-05	lb/MMBtu	AP-42 Table 3.4-3
Naphthalene	1.30E-04	lb/MMBtu	AP-42 Table 3.4-4
PAH, other than Napthalene	8.20E-05	lb/MMBtu	AP-42 Table 3.4-4
Toluene	2.81E-04	lb/MMBtu	AP-42 Table 3.4-3
Xylene	1.93E-04	lb/MMBtu	AP-42 Table 3.4-3
Total HAP	**1.57E-03**	**lb/MMBtu**	

Pollutant	EF	Unit	Source
Engines Less Than 600 hp			
CO_2	163.05	lb/MMBtu	40 CFR Part 98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
CO	6.68E-03	lb/hp-hr	AP-42 Table 3.3-1
NO_X	3.10E-02	lb/hp-hr	AP-42 Table 3.3-1
PM_{10}	2.20E-03	lb/hp-hr	AP-42 Table 3.3-1
$PM_{2.5}$	2.20E-03	lb/hp-hr	AP-42 Table 3.3-1
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.4-1
VOC	2.51E-03	lb/hp-hr	AP-42 Table 3.3-1
1,3-Butadiene	3.91E-05	lb/MMBtu	AP-42 Table 3.3-2
Acetaldehyde	7.67E-04	lb/MMBtu	AP-42 Table 3.3-2
Acrolein	9.25E-05	lb/MMBtu	AP-42 Table 3.3-2
Benzene	9.33E-04	lb/MMBtu	AP-42 Table 3.3-2
Formaldehyde	1.18E-03	lb/MMBtu	AP-42 Table 3.3-2
Napthalene	8.48E-05	lb/MMBtu	AP-42 Table 3.3-2
PAH, other than Napthalene	8.32E-05	lb/MMBtu	AP-42 Table 3.3-2
Toluene	4.09E-04	lb/MMBtu	AP-42 Table 3.3-2
Xylenes	2.85E-04	lb/MMBtu	AP-42 Table 3.3-2
Total HAP	**3.87E-03**	**lb/MMBtu**	

Phase	Emission Unit	Number of Units	Engine Capacity	Engine Capacity	Number of Hours Each Unit Used	Rate Each Engine Used	Applicable Emission Standard[1]				CO_2	CH_4	N_2O	CO	NO_X[2]	PM	PM_{10}[3]	$PM_{2.5}$[3]	SO_2	VOC	Total HAP
							NO_X + NMHC	NO_X	PM	CO											
			hp	kW	hours/year	hp-hr/year	g/kW-hr	g/kW-hr	g/kW-hr	g/kW-hr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Construction	OSS Generator - Permanent	3	800	600	4464	3,571,200	NA	0.67	0.03	3.5	2,220.74	9.01E-02	1.80E-02	30.82	5.90	0.26	0.36	0.36	6.50E-02	3.44	2.14E-02
	OSS Generator - Temporary	6	209	156	4486	937,574	NA	0.4	0.02	3.5	1,166.05	4.73E-02	9.46E-03	16.18	1.85	9.25E-02	0.12	0.12	3.41E-02	7.07	2.77E-02
	OSS Generator - Cable Pull-in c	3	50	37	600	30,000	4.7	NA	0.03	5	18.66	7.57E-04	1.51E-04	0.37	0.33	2.22E-03	3.03E-03	3.03E-03	5.46E-04	0.11	4.43E-04
	Array Cable Generator - WTG	98	50	37	731	36,527	4.7	NA	0.03	5	741.99	3.01E-02	6.02E-03	14.71	13.14	8.83E-02	8.93E-02	8.93E-02	2.17E-02	4.50E+00	1.76E-02
	Array Cable Generator - OSS	3	102	76	120	12,240	NA	0.4	0.02	5	7.61	3.09E-04	6.17E-05	0.15	0.01	6.04E-04	9.34E-04	9.34E-04	2.23E-04	0.05	0.00
										Total:	**4,155.04**	**0.17**	**3.37E-02**	**62.24**	**21.23**	**0.45**	**0.57**	**0.57**	**1.22E-01**	**15.17**	**6.74E-02**

[1] Applicable emission standard based on LAER determination, which is Tier 4 emission standards from 40 CFR 1039.101. The Tier 4 emission standard was used to estimate PTE for the following pollutants: NO_x, PM, PM_{10}, $PM_{2.5}$ and CO. All other pollutants (CO_2, CH_4, N_2O, SO_2, and VOC) were estimated using AP-42 emission factors from Tables 3.4-1 and 3.3-1. See footnote [2] for an explanation of how NO_x emissions were estimated when the applicable standard is in terms of NO_x + NMHC. See footnote [3] for an explanation of how PM_{10} and $PM_{2.5}$ emissions were estimated from the PM standard.

[2] NO_x emissions are estimated to comprise 95% of NO_x + NMHC emissions in accordance with CARB guidance. California Air Resources Board (CARB). 2004. Policy: CARB Emission Factors for CI Diesel Engines – Percent HC in Relation to NMHC + NO_x. Retrieved from https://www.baaqmd.gov/~/media/files/engineering/policy_and_procedures/engines/emissionfactorsfordieselengines.pdf?la=en

[3] It is conservatively assumed that the PM emission standard is equal to the filterable portion of PM_{10} and $PM_{2.5}$. The condensable portion of PM_{10} and $PM_{2.5}$ was added using the AP-42 emission factor of 0.0077 lb/MMBtu from AP-42 Table 3.4-2 and converting to lb/hp-hr using the conversion factor 7,000 Btu/hp-hr from footnote 'e' of AP-42 Table 3.4-1, resulting in a condensable emission factor of 0.0000539 lb/hp-hr.

Pollutant	Emission Factor	Unit	Source
Engines 600 hp or Greater			
CO_2	163.05	lb/MMBtu	41 CFR Part 98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
CO	5.50E-03	lb/hp-hr	AP-42 Table 3.4-1
NO_X	2.40E-02	lb/hp-hr	AP-42 Table 3.4-1
PM_{10}	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
$PM_{2.5}$	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.4-1
VOC	6.42E-04	lb/hp-hr	AP-42 Table 3.4-1
Acetaldehyde	2.52E-05	lb/MMBtu	AP-42 Table 3.4-3
Acrolein	7.88E-06	lb/MMBtu	AP-42 Table 3.4-3
Benzene	7.76E-04	lb/MMBtu	AP-42 Table 3.4-3
Formaldehyde	7.89E-05	lb/MMBtu	AP-42 Table 3.4-3
Naphthalene	1.30E-04	lb/MMBtu	AP-42 Table 3.4-4
PAH, other than Napthalene	8.20E-05	lb/MMBtu	AP-42 Table 3.4-4
Toluene	2.81E-04	lb/MMBtu	AP-42 Table 3.4-3
Xylene	1.93E-04	lb/MMBtu	AP-42 Table 3.4-3
Total HAP	**1.57E-03**	**lb/MMBtu**	

Pollutant	Emission Factor	Unit	Source
Engines Less Than 600 hp			
CO_2	163.05	lb/MMBtu	98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	98 Subpart C Table C-2
CO	6.68E-03	lb/hp-hr	42 Table 3.3-1
NO_X	3.10E-02	lb/hp-hr	42 Table 3.3-1
PM_{10}	2.20E-03	lb/hp-hr	42 Table 3.3-1
$PM_{2.5}$	2.20E-03	lb/hp-hr	42 Table 3.3-1
SO_2	1.21E-05	lb/hp-hr	42 Table 3.4-1
VOC	2.51E-03	lb/hp-hr	42 Table 3.3-1
1,3-Butadiene	3.91E-05	lb/MMBtu	42 Table 3.3-2
Acetaldehyde	7.67E-04	lb/MMBtu	42 Table 3.3-2
Acrolein	9.25E-05	lb/MMBtu	42 Table 3.3-2
Benzene	9.33E-04	lb/MMBtu	42 Table 3.3-2
Formaldehyde	1.18E-03	lb/MMBtu	42 Table 3.3-2
Napthalene	8.48E-05	lb/MMBtu	42 Table 3.3-2
PAH, other than Napthalene	8.32E-05	lb/MMBtu	42 Table 3.3-2
Toluene	4.09E-04	lb/MMBtu	42 Table 3.3-2
Xylenes	2.85E-04	lb/MMBtu	42 Table 3.3-2
Total HAP	**3.87E-03**	**lb/MMBtu**	

Main Engine - Annual Emissions - OCS Transit:

tons/year=	hrs/year x kW, main engine x load factor, propulsion engine x EF x 1.1X10^-6 g/ton x # of Vessels										
	CO_2	CH_4	N_2O	CO	NO_X	PM [1]	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Crew	5.76	3.56E-05	2.76E-04	2.04E-02	0.09	2.82E-03	2.74E-03	2.65E-03	1.13E-04	4.01E-07	1.28E-03
Jackup	6.70	4.14E-05	3.21E-04	2.38E-02	1.04E-01	3.28E-03	3.18E-03	3.08E-03	1.32E-04	4.67E-07	1.49E-03
Tug	25.47	1.57E-04	1.22E-03	9.04E-02	0.39	1.25E-02	1.21E-02	1.17E-02	5.01E-04	1.77E-06	5.68E-03
Crew	103.68	6.41E-04	4.97E-03	0.37	1.61	5.08E-02	4.93E-02	4.77E-02	2.04E-03	7.22E-06	2.31E-02

Auxiliary Engine - Annual Emissions - OCS Transit:

tons/year=	hrs/year x kW, aux engine x load factor, aux engine x EF x 1.1X10^-6 g/ton x # of Vessels										
	CO_2	CH_4	N_2O	CO	NO_X	PM [2]	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Crew	0.22	1.36E-06	1.05E-05	8.41E-04	3.91E-03	1.42E-04	1.08E-04	1.05E-04	2.03E-06	1.63E-08	4.75E-05
Jackup	0.73	4.50E-06	3.49E-05	2.79E-03	1.30E-02	4.72E-04	3.60E-04	3.49E-04	6.75E-06	5.40E-08	1.57E-04
Tug	1.15	7.13E-06	5.52E-05	4.42E-03	2.06E-02	7.47E-04	5.70E-04	5.52E-04	1.07E-05	8.55E-08	2.49E-04
Crew	3.96	2.44E-05	1.89E-04	1.51E-02	7.05E-02	2.56E-03	1.95E-03	1.89E-03	3.66E-05	2.93E-07	8.54E-04

Main Engine - Annual Emissions - Onsite Maneuvering:

tons/year=	hrs/year x kW, main engine x load factor, propulsion engine x EF x 1.1X10^-6 g/ton x # of Vessels										
	CO_2	CH_4	N_2O	CO	NO_X	PM [1]	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Crew	6.51	4.02E-05	3.12E-04	2.31E-02	0.10	3.19E-03	3.10E-03	3.00E-03	1.28E-04	4.54E-07	1.45E-03
Jackup	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tug	93.81	5.80E-04	4.49E-03	0.33	1.45	4.59E-02	4.46E-02	4.32E-02	1.84E-03	6.54E-06	2.09E-02
Crew	117.20	7.24E-04	5.61E-03	0.42	1.82	5.74E-02	5.57E-02	5.40E-02	2.30E-03	8.17E-06	2.61E-02

Auxiliary Engine - Annual Emissions - Onsite Maneuvering:

tons/year=	hrs/year x kW, main engine x load factor, propulsion engine x EF x 1.1X10^-6 g/ton x # of Vessels										
	CO_2	CH_4	N_2O	CO	NO_X	PM [2]	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Crew	1.43	8.84E-06	6.85E-05	5.48E-03	2.55E-02	9.26E-04	7.07E-04	6.85E-04	1.33E-05	1.06E-07	3.09E-04
Jackup	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tug	24.52	1.51E-04	1.17E-03	9.38E-02	0.44	1.59E-02	1.21E-02	1.17E-02	2.27E-04	1.82E-06	5.30E-03
Crew	25.78	1.59E-04	1.23E-03	0.10	0.46	1.67E-02	1.27E-02	1.23E-02	2.39E-04	1.91E-06	5.57E-03

Annual Operating Emissions

	CO_2	CH_4	N_2O	CO	NO_X	PM	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Total:	416.91	2.58E-03	2.00E-02	1.50	6.59	0.21	0.20	0.19	7.59E-03	2.93E-05	0.09

[1] BOEM emission factors for PM are not provided. It is assumed that PM emissions from main engines are 103% of PM_{10} emissions, based on page 3-35 of US Environmental Protection Agency (EPA). 2009. Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines. (EPA-420-R-09-019)

[2] BOEM emission factors for PM are not provided. It is assumed that PM emissions from auxiliary engines are 131% of PM_{10} emissions, based on page 3-35 of US Environmental Protection Agency (EPA). 2009. Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines. (EPA-420-R-09-019)

Phase	Emission Unit	Number of Units	Engine Capacity	Number of Hours Each Unit Used	Rate Each Engine Used	CO_2	CH_4	N_2O	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	Total HAP
			hp	hours/year	hp-hr/year	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
O&M	Jackup Vessel Generator - Small	1	5	410	2,052	0.43	1.73E-05	3.45E-06	6.85E-03	3.18E-02	2.26E-03	2.26E-03	1.25E-05	2.58E-03	1.01E-05
	Jackup Vessel Generator - Large	1	100	410	41,042	8.51	3.45E-04	6.90E-05	0.14	0.64	4.51E-02	4.51E-02	2.49E-04	5.16E-02	2.02E-04
	Jackup Vessel Cherry Picker	1	6	410	2,463	0.51	2.07E-05	4.14E-06	8.22E-03	3.82E-02	2.71E-03	2.71E-03	1.49E-05	3.10E-03	1.21E-05
	Feeder Barge Crane Type 1	1	760	330	250,971	52.02	2.11E-03	4.22E-04	6.90E-01	3.01	8.78E-02	8.78E-02	1.52E-03	8.05E-02	5.02E-04
					Total:	**61.46**	**2.49E-03**	**4.99E-04**	**0.84**	**3.72**	**1.38E-01**	**1.38E-01**	**1.80E-03**	**1.38E-01**	**7.27E-04**

Pollutant	Emission Factor	Unit	Source
Engines 600 hp or Greater			
CO_2	163.05	lb/MMBtu	41 CFR Part 98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
CO	5.50E-03	lb/hp-hr	AP-42 Table 3.4-1
NO_X	2.40E-02	lb/hp-hr	AP-42 Table 3.4-1
PM_{10}	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
$PM_{2.5}$	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.4-1
VOC	6.42E-04	lb/hp-hr	AP-42 Table 3.4-1
Acetaldehyde	2.52E-05	lb/MMBtu	AP-42 Table 3.4-3
Acrolein	7.88E-06	lb/MMBtu	AP-42 Table 3.4-3
Benzene	7.76E-04	lb/MMBtu	AP-42 Table 3.4-3
Formaldehyde	7.89E-05	lb/MMBtu	AP-42 Table 3.4-3
Naphthalene	1.30E-04	lb/MMBtu	AP-42 Table 3.4-4
PAH, other than Napthalene	8.20E-05	lb/MMBtu	AP-42 Table 3.4-4
Toluene	2.81E-04	lb/MMBtu	AP-42 Table 3.4-3
Xylene	1.93E-04	lb/MMBtu	AP-42 Table 3.4-3
Total HAP	**1.57E-03**	**lb/MMBtu**	

Pollutant	Emission Factor	Unit	Source
Engines Less Than 600 hp			
CO_2	163.05	lb/MMBtu	40 CFR Part 98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
CO	6.68E-03	lb/hp-hr	AP-42 Table 3.3-1
NO_X	3.10E-02	lb/hp-hr	AP-42 Table 3.3-1
PM_{10}	2.20E-03	lb/hp-hr	AP-42 Table 3.3-1
$PM_{2.5}$	2.20E-03	lb/hp-hr	AP-42 Table 3.3-1
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.4-1
VOC	2.51E-03	lb/hp-hr	AP-42 Table 3.3-1
1,3-Butadiene	3.91E-05	lb/MMBtu	AP-42 Table 3.3-2
Acetaldehyde	7.67E-04	lb/MMBtu	AP-42 Table 3.3-2
Acrolein	9.25E-05	lb/MMBtu	AP-42 Table 3.3-2
Benzene	9.33E-04	lb/MMBtu	AP-42 Table 3.3-2
Formaldehyde	1.18E-03	lb/MMBtu	AP-42 Table 3.3-2
Napthalene	8.48E-05	lb/MMBtu	AP-42 Table 3.3-2
PAH, other than Napthalene	8.32E-05	lb/MMBtu	AP-42 Table 3.3-2
Toluene	4.09E-04	lb/MMBtu	AP-42 Table 3.3-2
Xylenes	2.85E-04	lb/MMBtu	AP-42 Table 3.3-2
Total HAP	**3.87E-03**	**lb/MMBtu**	

Phase	Emission Unit	Number of Units	Engine Capacity	Engine Capacity	Number of Hours Each Unit Used	Rate Each Engine Used	Applicable Emission Standard[1]			CO_2	CH_4	N_2O	CO	NO_X	PM	PM_{10} [2]	$PM_{2.5}$ [2]	SO_2	VOC	Total HAP
							NO_X	PM	CO											
			hp	kW	hours/year	hp-hr/year	g/kW-hr	g/kW-hr	g/kW-hr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
O&M	Substation Emergency Generator	3	800	600	1000	800,000	0.67	0.03	3.5	497.48	2.02E-02	4.04E-03	6.90	1.32	5.92E-02	8.07E-02	8.07E-02	1.46E-02	0.77	4.80E-03

[1] Applicable emission standard based on LAER determination, which is Tier 4 emission standards from 40 CFR 1039.101. The Tier 4 emission standard was used to estimate PTE for the following pollutants: NO_x, PM, PM_{10}, $PM_{2.5}$ and CO. All other pollutants (CO_2, CH_4, N_2O, SO_2, and VOC) were estimated using AP-42 emission factors from Tables 3.4-1 and 3.3-1. See footenote [2] for an explanation of how PM_{10} and $PM_{2.5}$ emissions were estimated from the PM standard.

[3] It is conservatively assumed that the PM emission standard is equal to the filterable portion of PM_{10} and $PM_{2.5}$. The condensable portion of PM_{10} and $PM_{2.5}$ was added using the AP-42 emission factor of 0.0077 lb/MMBtu from AP-42 Table 3.4-2 and converting to lb/hp-hr using the conversion factor 7,000 Btu/hp-hr from footnote 'e' of AP-42 Table 3.4-1, resulting in a condensable emission factor of 0.0000539 lb/hp-hr.

Pollutant	Emission Factor	Unit	Source
Engines 600 hp or Greater			
CO_2	163.05	lb/MMBtu	41 CFR Part 98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
CO	5.50E-03	lb/hp-hr	AP-42 Table 3.4-1
NO_X	2.40E-02	lb/hp-hr	AP-42 Table 3.4-1
PM_{10}	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
$PM_{2.5}$	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.4-1
VOC	6.42E-04	lb/hp-hr	AP-42 Table 3.4-1
Acetaldehyde	2.52E-05	lb/MMBtu	AP-42 Table 3.4-3
Acrolein	7.88E-06	lb/MMBtu	AP-42 Table 3.4-3
Benzene	7.76E-04	lb/MMBtu	AP-42 Table 3.4-3
Formaldehyde	7.89E-05	lb/MMBtu	AP-42 Table 3.4-3
Naphthalene	1.30E-04	lb/MMBtu	AP-42 Table 3.4-4
PAH, other than Napthalene	8.20E-05	lb/MMBtu	AP-42 Table 3.4-4
Toluene	2.81E-04	lb/MMBtu	AP-42 Table 3.4-3
Xylene	1.93E-04	lb/MMBtu	AP-42 Table 3.4-3
Total HAP	**1.57E-03**	**lb/MMBtu**	

Pollutant	Emission Factor	Unit	Source
Engines Less Than 600 hp			
CO_2	163.05	lb/MMBtu	98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	98 Subpart C Table C-2
CO	6.68E-03	lb/hp-hr	42 Table 3.3-1
NO_X	3.10E-02	lb/hp-hr	42 Table 3.3-1
PM_{10}	2.20E-03	lb/hp-hr	42 Table 3.3-1
$PM_{2.5}$	2.20E-03	lb/hp-hr	42 Table 3.3-1
SO_2	1.21E-05	lb/hp-hr	42 Table 3.4-1
VOC	2.51E-03	lb/hp-hr	42 Table 3.3-1
1,3-Butadiene	3.91E-05	lb/MMBtu	42 Table 3.3-2
Acetaldehyde	7.67E-04	lb/MMBtu	42 Table 3.3-2
Acrolein	9.25E-05	lb/MMBtu	42 Table 3.3-2
Benzene	9.33E-04	lb/MMBtu	42 Table 3.3-2
Formaldehyde	1.18E-03	lb/MMBtu	42 Table 3.3-2
Napthalene	8.48E-05	lb/MMBtu	42 Table 3.3-2
PAH, other than Napthalene	8.32E-05	lb/MMBtu	42 Table 3.3-2
Toluene	4.09E-04	lb/MMBtu	42 Table 3.3-2
Xylenes	2.85E-04	lb/MMBtu	42 Table 3.3-2
Total HAP	**3.87E-03**	**lb/MMBtu**	

Paint Usage Information

Equipment	Number of Lifetime Events	Volume Paint Used per Event [3] gallons	Total Volume of Paint gallons/lifetime	Type of Paint Used (Representative)
WTG Repair Painting [1]	347	3	1041	RAL 7035
OSS Foundation Painting [2]	3	3	9	Interzone 9545
WTG Foundation Painting [2]	347	3	1041	Interzone 9545

[1] It is assumed WTGs will be repainted at the same rate as WTG Foundations. Representative type of paint obtained from page 155 of Volume I of Ocean Wind COP (dated March 2021).

[2] Maximum number of times foundations will be repainted obtained from Table 6.1.2-7 of Volume I of Ocean Wind's COP (dated March 2021).

[3] Volume of paint based on other offshore wind permit applications (Vineyard Wind assumed 50 gallons of marine paint per year for all touch ups).

Paint Data

Paint [1]	VOC Content % by Weight	HAP Content [2] % by Weight	Density lb/gal
RAL 7035	44.07	16.2	6.69
Interzone 9545	3.88	0	13.90
Interzone 9545	3.88	0	13.90

[1] Data from Custom-Pak Products RAL 7035 SDS and Interzone 9545 SDS.

[2] HAP content of Interzone 9545 not provided on SDS.

Emissions [1]

Equipment	VOC tons/year	VOC tons/lifetime	HAP tons/year	HAP tons/lifetime
WTG Painting	3.84E-02	1.54	1.41E-02	0.56
OSS Foundation Painting	6.07E-05	2.43E-03	0.00E+00	0.00E+00
WTG Foundation Painting	7.02E-03	0.28	0.00E+00	0.00E+00
Total:	**4.55E-02**	**1.82**	**1.41E-02**	**0.56**

[1] Conservatively assuming that all VOC/HAP content is emitted.

SF_6 Project Usage Rates

Equipment	SF_6 per Equipment	Unit	Equipment Number	Total SF_6	Unit
WTG Switchgear [1]	243	lbs	99	24,057	lbs
OSS Switchgear [2]	793	gallons	4	3,172	gallons

[1] SF_6 per WTG obtained from Table 8.1-1 of Volume I of Ocean Wind's COP (dated March 2021).

[2] SF_6 per OSS obtained from Table 8.1-2 of Volume I of Ocean Wind's COP (dated March 2021).

Density of SF_6 0.0535 lbs/gal

Total Mass of SF6

WTG Switchgear	24057	lbs
OSS Switchgear	169.6831028	lbs
Total:	**24,226.68**	**lbs**

Mass of SF_6 Leaked

Total Mass of SF_6	24,226.68	lbs
Annual Leakage Rate [1]	0.50%	
Total Mass Leaked per Year	121.13	lbs
Total Mass Leaked over 35-Year Life	4845.34	lbs

[1] Annual leakage rate obtained from: Blackman, J., Averyt, M., & Taylor, Z. SF_6 Leak Rates from High Voltage Circuit Breakers - U.S. EPA Investigates Potential Greenhouse Gas Emissions Source. Retrieved April 15, 2021, from https://www.epa.gov/sites/production/files/2016-02/documents/leakrates_circuitbreakers.pdf

GHG Emissions due to SF_6 Leakage

Global Warming Potential (GWP) of SF_6 [1]	22,800	Unitless
Annual GHG Emissions	1,380.92	tons/year
Lifetime GHG Emissions	55,236.84	tons

[1] GWP of SF_6 obtained from 40 CFR Part 98 Subpart A Table A-1.

Marine Vessel HAP Profiles [1]			Category 1 & 2 Vessel Engines		Category 3 Vessel Engines		
			In-port Maneuvering	Underway	In-port Hoteling	In-port Maneuvering	Underway
Pollutant Code	Pollutant	Fraction of	Fraction				
130498292	POM as 7-PAH	PM	NA	NA	4.50E-07	4.90E-07	4.90E-07
NH3	Ammonia	PM10	1.00E-02	2.00E-02	1.08E-02	2.38E-03	4.77E-03
7440382	Arsenic	PM10	1.75E-05	3.00E-05	4.00E-04	8.74E-05	1.75E-04
50328	Benzo[a]Pyrene	PM10	2.50E-06	5.00E-06	2.00E-06	4.37E-07	8.74E-07
205992	Benzo[b]Fluoranthene	PM10	5.00E-06	1.00E-05	4.00E-06	8.74E-07	1.75E-06
207089	Benzo[k]Fluoranthene	PM10	2.50E-06	5.00E-06	2.00E-06	4.37E-07	8.74E-07
7440417	Beryllium	PM10	NA	NA	5.46E-07	5.46E-07	5.46E-07
7440439	Cadmium	PM10	2.83E-06	5.15E-06	5.90E-06	2.26E-05	2.26E-05
7440473	Chromium	PM10	NA	5.00E-05	NA	NA	1.92E-04
16065831	Chromium III	PM10	1.65E-05	3.30E-05	3.96E-04	1.27E-04	1.27E-04
18540299	Chromium VI	PM10	8.50E-06	1.70E-05	2.04E-04	6.53E-05	6.53E-05
7440484	Cobalt	PM10	NA	NA	2.92E-04	5.94E-05	1.54E-04
	Copper	PM10	9.58E-04	1.75E-03	9.08E-04	1.91E-04	3.48E-04
628	Dioxin	PM10	2.50E-09	5.00E-09	2.00E-09	4.37E-10	8.74E-10
118741	HCB	PM10	2.00E-08	4.00E-08	1.60E-08	3.50E-09	6.99E-09
193395	Indeno[1,2,3-c,d]Pyrene	PM10	5.00E-06	1.00E-05	4.00E-06	8.74E-07	1.75E-06
7439921	Lead	PM10	7.50E-05	1.50E-04	6.00E-05	1.40E-05	2.62E-05
7439965	Manganese	PM10	1.53E-06	1.28E-06	5.73E-05	5.73E-05	5.73E-05
7439976	Mercury	PM10	2.50E-08	5.00E-08	1.40E-06	2.71E-07	5.24E-07
7440020	Nickel	PM10	5.00E-04	1.00E-03	1.54E-02	3.25E-03	5.89E-03
1336363	PCB	PM10	2.50E-07	5.00E-07	2.00E-07	4.37E-08	8.74E-08
7723140	Phosphorous	PM10	NA	NA	4.38E-03	1.79E-03	5.73E-03
7782492	Selenium	PM10	2.83E-08	5.15E-08	9.08E-06	1.91E-06	3.48E-06
	Zinc	PM10	5.00E-04	1.00E-03	6.00E-04	1.31E-04	2.62E-04
	Total Fraction of PM10:		**1.21E-02**	**2.41E-02**	**3.35E-02**	**8.18E-03**	**1.78E-02**
83329	Acenaphthene	PM2.5	1.80E-05	1.50E-05	3.40E-07	3.40E-07	3.40E-07
208968	Acenaphthylene	PM2.5	2.78E-05	2.31E-05	5.25E-07	5.25E-07	5.25E-07
120127	Anthracene	PM2.5	2.78E-05	2.31E-05	5.25E-07	5.25E-07	5.25E-07
56553	Benz[a]Anthracene	PM2.5	3.00E-05	2.50E-05	5.67E-07	5.67E-07	5.67E-07
191242	Benzo[g,h,I,]Perylene	PM2.5	6.75E-06	5.63E-06	1.28E-07	1.28E-07	1.28E-07
218019	Chrysene	PM2.5	5.25E-06	4.38E-06	9.93E-08	9.93E-08	9.93E-08
53703	Dibenzo[a,h]Anthracene	PM2.5	NA	NA	0.00E+00	0.00E+00	0.00E+00
206440	Fluoranthene	PM2.5	1.65E-05	1.38E-05	3.12E-07	3.12E-07	3.12E-07
86737	Fluorene	PM2.5	3.68E-05	3.06E-05	6.95E-07	6.95E-07	6.95E-07
91203	Naphthalene	PM2.5	1.05E-03	8.76E-04	1.99E-05	1.99E-05	1.99E-05
85018	Phenanthrene	PM2.5	4.20E-05	3.50E-05	7.94E-07	7.94E-07	7.94E-07
130498292	POM as 16-PAH	PM2.5	NA	NA	2.49E-05	2.49E-05	2.49E-05
129000	Pyrene	PM2.5	2.93E-05	2.44E-05	5.53E-07	5.53E-07	5.53E-07
	Total Fraction of PM2.5:		**1.29E-03**	**1.08E-03**	**4.93E-05**	**4.93E-05**	**4.93E-05**
540841	2,2,4-trimethylpentane	VOC	3.00E-04	2.50E-04	NA	NA	NA
75070	Acetaldehyde	VOC	5.57E-02	4.64E-02	2.29E-04	2.29E-04	2.29E-04
107028	Acrolein	VOC	2.63E-03	2.19E-03	NA	NA	NA
71432	Benzene	VOC	1.53E-02	1.27E-02	9.80E-06	9.80E-06	9.80E-06
100414	Ethylbenzene	VOC	1.50E-03	1.25E-03	NA	NA	NA
50000	Formaldehyde	VOC	0.11	9.35E-02	1.57E-03	1.57E-03	1.57E-03
110543	n-Hexane	VOC	4.13E-03	3.44E-03	NA	NA	NA
123386	Propionaldehyde	VOC	4.58E-03	3.81E-03	NA	NA	NA
100425	Styrene	VOC	1.58E-03	1.31E-03	NA	NA	NA
108883	Toluene	VOC	2.40E-03	2.00E-03	NA	NA	NA
1330207	Xylene	VOC	3.60E-03	3.00E-03	NA	NA	NA
	Total Fraction of VOC:		**0.20**	**0.17**	**1.81E-03**	**1.81E-03**	**1.81E-03**

[1] HAP emissions from marine vessel engines estimated using fractions of VOC and PM/PM_{10}/$PM_{2.5}$ estimates, in accordance with Appendix F of Draft 2014 National Emissions Inventory, version 1 Technical Support Document (2015).

Phase	Activity	Vessel Description	Vessel Type [1]	Number of Vessels	Main Engine Rating (kW)	Assumed Engine Type [2]	Auxiliary Engine Rating (kW)	Assumed Engine Type [2]	Transit Total HAP - Main Engine (tons/year)	Transit Total HAP - Auxiliary Engine (tons/year)	On-site Manuevering Total HAP - Main Engine (tons/year)	On-site Manuevering Total HAP - Auxiliary Engine (tons/year)
Construction	Array Cable Installation	Pre-lay Survey Vessel	Crew	1	2,060.00	Cat1/2	201.05	Cat1/2	3.78E-04	1.47E-05	1.93E-02	1.92E-03
Construction		Pre-lay Grapnel Run (PLGR) Vessel	Dredging	1	3,233.66	Cat3	963.82	Cat1/2	1.51E-04	8.10E-05	2.03E-03	5.76E-03
Construction		Boulder Clearance Vessel	Multi-Purpose Service Vessel	1	3,131.92	Cat3	1,006.68	Cat1/2	1.46E-04	8.46E-05	2.82E-03	8.60E-03
Construction		Sandwave Clearance Vessel	Dredging	1	3,233.66	Cat3	963.82	Cat1/2	1.51E-04	8.10E-05	2.03E-03	5.76E-03
Construction		Cable Laying Vessel	Cable Laying	1	6,657.62	Cat3	3,025.77	Cat3	1.38E-03	2.23E-04	1.12E-02	4.54E-03
Construction		Cable Burial Vessel	Cable Laying	1	6,657.62	Cat3	3,025.77	Cat3	1.38E-03	2.23E-04	1.69E-02	6.82E-03
Construction		Crew Transport Vessel	Crew	2	2,060.00	Cat1/2	201.05	Cat1/2	1.91E-02	7.42E-04	9.40E-02	9.36E-03
Construction		Walk to Work Vessel	Multi-Purpose Service Vessel	1	3,131.92	Cat3	1,006.68	Cat1/2	4.82E-03	2.79E-03	6.54E-03	2.00E-02
Construction		Post-Lay Inspection Survey Vessel	Crew	1	2,060.00	Cat1/2	201.05	Cat1/2	6.30E-03	2.44E-04	3.48E-02	3.46E-03
Construction		DP2 Construction Vessel - Jack of All Trades	Multi-Purpose Service Vessel	1	3,131.92	Cat3	1,006.68	Cat1/2	2.48E-03	1.44E-03	3.90E-03	1.19E-02
Construction	Offshore Export Cable & Interconnection Cable Installation	Cable Lay and Burial Vessel	Cable Laying	1	6,657.62	Cat3	3,025.77	Cat3	1.96E-03	3.18E-04	2.25E-02	9.09E-03
Construction		Cable Burial Vessel	Cable Laying	1	6,657.62	Cat3	3,025.77	Cat3	2.06E-03	3.34E-04	1.59E-03	6.43E-04
Construction		Anchor Handling Tug	Tug	1	2,053.16	Cat1/2	238.13	Cat1/2	5.31E-03	2.00E-04	2.54E-02	2.40E-03
Construction		Pull tug to move barges	Tug	1	2,053.16	Cat1/2	238.13	Cat1/2	1.52E-02	5.73E-04	7.29E-02	6.87E-03
Construction		Pull ahead export cable tug for assist CLV	Anchor Tug	1	1,230.00	Cat1/2	357.00	Cat1/2	7.42E-03	7.00E-04	3.42E-02	8.07E-03
Construction		Pre-lay Grapnel Run (PLGR) Vessel	Dredging	1	3,233.66	Cat3	963.82	Cat1/2	5.53E-04	2.97E-04	3.47E-03	9.83E-03
Construction		Boulder Clearance Vessel	Multi-Purpose Service Vessel	1	3,131.92	Cat3	1,006.68	Cat1/2	2.44E-04	1.41E-04	1.68E-03	5.14E-03
Construction		Crew Transport Vessel	Crew	2	2,060.00	Cat1/2	201.05	Cat1/2	2.12E-03	8.24E-05	8.68E-02	8.64E-03
Construction		Guard Vessel	Guard Vessel	5	2,460.00	Cat1/2	357.00	Cat1/2	1.92E-01	7.50E-03	3.17E+00	3.04E-01
Construction		Post-Lay Inspection Survey Vessel	Crew	2	2,060.00	Cat1/2	201.05	Cat1/2	5.64E-03	2.19E-04	2.19E-02	2.19E-03
Construction		General Work Vessel	Multi-Purpose Service Vessel	1	3,131.92	Cat3	1,006.68	Cat1/2	7.31E-04	4.23E-04	3.75E-03	1.14E-02
Construction	OSS Topside	Heavy Transport Vessel	Heavy Transport Vessel	2	10,022.00	Cat3	0.00	Cat1/2	5.30E-03	0.00E+00	1.60E-03	0.00E+00
Construction	WTG & Platform Foundation Installation	Heavy Lift Installation Vessel	Heavy Transport Vessel	1	10,022.00	Cat3	0.00	Cat1/2	1.29E-02	0.00E+00	3.03E-02	0.00E+00
Construction		Secondary Steel Installation	Jackup	1	3,214.91	Cat3	895.08	Cat1/2	4.13E-03	2.48E-03	0.00E+00	0.00E+00
Construction		Feeder Barge Tug	Feeder Barge Tug	2	8,113.00	Cat3	340.00	Cat1/2	4.47E-02	3.77E-03	4.45E-02	2.03E-02
Construction		Rock Dumping Vessel	Multi-Purpose Service Vessel	1	3,131.92	Cat3	1,006.68	Cat1/2	4.82E-03	2.79E-03	5.77E-03	1.76E-02
Construction		Bubble Curtain Vessel	Platform Support Vessel	1	4,516.00	Cat3	1,618.00	Cat1/2	6.06E-03	4.48E-03	1.02E-02	4.08E-02
Construction		Heavy Transport Vessel	Heavy Transport Vessel	1	10,022.00	Cat3	0.00	Cat1/2	1.29E-02	0.00E+00	0.00E+00	0.00E+00
Construction		Crew Transport Vessel	Crew	1	2,060.00	Cat1/2	201.05	Cat1/2	5.63E-03	2.19E-04	6.69E-02	6.67E-03
Construction		Noise Monitoring Vessel	Noise Monitoring Vessel	2	970.00	Cat1/2	0.00	Cat1/2	3.31E-02	0.00E+00	8.36E-02	0.00E+00
Construction		Platform Support Vessel	Platform Support Vessel	2	4,516.00	Cat3	1,618.00	Cat1/2	2.43E-02	1.79E-02	2.83E-02	1.13E-01
Construction	WTG Construction	Installation Vessel	Jackup	1	3,214.91	Cat3	895.08	Cat1/2	7.10E-04	4.26E-04	0.00E+00	0.00E+00
Construction		Towing Tug	Tug	2	2,053.16	Cat1/2	238.13	Cat1/2	1.17E-02	4.40E-04	8.58E-02	8.09E-03
Construction	Construction Package	Safety Vessel	Supply Ship	1	3,842.65	Cat3	873.99	Cat1/2	6.19E-03	2.90E-03	3.81E-02	9.69E-02
Construction		Crew Transport Vessel	Crew	6	2,060.00	Cat1/2	201.05	Cat1/2	4.00E+00	1.55E-01	5.69E+00	5.66E-01
Construction		Service Operation Vessel	Multi-Purpose Service Vessel	1	3,131.92	Cat3	1,006.68	Cat1/2	2.89E-03	1.67E-03	2.77E-02	8.45E-02
								Total Construction HAP:	4.44	0.21	9.75	1.40
									15.80			
Operations	Annual O&M	Crew Transport Vessel - Minor Repairs	Crew	2	2,060.00	Cat1/2	201.05	Cat1/2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Operations		Crew Transport Vessel	Crew	1	2,060.00	Cat1/2	201.05	Cat1/2	2.87E-04	1.08E-05	3.37E-04	7.25E-05
Operations		Jackup - Major Repairs	Jackup	1	3,214.91	Cat3	895.08	Cat1/2	5.96E-05	3.58E-05	0.00E+00	0.00E+00
Operations		Feeder Barge Tug	Tug	1	2,053.16	Cat1/2	238.13	Cat1/2	1.27E-03	5.67E-05	4.86E-03	1.24E-03
Operations		Crew Transport Vessel	Crew	3	2,060.00	Cat1/2	201.05	Cat1/2	5.16E-03	1.94E-04	1.82E-02	3.91E-03
								Total Annual Operation and Maintenance HAP:	6.78E-03	2.97E-04	2.34E-02	5.23E-03
									3.57E-02			

[1] Vessel specifications for offshore substation construction, foundation installation and WTG construction are representative of vessels likely to be used for installation activities and are not BOEM default factors but are from installation vessel spec sheets.

[2] It is assumed that Category 1 and 2 engines are smaller than 3,000 kW and Category 3 engines are larger than 3,000 kW, based on Browning and Bailey: Browning, ICF Consulting and Bailey, USEPA. Current Methodologies and Best Practice for Preparing Port Emission Inventories. https://www3.epa.gov/ttnchie1/conference/ei15/session1/browning.pdf

Project Emissions - Sulfuric Acid (H_2SO_4)

Assumption

3.00% of fuel sulfur forms H_2SO_4 [1]

[1] EPA, 2008. *Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder*

Given

MW SO_2	64.06	g/mol
MW SO_3	80.06	g/mol
MW H_2SO_4	98.08	g/mol

	SO_2	H_2SO_4
	tons/yr	
Year 1 - Transit OCS	0.94	0.04
Year 1 - Onsite Maneuvering	5.69	0.26
Year 1 Total	6.63	0.30
Operations - Annual	0.02	0.00
Operations - 35-Yr Total	0.84	0.04

Project Emissions Summary

Construction

	CO2	CH4	N2O	CO2e	CO	NOX	PM	PM10	PM2.5	SO2	Lead	VOC	HAP
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
Vessel Transit	30,256	0.19	1.45	30,693	107.40	343.75	11.13	10.66	10.43	0.94	2.12E-03	7.33	4.65
Vessel Onsite Maneuvering	100,179	0.62	4.83	101,634	357.08	1,332	47.26	43.85	42.48	5.69	6.85E-03	28.03	11.15
Vessel Total - Construction	**130,435**	**0.81**	**6.28**	**132,327**	**464.48**	**1,676**	**58.40**	**54.51**	**52.91**	**6.63**	**8.97E-03**	**35.36**	**15.80**
Auxiliary Equipment	5,301	0.22	4.30E-02	5,319	75.15	17.28	0.52	0.52	0.66	0.16	0.00E+00	29.44	0.12
Generators	4,155	0.17	3.37E-02	4,169	62.24	21.23	0.45	0.45	0.57	1.22E-01	0.00E+00	15.17	6.74E-02

Operations

	CO2	CH4	N2O	CO2e	CO	NOX	PM	PM10	PM2.5	SO2	Lead	VOC	HAP
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
Vessels	416.91	2.58E-03	2.00E-02	422.92	1.50	6.59	0.21	0.20	0.19	7.59E-03	2.93E-05	0.09	3.57E-02
Auxiliary Equipment	61.46	2.49E-03	4.99E-04	61.68	0.84	3.72	0.14	1.38E-01	1.38E-01	1.80E-03	0.00E+00	1.38E-01	7.27E-04
Generators	497.48	2.02E-02	4.04E-03	499.18	6.90	1.32	5.92E-02	5.92E-02	8.07E-02	1.46E-02	0.00E+00	0.77	4.80E-03
Fugitive (SF6 Leakage and Paint)	0.00E+00	0.00E+00	0.00E+00	1,380.92	0.00E+00	0.00E+00	1.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.55E-02	1.41E-02

	CO2	CH4	N2O	CO2e	CO	NOX	PM	PM10	PM2.5	SO2	Lead	VOC	HAP
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
Construction - Total	139,891	1.19	6.36	141,815	601.87	1,714	59.36	55.48	54.14	6.90	8.97E-03	79.97	15.98
Operations - Annual Total	976	2.52E-02	2.45E-02	2,365	9.24	11.63	1.41	0.40	0.41	2.40E-02	2.93E-05	1.05	5.53E-02
Operations - 35 Year Total	34,155	0.88	0.86	82,765	323.49	407.18	49.36	13.87	14.41	0.84	1.03E-03	36.60	1.94

New Jersey's Banked Emission Credits - NY-NJ-CT- PA-NJ-DE-MD Ozone Nonattainment Area

Facilities that have Shutdown Credits from Today to 5 Years

New Jersey Counties: Atlantic, Bergen, Burlington, Camden, Cape May, Cumberland, Essex, Gloucester, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Salem, Somerset, Sussex, Union, Warren

				Available (TPY)						
PI No.	Company Name, Location	Entry Date	Log Number	VOC	NOx	CO	SO2	PM10	PM2.5	TSP
BERGEN										
02626	LNG PLANT STATION 240, CARLSTADT	4/16/2020	2020-1478	3.54	6.03	9.86	0.02	0.21	0.21	0.21
02626	LNG PLANT STATION 240, CARLSTADT	4/16/2020	2020-1479	0.97	4.31	3.42	0.01	0.11	0.11	0.11
02626	LNG PLANT STATION 240, CARLSTADT	4/16/2020	2020-1480	0.87	3.86	3.06	0.005	0.1	0.1	0.1
02626	LNG PLANT STATION 240, CARLSTADT	4/16/2020	2020-1481	0.86	3.83	3.04	0	0.1	0.1	0.1
02626	LNG PLANT STATION 240, CARLSTADT	4/15/2020	2020-1477	4.42	9.36	11.55	0.02	0.27	0.27	0.27
			Total for Bergen County:	**10.66**	**27.39**	**30.93**	**0.055**	**0.79**	**0.79**	**0.79**
HUDSON										
12061	DONNELLEY FINANCIAL SECAUCUS, LANCASTER	9/22/2021	2021-1491	8.57	0	0	0	0	0	0
12202	PSEG FOSSIL LLC - HUDSON GENERATING STATION, JERSEY CITY	8/30/2017	2017-1407	10.54	492.57	81.15	162.45	31.69	31.69	32.59
12202	PSEG FOSSIL LLC - HUDSON GENERATING STATION, JERSEY CITY	8/30/2017	2017-1408	0.1	1.63	0.15	0.03	0.29	0.29	0.29
			Total for Hudson County:	**19.21**	**494.2**	**81.3**	**162.48**	**31.98**	**31.98**	**32.88**
HUNTERDON										
80337	LAMBRETVILLE COMPRESSOR STATION, LAMBERTVILLE	6/9/2020	2020-1482	0	32.42	0	0	0	0	0
			Total for Hunterdon County:	**0**	**32.42**	**0**	**0**	**0**	**0**	**0**
MERCER										
61057	PSEG FOSSIL MERCER GENERATING STATION, HAMILTON	8/30/2017	2017-1409	25.57	94.74	8.81	67.12	7.29	7.29	2.86
61057	PSEG FOSSIL MERCER GENERATING STATION, HAMILTON	8/30/2017	2017-1410	5.35	116.22	20.02	60.73	32.03	32.03	2.59
			Total for Mercer County:	**30.92**	**210.96**	**28.83**	**127.85**	**39.32**	**39.32**	**5.45**
MIDDLESEX										
17880	SCHWEITZER MAUDUIT INTERNATIONAL INC,	3/8/2021	2021-1483	0.19	0	0	0	0	0	0
17880	SCHWEITZER MAUDUIT INTERNATIONAL INC,	8/24/2021	2021-1489	0.065	2.835	0	0	0	0	0
17880	SCHWEITZER MAUDUIT INTERNATIONAL INC,	3/8/2021	2021-1484	0	0.23	0	0	0	0	0
			Total for Middlesex County:	**0.255**	**3.065**	**0**	**0**	**0**	**0**	**0**
NA										

All Shutdown emission credits are adjusted for time discounts as per N.J.A.C 7:27-18.8 (f) and (g). Accordingly, this report shows the current value of shutdown credits if the 50% discount was applied, based on the 5-year period from the Entry Date. For additional information check the guidance at: http://www.nj.gov/dep/aqpp/permitguide/CERGuidance.pdf

New Jersey's Banked Emission Credits - NY-NJ-CT- PA-NJ-DE-MD Ozone Nonattainment Area

Facilities that have Shutdown Credits from Today to 5 Years

New Jersey Counties: Atlantic, Bergen, Burlington, Camden, Cape May, Cumberland, Essex, Gloucester, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Salem, Somerset, Sussex, Union, Warren

				Available (TPY)						
PI No.	Company Name, Location	Entry Date	Log Number	VOC	NOx	CO	SO2	PM10	PM2.5	TSP
00009	FAR ROCKWAY POWER STATION, FAR ROCKWAY	10/31/2017	2017-1419	0	0	0	0	0	0	0
00010	POLETTI POWER, ASTORIA	12/6/2017	2017-1426	0	0	0	0	0	0	0
00008	ST. BARNABAS HOSPITAL, BRONX	10/23/2017	2017-1416	0	0	0	0	0	0	0
			Total for NA County:	**0**	**0**	**0**	**0**	**0**	**0**	**0**
SALEM										
65482	PRAXAIR, INC (LINDE, INC), EAST CHICAGO	3/7/2019	2019-1473	0.37	29.43	0.04	0.08	0.55	0.55	1.03
65482	PRAXAIR, INC (LINDE, INC), EAST CHICAGO	3/7/2019	2019-1474	0.62	11.82	69.75	0	0.02	0.02	0.02
			Total for Salem County:	**0.99**	**41.25**	**69.79**	**0.08**	**0.57**	**0.57**	**1.05**
WARREN										
85455	COVANTA WARREN ENERGY RESOURCES, OXFORD	12/23/2019	2019-1475	0	81.35	0	0	0	0	0
85455	COVANTA WARREN ENERGY RESOURCES, OXFORD	12/23/2019	2019-1476	0	80.65	0	0	0	0	0
			Total for Warren County:	**0**	**162**	**0**	**0**	**0**	**0**	**0**
r_Root_RS			**Total for all New Jersey Counties:**	**62.035**	**971.29**	**210.85**	**290.47**	**72.66**	**72.66**	**40.17**

All Shutdown emission credits are adjusted for time discounts as per N.J.A.C 7:27-18.8 (f) and (g). Accordingly, this report shows the current value of shutdown credits if the 50% discount was applied, based on the 5-year period from the Entry Date. For additional information check the guidance at: http://www.nj.gov/dep/aqpp/permitguide/CERGuidance.pdf

Vessel Transit Distances: Construction Phase [1] [2]	Distance Within OCS nautical miles	Distance Outside OCS nautical miles	Total Trip Distance (One-Way) nautical miles
Atlantic City, NJ	21.2	0	21.2
Charleston, SC	25	513.6	538.6
Europe	25	168.1	193.1
Hope Creek, NJ	25	67.9	92.9
Norfolk, VA	25	166.0	191.0
Paulsboro, NJ	25	101.8	126.8
Port Elizabeth, NJ	25	57.2	82.2
Repauno, NJ	25	118.3	124.5

[1] The ports listed are the expected list of ports Ocean Wind may use; this table displays distances to each port and breaks it down into distances occuring within the 25 nautical mile radius from the centroid of the array area and those outside that circle. When calculating time spent in transit for the purpose of estimating emissions, the longest route was selected among the list of expected possible ports for each vessel as a conservative assumption.

[2] It is assumed all crew transfer vessels utilize Atlantic City port.

Vessel Transit Distances: Operations Phase	Distance Within OCS nautical miles	Distance Outside OCS nautical miles	Total Trip Distance (One-Way) nautical miles
Atlantic City, NJ	21.2	0	21.2
Europe	25	168.1	193.1

Project Information - Bureau of Ocean Energy Management (BOEM) Default Vessel Parameters [1]

Vessel Type [1]	Vessel Speed [1] Knots			Main Engine Power Rating [1] kW			Auxiliary Engine Power Rating [1] kW		
	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
Anchor Handling Tugs	12.37	12.37	12.37	5,732.71	5,732.71	5,732.71	1,237.10	1,237.10	1,237.10
Barge	19.99	19.99	19.99	22,424.22	22,424.22	22,424.22	3,020.00	3,020.00	3,020.00
Cable Laying	12.24	12.24	12.24	6,657.62	6,657.62	6,657.62	3,025.77	3,025.77	3,025.77
Crew	22.13	22.13	22.13	3,013.01	3,013.01	3,013.01	201.05	201.05	201.05
Dredging	10.92	10.92	10.92	3,233.66	3,233.66	3,233.66	963.82	963.82	963.82
Jackup	7.00	7.00	7.00	3,214.91	3,214.91	3,214.91	895.08	895.08	895.08
Research/Survey	12.46	12.46	12.46	2,996.75	2,996.75	2,996.75	1,362.92	1,362.92	1,362.92
Shuttle Tanker	14.76	14.76	14.76	17,484.02	17,484.02	17,484.02	30,769.22	30,769.22	30,769.22
Supply Ship	12.12	12.12	12.12	3,842.65	3,842.65	3,842.65	873.99	873.99	873.99
Tug	11.53	11.53	11.53	2,053.16	2,053.16	2,053.16	238.13	238.13	238.13

[1] Chang, R., B. Do, and R. Billings. 2017. Technical Summary for the Offshore Wind Energy Facilities Emission Estimating Tool. US Dept. of the Interior, Bureau of Ocean Energy Management, Sterling, VA. OCS Study BOEM 2017. 9 pp.

Engine	Type [1]	Units	Emission Factors									
			CO_2	CH_4	N_2O	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Main	Anchor Handling Tugs	g/kW-hr	636.09	4.00E-03	3.10E-02	2.16	9.26	0.34	0.33	7.87E-02	4.03E-05	0.24
Main	Barge	g/kW-hr	588.90	4.00E-03	3.10E-02	1.40	13.61	0.45	0.42	0.36	1.18E-05	0.63
Main	Cable Laying	g/kW-hr	635.02	4.00E-03	3.10E-02	2.20	9.49	0.34	0.33	8.51E-02	3.88E-05	0.25
Main	Crew	g/kW-hr	648.16	4.00E-03	3.10E-02	2.30	5.51	0.15	0.15	6.24E-03	4.65E-05	0.14
Main	Dredging	g/kW-hr	630.62	4.00E-03	3.10E-02	2.13	9.60	0.36	0.34	0.11	3.70E-05	0.28
Main	Jackup	g/kW-hr	647.08	4.00E-03	3.10E-02	2.30	10.03	0.31	0.30	1.27E-02	4.51E-05	0.14
Main	Research/Survey	g/kW-hr	638.26	4.00E-03	3.10E-02	2.25	9.86	0.34	0.33	6.57E-02	4.15E-05	0.22
Main	Shuttle Tanker	g/kW-hr	588.90	4.00E-03	3.10E-02	1.40	9.05	0.45	0.42	0.36	1.18E-05	0.63
Main	Supply Ship	g/kW-hr	644.58	4.00E-03	3.10E-02	2.29	9.44	0.32	0.31	2.77E-02	4.45E-05	0.17
Main	Tug	g/kW-hr	643.66	4.00E-03	3.10E-02	2.29	9.52	0.33	0.32	3.33E-02	4.48E-05	0.18
Main	Feeder Barge Tug	g/kW-hr	643.66	4.00E-03	3.10E-02	2.29	9.52	0.33	0.32	0.03	0.00	0.18
Main	Multi-Purpose Service Vessel	g/kW-hr	630.62	4.00E-03	3.10E-02	2.13	9.60	0.36	0.34	0.11	0.00	0.28
Main	Noise Monitoring Vessel	g/kW-hr	643.66	4.00E-03	3.10E-02	2.29	9.52	0.33	0.32	0.03	0.00	0.18
Main	Guard Vessel	g/kW-hr	638.26	4.00E-03	3.10E-02	2.25	9.86	0.34	0.33	6.57E-02	4.15E-05	0.22
Main	Heavy Lift Installation Vessel	g/kW-hr	647.08	4.00E-03	3.10E-02	2.30	10.03	0.31	0.30	1.27E-02	4.51E-05	0.14
Main	Platform Support Vessel	g/kW-hr	644.58	4.00E-03	3.10E-02	2.29	9.44	0.32	0.31	2.77E-02	4.45E-05	0.17
Main	Compressor	g/kW-hr	647.08	4.00E-03	3.10E-02	2.30	10.03	0.31	0.30	1.27E-02	4.51E-05	0.14
Main	Heavy Transport Vessel	g/kW-hr	647.08	4.00E-03	3.10E-02	2.30	10.03	0.31	0.30	1.27E-02	4.51E-05	0.14
Main	Support Vessel - Small	g/kW-hr	644.58	4.00E-03	3.10E-02	2.29	9.44	0.32	0.31	0.03	0.00	0.17
Main	Support Vessel - Large	g/kW-hr	638.26	4.00E-03	3.10E-02	2.25	9.86	0.34	0.33	0.07	0.00	0.22
Auxiliary	Anchor Handling Tugs	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	9.88	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Barge	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	12.57	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Cable Laying	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	9.89	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Crew	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	5.51	0.15	0.15	6.00E-03	4.80E-05	0.14
Auxiliary	Dredging	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	9.85	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Jackup	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	11.55	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Research/Survey	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.21	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Shuttle Tanker	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	9.80	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Supply Ship	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.43	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Tug	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.10	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Feeder Barge Tug	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.10	0.32	0.31	0.01	0.00	0.14
Auxiliary	Multi-Purpose Service Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	9.85	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Noise Monitoring Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.10	0.32	0.31	0.01	0.00	0.14
Auxiliary	Guard Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.21	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Heavy Lift Installation Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	11.55	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Platform Support Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.43	0.32	0.31	0.01	0.00	0.14
Auxiliary	Compressor	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	11.55	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Heavy Transport Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	11.55	0.32	0.31	6.00E-03	4.80E-05	0.14
Auxiliary	Support Vessel - Small	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.43	0.32	0.31	0.01	0.00	0.14
Auxiliary	Support Vessel - Large	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.21	0.32	0.31	0.01	0.00	0.14

[1] Emission factors for project-specific vessels are assumed to be equivalent to BOEM Wind Tool emission factors for the vessel that is closest in engine rating, except for crew vessels. The NO_x, PM_{10}, and $PM_{2.5}$ emission facors correspond to the lowest (resulting in highest emissions) Tier emission standard in 40 CFR § 1042 that this vessel type may be certified by the manufacturer as meeting.

Vessel Type [1]	Equivalent Vessel Type in BOEM WindTool	Maneuvering Time per Roundtrip [1] [2] (hours)
Misc.	All others	1
Tanker	Shuttle Tanker	1
Tug	Tug	1.7
Vehicle Carrier	Barge	1

[1] U.S.EPA. (2018). 2014 National Emissions Inventory, Version 2 Technical Support Document.

[2] Manuevering time at port and vessel type obtained from Table 4-111 of 2014 NEI Technical Support Document. The types of vessels the Project will use was aligned with the vessel types given in the NEI table as shown in column 'Equivalent Vessel Type in BOEM WindTool'. The time Project vessels spend maneuvering at port is subtracted, along with other activities, from the total time the vessel is used to obtain time spent in on-site maneuvering.

Propulsion Engines Load Factor [1]				
Vessel Type	Transit	On-site Maneuvering	Port Maneuvering	Hoteling [2]
All	0.82	0.2	0.2	0
Jackup [3]	0.82	0	0.2	0

[1] Load factors for the propulsion engines are the default BOEM WindTool load factors, as a worst case assumption. The default BOEM load factors for propulsion engines are consistent with other available sources of marine vessel load factors, including USEPA (2000), 2009 USEPA, and 2014 NEI (EPA, 2018). Note that the terms propulsion engine and main engine are used interchangeably throughout workbook.

[2] It is assumed only auxiliary engines are used for hoteling for all vessel types, based on 2014 NEI (EPA, 2018).

[3] Jack-up vessels plant their legs on the seafloor to remain in place, so it is assumed the propulsion engines of jack-up vessels will not engage in on-site maneuvering.

Auxiliary Engines Load Factor				
Table 4-120 of 2014 NEI				Table 2-7 of 2009 USEPA [1]
Vessel Type	Type in BOEM WindTool	Maneuvering	Hotel [2]	Transit
Drilling	Dredging	0.45	0.22	0.32
Jackup [3]	Jackup	0	0.22	0.32
Pipelaying	Cable Laying	0.45	0.22	0.32
Research	Research/Survey	0.45	0.22	0.32
Supply	Supply Ship	0.45	0.22	0.32
Support	Crew	0.45	0.22	0.32
Tanker	Shuttle Tanker	0.33	0.26	0.32
Tug	Tug	0.45	0.22	0.32
Vehicle Carrier	Barge	0.45	0.22	0.32

[1] Load factors for auxiliary engines in transit are from 2009 USEPA, which based load factors on a study conducted for the 2005 emissions inventory for the Port of Los Angeles. Excluding cruise ships, the highest load factor among cruise load factors and Reduced Speed Zone (RSZ) load factors is assumed to represent transit load factors for all vessels used for Ocean Wind, as a conservative assumption.

[2] It is assumed vessels equipped with Category 1 or 2 propulsion engines do not engage propulsion or auxiliary engines while hoteling based on 2014 NEI (EPA, 2018) and assume to engage in cold ironing. Category 1, 2 and 3 marine vessel engines are defined in 40 CFR 1042.901 based on engine displacement. Because engine displacement information is unknown, it was assumed that Category 1 and 2 engines are typically smaller than 3,000 kW (Browning and Bailey). If the propulsion engine is greater than 3,000 kW then the load factor displayed is utilized in emissions calculations for hoteling for auxiliary engines.

[3] Jack-up vessels plant their legs on the seafloor to remain in place, so it is assumed the auxiliary engines of jack-up vessels will not engage in on-site maneuvering.

Sources:

2014 NEI: U.S.EPA. (2018). 2014 National Emissions Inventory, Version 2 Technical Support Document.

Browning and Bailey: Browning, ICF Consulting and Bailey, USEPA. Current Methodologies and Best Practice for Preparing Port Emission Inventories. https://www3.epa.gov/ttnchie1/conference/ei15/session1/browning.pdf

U.S.EPA. (2000). Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data. https://nepis.epa.gov/Exe/ZyPDF.cgi/P1009Z2K.PDF?Dockey=P1009Z2K.PDF

2009 USEPA: U.S.EPA. (2009). Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories. https://www.epa.gov/sites/production/files/2016-06/documents/2009-port-inventory-guidance.pdf

Phase	Activity	Vessel Description	Project-Specific Vessel Type	BOEM Wind Tool Vessel Type	Vessel Type [1]	Number of Vessels	Port	Longest Overall Route Distance	Main Engine Rating (kW)	Auxiliary Engine Rating (kW)	Average Speed of Vessel (nm/hr) 1 knot = 1 nm/hr	Number of One Way Trips Per Vessel Between Array and Port	Installation Duration Not Including Transit (Days)	Transit & Installation Duration (Days)	Propulsion Engines Load Factor: Transit	Propulsion Engine Load Factor: Maneuvering	Propulsion Engine Load Factor: Hoteling	Auxiliary Engine Load Factor: Transit	Auxiliary Engine Load Factor: Maneuvering	Auxiliary Engine Load Factor: Hoteling
Construction	Array Cable Installation	Pre-lay Survey Vessel	Not Given	Crew	Crew	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,060.00	201.05	10.00	3	60	67	0.82	0.2	0	0.32	0.45	0
Construction		Pre-lay Grapnel Run (PLGR) Vessel	Not Given	Dredging	Dredging	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,233.66	963.82	10.00	3	35	42	0.82	0.2	0	0.32	0.45	0.22
Construction		Boulder Clearance Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,131.92	1,006.68	10.00	3	50	57	0.82	0.2	0	0.32	0.45	0.22
Construction		Sandwave Clearance Vessel	Not Given	Dredging	Dredging	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,233.66	963.82	10.00	3	35	42	0.82	0.2	0	0.32	0.45	0.22
Construction		Cable Laying Vessel	Not Given	Cable Laying	Cable Laying	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	6,657.62	3,025.77	10.00	14	100	131	0.82	0.2	0	0.32	0.45	0.22
Construction		Cable Burial Vessel	Not Given	Cable Laying	Cable Laying	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	6,657.62	3,025.77	10.00	14	150	181	0.82	0.2	0	0.32	0.45	0.22
Construction		Crew Transport Vessel	Not Given	Crew	Crew	2	Atlantic City, NJ	Atlantic City, NJ	2,060.00	201.05	22.13	99	75	79	0.82	0.2	0	0.32	0.45	0
Construction		Walk to Work Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,131.92	1,006.68	10.00	99	120	342	0.82	0.2	0	0.32	0.45	0.22
Construction		Post-Lay Inspection Survey Vessel	Not Given	Crew	Crew	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,060.00	201.05	10.00	50	110	222	0.82	0.2	0	0.32	0.45	0
Construction		DP2 Construction Vessel - Jack of All Trades	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,131.92	1,006.68	10.00	51	71	186	0.82	0.2	0	0.32	0.45	0.22
Construction	Offshore Export Cable & Interconnection Cable Installation	Cable Lay and Burial Vessel	Not Given	Cable Laying	Cable Laying	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	6,657.62	3,025.77	10.00	20	200	245	0.82	0.2	0	0.32	0.45	0.22
Construction		Cable Burial Vessel	Not Given	Cable Laying	Cable Laying	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	6,657.62	3,025.77	10.00	21	15	62	0.82	0.2	0	0.32	0.45	0.22
Construction		Anchor Handling Tug	Not Given	Tug	Tug	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,053.16	238.13	10.00	30	60	127	0.82	0.2	0	0.32	0.45	0
Construction		Pull tug to move barges	Not Given	Tug	Tug	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,053.16	238.13	10.00	100	200	424	0.82	0.2	0	0.32	0.45	0
Construction		Pull ahead export cable tug for assist CLV	Anchor Tug	NA	Anchor Tug	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	1,230.00	357.00	10.00	70	135	292	0.82	0.2	0	0.32	0.45	0
Construction		Pre-lay Grapnel Run (PLGR) Vessel	Not Given	Dredging	Dredging	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,233.66	963.82	10.00	11	60	85	0.82	0.2	0	0.32	0.45	0.22
Construction		Boulder Clearance Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,131.92	1,006.68	10.00	5	30	41	0.82	0.2	0	0.32	0.45	0.22
Construction		Crew Transport Vessel	Not Given	Crew	Crew	2	Atlantic City, NJ	Atlantic City, NJ	2,060.00	201.05	22.13	11	68	68	0.82	0.2	0	0.32	0.45	0
Construction		Guard Vessel	Guard Vessel	NA	Guard Vessel	5	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,460.00	357.00	10.00	30	200	267	0.82	0.2	0	0.32	0.45	0
Construction		Post-Lay Inspection Survey Vessel	Not Given	Crew	Crew	2	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,060.00	201.05	10.00	11	18	43	0.82	0.2	0	0.32	0.45	0
Construction		General Work Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,131.92	1,006.68	10.00	15	67	101	0.82	0.2	0	0.32	0.45	0.22
Construction	OSS Topside	Heavy Transport Vessel	Heavy Transport Vessel	NA	Heavy Transport Vessel	2	Atlantic City, NJ	Atlantic City, NJ	10,022.00	0.00	10.00	12	3	4	0.82	0.2	0	0.32	0.45	0.22
Construction	WTG & OSS Platform Foundation Installation	Heavy Lift Installation Vessel	Heavy Transport Vessel	NA	Heavy Transport Vessel	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	10,022.00	0.00	10.00	99	210	290	0.82	0.2	0	0.32	0.45	0.22
Construction		Secondary Steel Installation	Not Given	Jackup	Jackup	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	3,214.91	895.08	10.00	99	210	290	0.82	0	0	0.32	0	0.22
Construction		Feeder Barge Tug	Feeder Barge Tug	Tug	Feeder Barge Tug	2	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	8,113.00	340.00	10.00	99	90	170	0.82	0.2	0	0.32	0.45	0.22
Construction		Rock Dumping Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	3,131.92	1,006.68	10.00	99	105	185	0.82	0.2	0	0.32	0.45	0.22
Construction		Bubble Curtain Vessel	Platform Support Vessel	NA	Platform Support Vessel	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	4,516.00	1,618.00	10.00	99	150	230	0.82	0.2	0	0.32	0.45	0.22
Construction		Heavy Transport Vessel	Heavy Transport Vessel	NA	Heavy Transport Vessel	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	10,022.00	0.00	10.00	99	180	260	0.82	0.2	0	0.32	0.45	0.22
Construction		Crew Transport Vessel	Not Given	Crew	Crew	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	2,060.00	201.05	22.13	99	210	246	0.82	0.2	0	0.32	0.45	0
Construction		Noise Monitoring Vessel	Noise Monitoring Vessel	NA	Noise Monitoring Vessel	2	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	970.00	0.00	10.00	99	105	185	0.82	0.2	0	0.32	0.45	0
Construction		Platform Support Vessel	Platform Support Vessel	NA	Platform Support Vessel	2	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	4,516.00	1,618.00	10.00	99	105	185	0.82	0.2	0	0.32	0.45	0.22
Construction	WTG Construction	Installation Vessel	Not Given	Jackup	Jackup	1	Norfolk, VA or Hope Creek, NJ	Norfolk, VA	3,214.91	895.08	10.00	17	100	114	0.82	0	0	0.32	0	0.22
Construction		Towing Tug	Not Given	Tug	Tug	2	Norfolk, VA or Hope Creek, NJ	Norfolk, VA	2,053.16	238.13	10.00	17	50	63	0.82	0.2	0	0.32	0.45	0
Construction	Construction Package	Safety Vessel	Not Given	Supply Ship	Supply Ship	1	Atlantic City, NJ	Atlantic City, NJ	3,842.65	873.99	10.00	140	650	662	0.82	0.2	0	0.32	0.45	0.22
Construction		Crew Transport Vessel	Not Given	Crew	Crew	6	Atlantic City, NJ	Atlantic City, NJ	2,060.00	201.05	22.13	2300	539	631	0.82	0.2	0	0.32	0.45	0
Construction		Service Operation Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Atlantic City, NJ	Atlantic City, NJ	3,131.92	1,006.68	10.00	70	491	497	0.82	0.2	0	0.32	0.45	0.22
Operations	Annual O&M	Crew Transport Vessel - Minor Repairs	Not Given	Crew	Crew	2	Atlantic City, NJ	Atlantic City, NJ	2,060.00	201.05	22.13	240	50	60	0.82	0.2	0	0.32	0.45	0
Operations		Crew Transport Vessel	Not Given	Crew	Crew	1	Atlantic City, NJ	Atlantic City, NJ	2,060.00	201.05	22.13	100	21	25	0.82	0.2	0	0.32	0.45	0
Operations		Jackup - Major Repairs	Not Given	Jackup	Jackup	1	Paulsboro, NJ	Europe	3,214.91	895.08	7.00	1	364	365	0.82	0	0	0.32	0	0.22
Operations		Feeder Barge Tug	Not Given	Tug	Tug	1	Paulsboro, NJ	Paulsboro, NJ	2,053.16	238.13	11.53	196	275	365	0.82	0.2	0	0.32	0.45	0
Operations		Crew Transport Vessel	Not Given	Crew	Crew	3	Atlantic City, NJ	Atlantic City, NJ	2,060.00	201.05	22.13	600	125	149	0.82	0.2	0	0.32	0.45	0

[1] Vessel specifications are from vessel specificiation sheets, where possible; otherwise, vessel specifications are BOEM defaults.

Project-Specific Information - Activity Hours for Each Marine Vessel

Phase	Activity	Vessel Description	Vessel Type	Number of Vessels	Average Speed of Vessel (nm/hr) 1 knot = 1 nm/hr	Number of One Way Trips Per Vessel Between Array and Port	Duration (Total Days)	Year 1 Hours of Transit within OCS	Year 1 Hours of Transit Outside OCS	Year 1 Hours of Maneuvering at Port	Year 1 Hours of Hoteling [1]	Year 1 Total Hours of Onsite Maneuvering [2]
Construction	Array Cable Installation	Pre-lay Survey Vessel	Crew	1	10.00	3.0	67	8	154	1.50	0	1,422
Construction		Pre-lay Grapnel Run (PLGR) Vessel	Dredging	1	10.00	3.0	42	8	154	1.50	10	828
Construction		Boulder Clearance Vessel	Multi-Purpose Service Vessel	1	10.00	3.0	57	8	154	1.50	14	1,185
Construction		Sandwave Clearance Vessel	Dredging	1	10.00	3.0	42	8	154	1.50	10	828
Construction		Cable Laying Vessel	Cable Laying	1	10.00	14.0	131	35	719	7.00	32	2,361
Construction		Cable Burial Vessel	Cable Laying	1	10.00	14.0	181	35	719	7.00	44	3,549
Construction		Crew Transport Vessel	Crew	2	22.13	99.0	79	95	0	49.50	0	1,732
Construction		Walk to Work Vessel	Multi-Purpose Service Vessel	1	10.00	99.0	342	248	5,085	49.50	82	2,748
Construction		Post-Lay Inspection Survey Vessel	Crew	1	10.00	50.0	222	125	2,568	25.00	0	2,562
Construction		DP2 Construction Vessel - Jack of All Trades	Multi-Purpose Service Vessel	1	10.00	51.0	186	128	2,619	25.50	45	1,641
Construction	Offshore Export Cable & Interconnection Cable Installation	Cable Lay and Burial Vessel	Cable Laying	1	10.00	20.0	245	50	1,027	10.00	59	4,731
Construction		Cable Burial Vessel	Cable Laying	1	10.00	21.0	62	53	1,079	10.50	15	335
Construction		Anchor Handling Tug	Tug	1	10.00	30.0	127	75	1,541	15.00	0	1,394
Construction		Pull tug to move barges	Tug	1	10.00	100.0	424	215	4,417	43.00	0	3,997
Construction		Pull ahead export cable tug for assist CLV	Anchor Tug	1	10.00	70.0	292	175	3,595	35.00	0	3,135
Construction		Pre-lay Grapnel Run (PLGR) Vessel	Dredging	1	10.00	11.0	85	28	565	5.50	20	1,414
Construction		Boulder Clearance Vessel	Multi-Purpose Service Vessel	1	10.00	5.0	41	13	257	2.50	10	708
Construction		Crew Transport Vessel	Crew	2	22.13	11.0	68	11	0	5.50	0	1,598
Construction		Guard Vessel	Guard Vessel	5	10.00	30.0	267	75	1,541	15.00	0	4,721
Construction		Post-Lay Inspection Survey Vessel	Crew	2	10.00	11.2	43	28	575	5.60	0	404
Construction		General Work Vessel	Multi-Purpose Service Vessel	1	10.00	15.0	101	38	770	7.50	24	1,576
Construction	OSS Topside	Heavy Transport Vessel	Heavy Transport Vessel	2	10.00	12.0	4	25	0	6.00	1	65
Construction	WTG & OSS Platform Foundation Installation	Heavy Lift Installation Vessel	Heavy Transport Vessel	1	10.00	99.0	290	248	1,664	49.50	70	4,921
Construction		Secondary Steel Installation	Jackup	1	10.00	99.0	290	248	1,664	49.50	70	4,921
Construction		Feeder Barge Tug	Feeder Barge Tug	2	10.00	99.0	170	248	1,664	49.50	41	2,070
Construction		Rock Dumping Vessel	Multi-Purpose Service Vessel	1	10.00	99.0	185	248	1,664	49.50	44	2,426
Construction		Bubble Curtain Vessel	Platform Support Vessel	1	10.00	99.0	230	248	1,664	49.50	55	3,495
Construction		Heavy Transport Vessel	Heavy Transport Vessel	1	10.00	99.0	260	248	1,664	49.50	62	0
Construction		Crew Transport Vessel	Crew	1	22.13	99.0	246	112	752	49.50	0	4,931
Construction		Noise Monitoring Vessel	Noise Monitoring Vessel	2	10.00	99.0	185	248	1,664	49.50	0	2,426
Construction		Platform Support Vessel	Platform Support Vessel	2	10.00	99.0	185	248	1,664	49.50	44	2,426
Construction	WTG Construction	Installation Vessel	Jackup	1	10.00	17.0	114	43	282	8.50	27	2,364
Construction		Towing Tug	Tug	2	10.00	16.5	63	41	274	8.25	0	1,177
Construction	Construction Package	Safety Vessel	Supply Ship	1	10.00	140.0	662	297	0	70.00	159	15,371
Construction		Crew Transport Vessel	Crew	6	22.13	2300.0	631	2,204	0	1,150.00	0	11,639
Construction		Service Operation Vessel	Multi-Purpose Service Vessel	1	10.00	70.0	497	148	0	35.00	119	11,630
Operations	Annual O&M	Crew Transport Vessel - Minor Repairs	Crew	2	22.13	240.0	60	230	0	120.00	0	1,066
Operations		Crew Transport Vessel	Crew	1	22.13	100.0	25	96	0	50.00	0	444
Operations		Jackup - Major Repairs	Jackup	1	7.00	1.0	365	4	24	0.50	88	8,644
Operations		Feeder Barge Tug	Tug	1	11.53	196.0	365	425	1,730	98.00	0	6,419
Operations		Crew Transport Vessel	Crew	3	22.13	600.0	149	575	0	300.00	0	2,664

[1] Hoteling is the amount of time vessels spend at port. To estimate hours vessels spend hoteling, Ocean Wind assumes that vessels spend 1% of time hoteling, based on time the ratio of time spent at port vs. underway for Deepwater Vessel Type from Table 3 of USEPA. (2015) Category 1 / Category 2 Vessel Port Underway Split for 2011 National Emission Inventory. https://www3.epa.gov/ttn/chief/conference/ei21/session7/billings.pdf. It is also assumed vessels equipped with Category 1 or 2 propulsion engines do not engage propulsion or auxiliary engines while hoteling based on 2014 NEI (2017) because it is assumed vessels engage in cold ironing. Category 1 and 2 engines are typically smaller than 3,000 kW (Browning and Bailey).

[2] As a worst-case assumption, it is assumed that marine vessel engines are being utilized 24 hours per day for the expected duration of the construction activity. It is assumed that vessel engines are engaged in on-site maneuvering every hour the vessel is not at port and not in transit. Based on the definition of potential emissions in 40 CFR Part 55.2, emissions from vessel engines while they are at port are not included in the *potential emissions* of the OCS source even if the port is within 25 miles of the OCS source because vessels at port are not 'enroute to or from the source'.

Construction Emissions from Vessel Engines - Transit within OCS Area [1]

Main Engine:											
tons/year=	hrs/year x kW, main engine x load factor, propulsion engine x EF x 1.1X10^-6 g/ton x # of Vessels										
	CO_2	CH_4	N_2O	CO	NO_X	PM [2]	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Construction	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	9.03	5.57E-05	0.00	0.03	0.08	0.00	0.00	0.00	0.00	6.47E-07	0.00
Dredging	13.80	8.75E-05	0.00	0.05	0.21	0.01	0.01	0.01	0.00	8.10E-07	0.01
Multi-Purpose Service Vessel	13.36	8.47E-05	0.00	0.05	0.20	0.01	0.01	0.01	0.00	7.85E-07	0.01
Dredging	13.80	8.75E-05	0.00	0.05	0.21	0.01	0.01	0.01	0.00	8.10E-07	0.01
Cable Laying	133.47	8.41E-04	0.01	0.46	2.00	0.07	0.07	0.07	0.02	8.15E-06	0.05
Cable Laying	133.47	8.41E-04	0.01	0.46	2.00	0.07	0.07	0.07	0.02	8.15E-06	0.05
Crew	228.47	1.41E-03	0.01	0.81	1.94	0.06	0.05	0.05	0.00	1.64E-05	0.05
Multi-Purpose Service Vessel	440.92	2.80E-03	0.02	1.49	6.71	0.26	0.25	0.24	0.08	2.59E-05	0.20
Crew	150.54	9.29E-04	0.01	0.53	1.28	0.04	0.04	0.04	0.00	1.08E-05	0.03
Multi-Purpose Service Vessel	227.14	1.44E-03	0.01	0.77	3.46	0.13	0.13	0.12	0.04	1.33E-05	0.10
Cable Laying	190.67	1.20E-03	0.01	0.66	2.85	0.11	0.10	0.10	0.03	1.16E-05	0.07
Cable Laying	200.20	1.26E-03	0.01	0.69	2.99	0.11	0.11	0.10	0.03	1.22E-05	0.08
Tug	89.40	5.56E-04	0.00	0.32	1.32	0.05	0.05	0.04	0.00	6.22E-06	0.02
Tug	256.29	1.59E-03	0.01	0.91	3.79	0.13	0.13	0.13	0.01	1.78E-05	0.07
Anchor Tug	124.97	7.77E-04	0.01	0.44	1.85	0.07	0.06	0.06	0.01	8.70E-06	0.03
Dredging	50.58	3.21E-04	0.00	0.17	0.77	0.03	0.03	0.03	0.01	2.97E-06	0.02
Multi-Purpose Service Vessel	22.27	1.41E-04	0.00	0.08	0.34	0.01	0.01	0.01	0.00	1.31E-06	0.01
Crew	25.39	1.57E-04	0.00	0.09	0.22	0.01	0.01	0.01	0.00	1.82E-06	0.01
Guard Vessel	531.09	3.33E-03	0.03	1.87	8.21	0.29	0.28	0.27	0.05	3.46E-05	0.18
Crew	67.44	4.16E-04	0.00	0.24	0.57	0.02	0.02	0.02	0.00	4.83E-06	0.01
Multi-Purpose Service Vessel	66.81	4.24E-04	0.00	0.23	1.02	0.04	0.04	0.04	0.01	3.92E-06	0.03
Heavy Transport Vessel	297.62	1.84E-03	0.01	1.06	4.61	0.15	0.14	0.14	0.01	2.07E-05	0.07
Heavy Transport Vessel	1,447.75	8.95E-03	0.07	5.14	22.43	0.71	0.69	0.67	0.03	1.01E-04	0.32
Jackup	464.42	2.87E-03	0.02	1.65	7.20	0.23	0.22	0.21	0.01	3.24E-05	0.10
Feeder Barge Tug	2,331.57	1.45E-02	0.11	8.29	34.49	1.22	1.19	1.14	0.12	1.62E-04	0.64
Multi-Purpose Service Vessel	440.92	2.80E-03	0.02	1.49	6.71	0.26	0.25	0.24	0.08	2.59E-05	0.20
Platform Support Vessel	649.85	4.03E-03	0.03	2.31	9.52	0.33	0.32	0.31	0.03	4.49E-05	0.17
Heavy Transport Vessel	1,447.75	8.95E-03	0.07	5.14	22.43	0.71	0.69	0.67	0.03	1.01E-04	0.32
Crew	134.71	8.31E-04	0.01	0.48	1.15	0.03	0.03	0.03	0.00	9.66E-06	0.03
Noise Monitoring Vessel	278.76	1.73E-03	0.01	0.99	4.12	0.15	0.14	0.14	0.01	1.94E-05	0.08
Platform Support Vessel	1,299.71	8.07E-03	0.06	4.61	19.04	0.66	0.64	0.62	0.06	8.98E-05	0.34
Jackup	79.75	4.93E-04	0.00	0.28	1.24	0.04	0.04	0.04	0.00	5.56E-06	0.02
Tug	98.34	6.11E-04	0.00	0.35	1.45	0.05	0.05	0.05	0.01	6.85E-06	0.03
Supply Ship	663.10	4.11E-03	0.03	2.35	9.71	0.34	0.33	0.32	0.03	4.58E-05	0.17
Crew	15,923.41	9.83E-02	0.76	56.45	135.36	3.87	3.76	3.76	0.15	1.14E-03	3.36
Multi-Purpose Service Vessel	264.37	1.68E-03	0.01	0.89	4.02	0.15	0.15	0.14	0.05	1.55E-05	0.12

[1] OCS Area is the area within the OCS circle, which is a circle with a radius of 25 nautical miles measured from the centroid of the array area.

[2] BOEM emission factors for PM are not provided. It is assumed that PM emissions from main engines are 103% of PM_{10} emissions, based on page 3-35 of US Environmental Protection Agency (EPA). 2009. Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines. (EPA-420-R-09-019)

Construction Emissions from Vessel Engines - Transit within OCS Area [1]

Auxiliary Engine:											
tons/year=	hrs/year x kW, aux engine x load factor, aux engine x EF x 1.1X10^-6 g/ton x # of Vessels										
	CO_2	CH_4	N_2O	CO	NO_X	PM [3]	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Construction	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	0.34	2.12E-06	1.65E-05	0.00	0.00	0.00	0.00	0.00	3.18E-06	2.55E-08	0.00
Dredging	1.65	1.02E-05	7.89E-05	0.01	0.03	0.00	0.00	0.00	1.53E-05	1.22E-07	0.00
Multi-Purpose Service Vessel	1.72	1.06E-05	8.24E-05	0.01	0.03	0.00	0.00	0.00	1.59E-05	1.28E-07	0.00
Dredging	1.65	1.02E-05	7.89E-05	0.01	0.03	0.00	0.00	0.00	1.53E-05	1.22E-07	0.00
Cable Laying	24.16	1.49E-04	1.16E-03	0.09	0.37	0.02	0.01	0.01	2.24E-04	1.79E-06	0.01
Cable Laying	24.16	1.49E-04	1.16E-03	0.09	0.37	0.02	0.01	0.01	2.24E-04	1.79E-06	0.01
Crew	8.70	5.37E-05	4.16E-04	0.03	0.07	0.00	0.00	0.00	8.05E-05	6.44E-07	0.00
Multi-Purpose Service Vessel	56.85	3.51E-04	2.72E-03	0.22	0.86	0.04	0.03	0.03	5.26E-04	4.21E-06	0.01
Crew	5.73	3.54E-05	2.74E-04	0.02	0.05	0.00	0.00	0.00	5.31E-05	4.25E-07	0.00
Multi-Purpose Service Vessel	29.29	1.81E-04	1.40E-03	0.11	0.45	0.02	0.01	0.01	2.71E-04	2.17E-06	0.01
Cable Laying	34.52	2.13E-04	1.65E-03	0.13	0.53	0.02	0.02	0.02	3.20E-04	2.56E-06	0.01
Cable Laying	36.24	2.24E-04	1.73E-03	0.14	0.55	0.02	0.02	0.02	3.35E-04	2.68E-06	0.01
Tug	4.08	2.51E-05	1.95E-04	0.02	0.06	0.00	0.00	0.00	3.77E-05	3.02E-07	0.00
Tug	11.68	7.21E-05	5.59E-04	0.04	0.18	0.01	0.01	0.01	1.08E-04	8.65E-07	0.00
Anchor Tug	14.25	8.80E-05	6.82E-04	0.05	0.22	0.01	0.01	0.01	1.32E-04	1.06E-06	0.00
Dredging	6.05	3.73E-05	2.89E-04	0.02	0.09	0.00	0.00	0.00	5.60E-05	4.48E-07	0.00
Multi-Purpose Service Vessel	2.87	1.77E-05	1.37E-04	0.01	0.04	0.00	0.00	0.00	2.66E-05	2.13E-07	0.00
Crew	0.97	5.97E-06	4.62E-05	0.00	0.01	0.00	0.00	0.00	8.95E-06	7.16E-08	0.00
Guard Vessel	30.55	1.88E-04	1.46E-03	0.12	0.48	0.02	0.02	0.01	2.83E-04	2.26E-06	0.01
Crew	2.57	1.59E-05	1.23E-04	0.01	0.02	0.00	0.00	0.00	2.38E-05	1.90E-07	0.00
Multi-Purpose Service Vessel	8.61	5.32E-05	4.12E-04	0.03	0.13	0.01	0.00	0.00	7.97E-05	6.38E-07	0.00
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Jackup	50.55	3.12E-04	2.42E-03	0.19	0.90	0.03	0.02	0.02	4.68E-04	3.74E-06	0.01
Feeder Barge Tug	38.40	2.37E-04	1.84E-03	0.15	0.60	0.02	0.02	0.02	3.55E-04	2.84E-06	0.01
Multi-Purpose Service Vessel	56.85	3.51E-04	2.72E-03	0.22	0.86	0.04	0.03	0.03	5.26E-04	4.21E-06	0.01
Platform Support Vessel	91.37	5.64E-04	4.37E-03	0.35	1.47	0.06	0.05	0.04	8.46E-04	6.77E-06	0.02
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Crew	5.13	3.17E-05	2.45E-04	0.02	0.04	0.00	0.00	0.00	4.75E-05	3.80E-07	0.00
Noise Monitoring Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Platform Support Vessel	182.74	1.13E-03	8.74E-03	0.70	2.94	0.12	0.09	0.09	1.69E-03	1.35E-05	0.04
Jackup	8.68	5.36E-05	4.15E-04	0.03	0.15	0.01	0.00	0.00	8.03E-05	6.43E-07	0.00
Tug	4.48	2.77E-05	2.14E-04	0.02	0.07	0.00	0.00	0.00	4.15E-05	3.32E-07	0.00
Supply Ship	59.19	3.65E-04	2.83E-03	0.23	0.95	0.04	0.03	0.03	5.48E-04	4.38E-06	0.01
Crew	606.50	3.74E-03	2.90E-02	2.32	5.16	0.19	0.14	0.14	5.61E-03	4.49E-05	0.13
Multi-Purpose Service Vessel	34.09	2.10E-04	1.63E-03	0.13	0.52	0.02	0.02	0.02	3.16E-04	2.52E-06	0.01

[1] OCS Area is the area within the OCS circle, which is a circle with a radius of 25 nautical miles measured from the centroid of the array area.

[3] BOEM emission factors for PM are not provided. It is assumed that PM emissions from auxiliary engines are 131% of PM_{10} emissions, based on page 3-35 of US Environmental Protection Agency (EPA). 2009. Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines. (EPA-420-R-09-019)

	CO_2	CH_4	N_2O	CO	NO_X	PM	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Summary	30,255.77	0.19	1.45	107.40	343.75	11.13	10.66	10.43	0.94	0.00	7.33

Construction Emissions from Vessel Engines - Onsite Maneuvering

Main Engine:											
tons/year=	hrs/year x kW, main engine x load factor, propulsion engine x EF x 1.1X10^-6 g/ton x # of Vessels										
	CO_2	CH_4	N_2O	CO	NO_X	PM [1]	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Construction	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	417.85	2.58E-03	0.02	1.48	3.55	0.10	0.10	0.10	0.00	3.00E-05	0.09
Dredging	371.68	2.36E-03	0.02	1.25	5.66	0.22	0.21	0.20	0.07	2.18E-05	0.17
Multi-Purpose Service Vessel	514.85	3.27E-03	0.03	1.74	7.84	0.30	0.29	0.28	0.09	3.02E-05	0.23
Dredging	371.68	2.36E-03	0.02	1.25	5.66	0.22	0.21	0.20	0.07	2.18E-05	0.17
Cable Laying	2,196.40	1.38E-02	0.11	7.60	32.84	1.22	1.18	1.13	0.29	1.34E-04	0.85
Cable Laying	3,301.36	2.08E-02	0.16	11.43	49.36	1.83	1.77	1.70	0.44	2.02E-04	1.28
Crew	1,017.27	6.28E-03	0.05	3.61	8.65	0.25	0.24	0.24	0.01	7.29E-05	0.21
Multi-Purpose Service Vessel	1,194.20	7.57E-03	0.06	4.03	18.18	0.70	0.68	0.65	0.21	7.01E-05	0.54
Crew	752.48	4.64E-03	0.04	2.67	6.40	0.18	0.18	0.18	0.01	5.39E-05	0.16
Multi-Purpose Service Vessel	713.08	4.52E-03	0.04	2.41	10.85	0.42	0.40	0.39	0.13	4.19E-05	0.32
Cable Laying	4,400.52	2.77E-02	0.21	15.24	65.79	2.43	2.36	2.27	0.59	2.69E-04	1.71
Cable Laying	311.20	1.96E-03	0.02	1.08	4.65	0.17	0.17	0.16	0.04	1.90E-05	0.12
Tug	405.42	2.52E-03	0.02	1.44	6.00	0.21	0.21	0.20	0.02	2.82E-05	0.11
Tug	1,162.21	7.22E-03	0.06	4.13	17.19	0.61	0.59	0.57	0.06	8.09E-05	0.32
Anchor Tug	546.02	3.39E-03	0.03	1.94	8.08	0.29	0.28	0.27	0.03	3.80E-05	0.15
Dredging	634.44	4.02E-03	0.03	2.14	9.66	0.37	0.36	0.34	0.11	3.73E-05	0.29
Multi-Purpose Service Vessel	307.46	1.95E-03	0.02	1.04	4.68	0.18	0.17	0.17	0.05	1.81E-05	0.14
Crew	938.93	5.79E-03	0.04	3.33	7.98	0.23	0.22	0.22	0.01	6.73E-05	0.20
Guard Vessel	8,153.49	5.11E-02	0.40	28.72	126.00	4.46	4.33	4.16	0.84	5.30E-04	2.83
Crew	237.45	1.47E-03	0.01	0.84	2.02	0.06	0.06	0.06	0.00	1.70E-05	0.05
Multi-Purpose Service Vessel	684.94	4.34E-03	0.03	2.31	10.43	0.40	0.39	0.37	0.12	4.02E-05	0.31
Heavy Transport Vessel	185.55	1.15E-03	0.01	0.66	2.88	0.09	0.09	0.09	0.00	1.29E-05	0.04
Heavy Transport Vessel	7,020.82	4.34E-02	0.34	24.92	108.79	3.44	3.34	3.23	0.14	4.89E-04	1.57
Jackup	0.00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00
Feeder Barge Tug	4,755.69	2.96E-02	0.23	16.91	70.35	2.49	2.42	2.33	0.25	3.31E-04	1.30
Multi-Purpose Service Vessel	1,054.20	6.69E-03	0.05	3.56	16.05	0.61	0.60	0.57	0.19	6.19E-05	0.48
Platform Support Vessel	2,238.47	1.39E-02	0.11	7.95	32.79	1.14	1.11	1.07	0.10	1.55E-04	0.58
Heavy Transport Vessel	0.00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00
Crew	1,448.60	8.94E-03	0.07	5.14	12.31	0.35	0.34	0.34	0.01	1.04E-04	0.31
Noise Monitoring Vessel	666.50	4.14E-03	0.03	2.37	9.86	0.35	0.34	0.33	0.03	4.64E-05	0.18
Platform Support Vessel	3,107.49	1.93E-02	0.15	11.03	45.53	1.59	1.54	1.49	0.13	2.15E-04	0.81
Jackup	0.00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00
Tug	684.16	4.25E-03	0.03	2.43	10.12	0.36	0.35	0.34	0.04	4.76E-05	0.19
Supply Ship	8,375.99	5.20E-02	0.40	29.74	122.71	4.28	4.15	4.01	0.36	5.79E-04	2.17
Crew	20,512.71	1.27E-01	0.98	72.72	174.38	4.99	4.84	4.84	0.20	1.47E-03	4.33
Multi-Purpose Service Vessel	5,053.22	3.21E-02	0.25	17.06	76.91	2.95	2.86	2.73	0.89	2.97E-04	2.28

[1] BOEM emission factors for PM are not provided. It is assumed that PM emissions from main engines are 103% of PM_{10} emissions, based on page 3-35 of US Environmental Protection Agency (EPA). 2009. Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines. (EPA-420-R-09-019)

Auxiliary Engine:											
tons/year=	hrs/year x kW, aux engine x load factor, aux engine x EF x 1.1X10^-6 g/ton x # of Vessels										
	CO_2	CH_4	N_2O	CO	NO_X	PM [2]	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Construction	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	40.78	2.52E-04	1.95E-03	0.16	0.35	0.01	0.01	0.01	3.78E-04	3.02E-06	0.01
Dredging	113.87	7.03E-04	5.45E-03	0.44	1.73	0.07	0.06	0.05	1.05E-03	8.43E-06	0.02
Multi-Purpose Service Vessel	170.10	1.05E-03	8.13E-03	0.65	2.59	0.11	0.08	0.08	1.57E-03	1.26E-05	0.04
Dredging	113.87	7.03E-04	5.45E-03	0.44	1.73	0.07	0.06	0.05	1.05E-03	8.43E-06	0.02
Cable Laying	1,018.94	6.29E-03	4.87E-02	3.90	15.54	0.66	0.50	0.49	9.43E-03	7.55E-05	0.22
Cable Laying	1,531.55	9.45E-03	7.32E-02	5.86	23.36	0.99	0.76	0.73	1.42E-02	1.13E-04	0.33
Crew	99.29	6.13E-04	4.75E-03	0.38	0.84	0.03	0.02	0.02	9.19E-04	7.35E-06	0.02
Multi-Purpose Service Vessel	394.55	2.43E-03	1.89E-02	1.51	6.00	0.26	0.19	0.19	3.65E-03	2.92E-05	0.09
Crew	73.44	4.53E-04	3.51E-03	0.28	0.62	0.02	0.02	0.02	6.80E-04	5.44E-06	0.02
Multi-Purpose Service Vessel	235.59	1.45E-03	1.13E-02	0.90	3.58	0.15	0.12	0.11	2.18E-03	1.74E-05	0.05
Cable Laying	2,041.46	1.26E-02	9.76E-02	7.81	31.14	1.32	1.01	0.98	1.89E-02	1.51E-04	0.44
Cable Laying	144.37	8.91E-04	6.90E-03	0.55	2.20	0.09	0.07	0.07	1.34E-03	1.07E-05	0.03
Tug	47.35	2.92E-04	2.26E-03	0.18	0.74	0.03	0.02	0.02	4.38E-04	3.51E-06	0.01
Tug	135.75	8.38E-04	6.49E-03	0.52	2.12	0.09	0.07	0.06	1.26E-03	1.01E-05	0.03
Anchor Tug	159.60	9.85E-04	7.63E-03	0.61	2.49	0.10	0.08	0.08	1.48E-03	1.18E-05	0.03
Dredging	194.37	1.20E-03	9.30E-03	0.74	2.96	0.13	0.10	0.09	1.80E-03	1.44E-05	0.04
Multi-Purpose Service Vessel	101.58	6.27E-04	4.86E-03	0.39	1.54	0.07	0.05	0.05	9.40E-04	7.52E-06	0.02
Crew	91.64	5.66E-04	4.38E-03	0.35	0.78	0.03	0.02	0.02	8.48E-04	6.79E-06	0.02
Guard Vessel	1,201.68	7.42E-03	5.75E-02	4.60	18.92	0.78	0.59	0.57	1.11E-02	8.90E-05	0.26
Crew	23.18	1.43E-04	1.11E-03	0.09	0.20	0.01	0.01	0.01	2.15E-04	1.72E-06	0.01
Multi-Purpose Service Vessel	226.29	1.40E-03	1.08E-02	0.87	3.44	0.15	0.11	0.11	2.09E-03	1.68E-05	0.05
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Jackup	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Feeder Barge Tug	200.71	1.24E-03	9.60E-03	0.77	3.13	0.13	0.10	0.10	1.86E-03	1.49E-05	0.04
Multi-Purpose Service Vessel	348.29	2.15E-03	1.67E-02	1.33	5.30	0.23	0.17	0.17	3.22E-03	2.58E-05	0.08
Platform Support Vessel	806.50	4.98E-03	3.86E-02	3.09	12.98	0.52	0.40	0.39	7.47E-03	5.97E-05	0.17
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Crew	141.39	8.72E-04	6.76E-03	0.54	1.20	0.04	0.03	0.03	1.31E-03	1.05E-05	0.03
Noise Monitoring Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Platform Support Vessel	1,119.60	6.91E-03	5.35E-02	4.28	18.02	0.72	0.55	0.54	1.04E-02	8.29E-05	0.24
Jackup	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Tug	79.91	4.93E-04	3.82E-03	0.31	1.25	0.05	0.04	0.04	7.40E-04	5.92E-06	0.02
Supply Ship	1,915.77	1.18E-02	9.16E-02	7.33	30.83	1.24	0.95	0.92	1.77E-02	1.42E-04	0.41
Crew	2,002.07	1.24E-02	9.57E-02	7.66	17.02	0.62	0.47	0.47	1.85E-02	1.48E-04	0.43
Multi-Purpose Service Vessel	1,669.52	1.03E-02	7.98E-02	6.39	25.38	1.08	0.82	0.80	1.55E-02	1.24E-04	0.36

[2] BOEM emission factors for PM are not provided. It is assumed that PM emissions from auxiliary engines are 131% of PM_{10} emissions, based on page 3-35 of US Environmental Protection Agency (EPA). 2009. Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines. (EPA-420-R-09-019)

	CO_2	CH_4	N_2O	CO	NO_X	PM	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Summary	100,179.34	0.62	4.83	357.08	1,332.09	47.26	43.85	42.48	5.69	0.01	28.03

Activity	Emission Unit	Number of Units	Engine Capacity	Load Factor[1]	Number of Hours Each Unit Used	Rate Each Engine Used	Applicable Emission Standard[2]				CO_2	CH_4	N_2O	CO	NO_X[3]	PM	PM_{10} [4]	$PM_{2.5}$ [4]	SO_2	VOC	Total HAP
							NO_X + NMHC	NO_x	PM	CO											
			hp		hours/year	hp-hr/year	g/kW-hr	g/kW-hr	g/kW-hr	g/kW-hr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Foundation Installation	Heavy Lift Installation Vessel Generator	5	5	0.43	5040	10,836	7.5	NA	0.4	8	11.23	4.56E-04	9.11E-05	0.36	0.32	1.78E-02	1.81E-02	1.81E-02	3.29E-04	6.81E-02	2.67E-04
	Heavy Lift Installation Vessel Power Pack	1	1000	0.43	5040	2,167,200	NA	3.5	0.04	3.5	449.22	1.82E-02	3.64E-03	6.23	6.23	7.13E-02	0.13	0.13	1.31E-02	0.70	4.34E-03
	Secondary Steel Generator	3	5	0.43	5040	10,836	7.5	NA	0.4	8	6.74	2.73E-04	5.47E-05	0.21	0.19	1.07E-02	1.10E-02	1.10E-02	1.97E-04	4.09E-02	1.60E-04
	Bubble Curtain Vessel Generator	46	480	0.43	1800	371,520	NA	0.4	0.02	3.5	3,542.43	0.14	2.87E-02	49.17	5.62	0.28	0.29	0.29	0.10	21.48	0.08
	Heavy Transport Vessel Generator	1	5	0.43	4320	9,288	7.5	NA	0.4	8	1.93	7.81E-05	1.56E-05	6.11E-02	5.44E-02	3.05E-03	3.30E-03	3.30E-03	5.64E-05	1.17E-02	4.57E-05
OSS Topside	Heavy Lift Installation Vessel Generator	5	5	0.43	72	155	7.5	NA	0.4	8	0.16	6.51E-06	1.30E-06	5.09E-03	4.53E-03	2.54E-04	2.59E-04	2.59E-04	4.70E-06	9.73E-04	3.81E-06
WTG Construction	Jack-up Vessel Generator	5	5	0.43	2400	5,160	7.5	NA	0.4	8	5.35	2.17E-04	4.34E-05	0.17	0.15	8.48E-03	8.62E-03	8.62E-03	1.57E-04	3.24E-02	1.27E-04
	Jack-up Vessel Cherry Picker	2	90	0.43	2400	92,880	NA	0.4	0.02	5	38.50	1.56E-03	3.12E-04	0.76	0.06	3.05E-03	5.56E-03	5.56E-03	1.13E-03	0.23	9.15E-04
	Feeder Barge Generator	2	40	0.43	2400	41,280	4.7	NA	0.03	5.5	17.11	6.94E-04	1.39E-04	0.37	0.30	2.04E-03	3.15E-03	3.15E-03	5.01E-04	0.10	4.07E-04
	SOV Generator	6	5	0.43	2400	5,160	7.5	NA	0.4	8	6.42	2.60E-04	5.21E-05	0.20	0.18	1.02E-02	1.03E-02	1.03E-02	1.88E-04	0.04	1.52E-04
Offshore Export Cable	Cable Laying Vessel Generator	2	100	0.43	4800	206,400	NA	0.4	0.02	5	85.57	3.47E-03	6.94E-04	1.70	0.14	6.79E-03	1.23E-02	1.23E-02	2.50E-03	0.52	2.03E-03
	Cable Laying Vessel Generator	7	250	0.43	4800	516,000	NA	0.4	0.02	3.5	748.70	3.04E-02	6.07E-03	10.39	1.19	0.06	7.33E-02	7.33E-02	2.19E-02	4.54	1.78E-02
	Cable Laying Vessel Power Pack	1	500	0.43	4800	1,032,000	NA	0.4	0.02	3.5	213.92	8.68E-03	1.74E-03	2.97	0.34	1.70E-02	4.48E-02	4.48E-02	6.26E-03	1.30	5.08E-03
	Barge Generator	2	60.5	0.43	2208	57,441	4.7	NA	0.03	5	23.81	9.66E-04	1.93E-04	0.47	0.42	2.83E-03	4.38E-03	4.38E-03	6.97E-04	0.14	5.66E-04
	Barge Cherry Picker	1	760	0.43	2208	721,574	NA	3.5	0.04	3.5	149.57	6.07E-03	1.21E-03	2.08	2.08	2.37E-02	4.32E-02	4.32E-02	4.38E-03	0.23	1.44E-03
										Total:	**5,300.66**	**0.22**	**0.04**	**75.15**	**17.28**	**0.52**	**0.66**	**0.66**	**0.16**	**29.44**	**0.12**

[1] Load factor obtained from MOVES and applied to estimate emissions since this eqiupment will operate at varying loads during the construction process.

[2] Applicable emission standard based on LAER determination, which is Tier 4 emission standards from 40 CFR 1039.101. The Tier 4 emission standard was used to estimate PTE for the following pollutants: NO_x, PM, PM_{10}, $PM_{2.5}$ and CO. All other pollutants (CO_2, CH_4, N_2O, SO_2, and VOC) were estimated using AP-42 emission factors from Tables 3.4-1 and 3.3-1. See footnote [3] for an explanation of how NO_x emissions were estimated when the applicable standard is in terms of NO_x + NMHC. See footenote [4] for an explanation of how PM_{10} and $PM_{2.5}$ emissions were estimated from the PM standard.

[3] NO_x emissions are estimated to comprise 95% of NO_x + NMHC emissions in accordance with CARB guidance. California Air Resources Board (CARB). 2004. Policy: CARB Emission Factors for CI Diesel Engines – Percent HC in Relation to NMHC + NO_x. Retrieved from https://www.baaqmd.gov/~/media/files/engineering/policy_and_procedures/engines/emissionfactorsfordieselengines.pdf?la=en

[4] It is conservatively assumed that the PM emission standard is equal to the filterable portion of PM_{10} and $PM_{2.5}$. The condensable portion of PM_{10} and $PM_{2.5}$ was added using the AP-42 emission factor of 0.0077 lb/MMBtu from AP-42 Table 3.4-2 and converting to lb/hp-hr using the conversion factor 7,000 Btu/hp-hr from footnote 'e' of AP-42 Table 3.4-1, resulting in a condensable emission factor of 0.0000539 lb/hp-hr.

Pollutant	EF	Unit	Source
Engines 600 hp or Greater			
CO_2	163.05	lb/MMBtu	40 CFR Part 98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
CO	5.50E-03	lb/hp-hr	AP-42 Table 3.4-1
NO_X	2.40E-02	lb/hp-hr	AP-42 Table 3.4-1
PM_{10}	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
$PM_{2.5}$	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.4-1
VOC	6.42E-04	lb/hp-hr	AP-42 Table 3.4-1
Acetaldehyde	2.52E-05	lb/MMBtu	AP-42 Table 3.4-3
Acrolein	7.88E-06	lb/MMBtu	AP-42 Table 3.4-3
Benzene	7.76E-04	lb/MMBtu	AP-42 Table 3.4-3
Formaldehyde	7.89E-05	lb/MMBtu	AP-42 Table 3.4-3
Naphthalene	1.30E-04	lb/MMBtu	AP-42 Table 3.4-4
PAH, other than Napthalene	8.20E-05	lb/MMBtu	AP-42 Table 3.4-4
Toluene	2.81E-04	lb/MMBtu	AP-42 Table 3.4-3
Xylene	1.93E-04	lb/MMBtu	AP-42 Table 3.4-3
Total HAP	**1.57E-03**	**lb/MMBtu**	

Pollutant	EF	Unit	Source
Engines Less Than 600 hp			
CO_2	163.05	lb/MMBtu	40 CFR Part 98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
CO	6.68E-03	lb/hp-hr	AP-42 Table 3.3-1
NO_X	3.10E-02	lb/hp-hr	AP-42 Table 3.3-1
PM_{10}	2.20E-03	lb/hp-hr	AP-42 Table 3.3-1
$PM_{2.5}$	2.20E-03	lb/hp-hr	AP-42 Table 3.3-1
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.4-1
VOC	2.51E-03	lb/hp-hr	AP-42 Table 3.3-1
1,3-Butadiene	3.91E-05	lb/MMBtu	AP-42 Table 3.3-2
Acetaldehyde	7.67E-04	lb/MMBtu	AP-42 Table 3.3-2
Acrolein	9.25E-05	lb/MMBtu	AP-42 Table 3.3-2
Benzene	9.33E-04	lb/MMBtu	AP-42 Table 3.3-2
Formaldehyde	1.18E-03	lb/MMBtu	AP-42 Table 3.3-2
Napthalene	8.48E-05	lb/MMBtu	AP-42 Table 3.3-2
PAH, other than Napthalene	8.32E-05	lb/MMBtu	AP-42 Table 3.3-2
Toluene	4.09E-04	lb/MMBtu	AP-42 Table 3.3-2
Xylenes	2.85E-04	lb/MMBtu	AP-42 Table 3.3-2
Total HAP	**3.87E-03**	**lb/MMBtu**	

Phase	Emission Unit	Number of Units	Engine Capacity	Engine Capacity	Number of Hours Each Unit Used	Rate Each Engine Used	Applicable Emission Standard[1]				CO_2	CH_4	N_2O	CO	NO_X[2]	PM	PM_{10}[3]	$PM_{2.5}$[3]	SO_2	VOC	Total HAP
							NO_X + NMHC	NO_X	PM	CO											
			hp	kW	hours/year	hp-hr/year	g/kW-hr	g/kW-hr	g/kW-hr	g/kW-hr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Construction	OSS Generator - Permanent	3	800	600	4464	3,571,200	NA	0.67	0.03	3.5	2,220.74	9.01E-02	1.80E-02	30.82	5.90	0.26	0.36	0.36	6.50E-02	3.44	2.14E-02
	OSS Generator - Temporary	6	209	156	4486	937,574	NA	0.4	0.02	3.5	1,166.05	4.73E-02	9.46E-03	16.18	1.85	9.25E-02	0.12	0.12	3.41E-02	7.07	2.77E-02
	OSS Generator - Cable Pull-in c	3	50	37	600	30,000	4.7	NA	0.03	5	18.66	7.57E-04	1.51E-04	0.37	0.33	2.22E-03	3.03E-03	3.03E-03	5.46E-04	0.11	4.43E-04
	Array Cable Generator - WTG	98	50	37	731	36,527	4.7	NA	0.03	5	741.99	3.01E-02	6.02E-03	14.71	13.14	8.83E-02	8.93E-02	8.93E-02	2.17E-02	4.50E+00	1.76E-02
	Array Cable Generator - OSS	3	102	76	120	12,240	NA	0.4	0.02	5	7.61	3.09E-04	6.17E-05	0.15	0.01	6.04E-04	9.34E-04	9.34E-04	2.23E-04	0.05	0.00
										Total:	**4,155.04**	**0.17**	**3.37E-02**	**62.24**	**21.23**	**0.45**	**0.57**	**0.57**	**1.22E-01**	**15.17**	**6.74E-02**

[1] Applicable emission standard based on LAER determination, which is Tier 4 emission standards from 40 CFR 1039.101. The Tier 4 emission standard was used to estimate PTE for the following pollutants: NO_x, PM, PM_{10}, $PM_{2.5}$ and CO. All other pollutants (CO_2, CH_4, N_2O, SO_2, and VOC) were estimated using AP-42 emission factors from Tables 3.4-1 and 3.3-1. See footnote [2] for an explanation of how NO_x emissions were estimated when the applicable standard is in terms of NO_x + NMHC. See footnote [3] for an explanation of how PM_{10} and $PM_{2.5}$ emissions were estimated from the PM standard.

[2] NO_x emissions are estimated to comprise 95% of NO_x + NMHC emissions in accordance with CARB guidance. California Air Resources Board (CARB). 2004. Policy: CARB Emission Factors for CI Diesel Engines – Percent HC in Relation to NMHC + NO_x. Retrieved from https://www.baaqmd.gov/~/media/files/engineering/policy_and_procedures/engines/emissionfactorsfordieselengines.pdf?la=en

[3] It is conservatively assumed that the PM emission standard is equal to the filterable portion of PM_{10} and $PM_{2.5}$. The condensable portion of PM_{10} and $PM_{2.5}$ was added using the AP-42 emission factor of 0.0077 lb/MMBtu from AP-42 Table 3.4-2 and converting to lb/hp-hr using the conversion factor 7,000 Btu/hp-hr from footnote 'e' of AP-42 Table 3.4-1, resulting in a condensable emission factor of 0.0000539 lb/hp-hr.

Pollutant	Emission Factor	Unit	Source
Engines 600 hp or Greater			
CO_2	163.05	lb/MMBtu	41 CFR Part 98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
CO	5.50E-03	lb/hp-hr	AP-42 Table 3.4-1
NO_X	2.40E-02	lb/hp-hr	AP-42 Table 3.4-1
PM_{10}	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
$PM_{2.5}$	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.4-1
VOC	6.42E-04	lb/hp-hr	AP-42 Table 3.4-1
Acetaldehyde	2.52E-05	lb/MMBtu	AP-42 Table 3.4-3
Acrolein	7.88E-06	lb/MMBtu	AP-42 Table 3.4-3
Benzene	7.76E-04	lb/MMBtu	AP-42 Table 3.4-3
Formaldehyde	7.89E-05	lb/MMBtu	AP-42 Table 3.4-3
Naphthalene	1.30E-04	lb/MMBtu	AP-42 Table 3.4-4
PAH, other than Napthalene	8.20E-05	lb/MMBtu	AP-42 Table 3.4-4
Toluene	2.81E-04	lb/MMBtu	AP-42 Table 3.4-3
Xylene	1.93E-04	lb/MMBtu	AP-42 Table 3.4-3
Total HAP	**1.57E-03**	**lb/MMBtu**	

Pollutant	Emission Factor	Unit	Source
Engines Less Than 600 hp			
CO_2	163.05	lb/MMBtu	98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	98 Subpart C Table C-2
CO	6.68E-03	lb/hp-hr	42 Table 3.3-1
NO_X	3.10E-02	lb/hp-hr	42 Table 3.3-1
PM_{10}	2.20E-03	lb/hp-hr	42 Table 3.3-1
$PM_{2.5}$	2.20E-03	lb/hp-hr	42 Table 3.3-1
SO_2	1.21E-05	lb/hp-hr	42 Table 3.4-1
VOC	2.51E-03	lb/hp-hr	42 Table 3.3-1
1,3-Butadiene	3.91E-05	lb/MMBtu	42 Table 3.3-2
Acetaldehyde	7.67E-04	lb/MMBtu	42 Table 3.3-2
Acrolein	9.25E-05	lb/MMBtu	42 Table 3.3-2
Benzene	9.33E-04	lb/MMBtu	42 Table 3.3-2
Formaldehyde	1.18E-03	lb/MMBtu	42 Table 3.3-2
Napthalene	8.48E-05	lb/MMBtu	42 Table 3.3-2
PAH, other than Napthalene	8.32E-05	lb/MMBtu	42 Table 3.3-2
Toluene	4.09E-04	lb/MMBtu	42 Table 3.3-2
Xylenes	2.85E-04	lb/MMBtu	42 Table 3.3-2
Total HAP	**3.87E-03**	**lb/MMBtu**	

Main Engine - Annual Emissions - OCS Transit:

tons/year=	hrs/year x kW, main engine x load factor, propulsion engine x EF x 1.1X10^-6 g/ton x # of Vessels										
	CO_2	CH_4	N_2O	CO	NO_X	PM [1]	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	5.53E+02	3.42E-03	2.65E-02	1.96E+00	8.57E+00	2.71E-01	2.63E-01	2.55E-01	1.09E-02	3.85E-05	1.23E-01
Crew	115.19	7.12E-04	5.52E-03	4.09E-01	1.78	5.64E-02	5.48E-02	5.30E-02	2.26E-03	8.03E-06	2.57E-02
Jackup	6.70	4.14E-05	3.21E-04	2.38E-02	1.04E-01	3.28E-03	3.18E-03	3.08E-03	1.32E-04	4.67E-07	1.49E-03
Tug	509.35	3.15E-03	2.44E-02	1.81E+00	7.89	2.49E-01	2.42E-01	2.35E-01	1.00E-02	3.55E-05	1.14E-01
Crew	2073.51	1.28E-02	9.93E-02	7.36	32.13	1.02E+00	9.86E-01	9.55E-01	4.08E-02	1.44E-04	4.62E-01

Auxiliary Engine - Annual Emissions - OCS Transit:

tons/year=	hrs/year x kW, aux engine x load factor, aux engine x EF x 1.1X10^-6 g/ton x # of Vessels										
	CO_2	CH_4	N_2O	CO	NO_X	PM [2]	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	2.11E+01	1.30E-04	1.01E-03	8.07E-02	3.76E-01	1.36E-02	1.04E-02	1.01E-02	1.95E-04	1.56E-06	4.56E-03
Crew	4.39	2.71E-05	2.10E-04	1.68E-02	7.83E-02	2.84E-03	2.17E-03	2.10E-03	4.07E-05	3.25E-07	9.49E-04
Jackup	0.73	4.50E-06	3.49E-05	2.79E-03	1.30E-02	4.72E-04	3.60E-04	3.49E-04	6.75E-06	5.40E-08	1.57E-04
Tug	23.09	1.43E-04	1.10E-03	8.84E-02	4.11E-01	1.49E-02	1.14E-02	1.10E-02	2.14E-04	1.71E-06	4.99E-03
Crew	79.11	4.88E-04	3.78E-03	3.03E-01	1.41E+00	5.12E-02	3.91E-02	3.78E-02	7.32E-04	5.86E-06	1.71E-02

Main Engine - Annual Emissions - Onsite Maneuvering:

tons/year=	hrs/year x kW, main engine x load factor, propulsion engine x EF x 1.1X10^-6 g/ton x # of Vessels										
	CO_2	CH_4	N_2O	CO	NO_X	PM [1]	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	6.25E+02	3.86E-03	2.99E-02	2.22E+00	9.69E+00	3.06E-01	2.97E-01	2.88E-01	1.23E-02	4.36E-05	1.39E-01
Crew	130.22	8.05E-04	6.24E-03	4.62E-01	2.02	6.38E-02	6.19E-02	6.00E-02	2.56E-03	9.07E-06	2.90E-02
Jackup	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tug	1,876.14	1.16E-02	8.99E-02	6.66	29.07	9.19E-01	8.92E-01	8.64E-01	3.69E-02	1.31E-04	4.18E-01
Crew	2,343.93	1.45E-02	1.12E-01	8.32	36.32	1.15E+00	1.11E+00	1.08E+00	4.61E-02	1.63E-04	5.23E-01

Auxiliary Engine - Annual Emissions - Onsite Maneuvering:

tons/year=	hrs/year x kW, main engine x load factor, propulsion engine x EF x 1.1X10^-6 g/ton x # of Vessels										
	CO_2	CH_4	N_2O	CO	NO_X	PM [2]	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	1.37E+02	8.48E-04	6.58E-03	5.26E-01	2.45E+00	8.89E-02	6.79E-02	6.58E-02	1.27E-03	1.02E-05	2.97E-02
Crew	28.64	1.77E-04	1.37E-03	1.10E-01	5.10E-01	1.85E-02	1.41E-02	1.37E-02	2.65E-04	2.12E-06	6.19E-03
Jackup	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tug	490.45	3.03E-03	2.35E-02	1.88E+00	8.74	3.17E-01	2.42E-01	2.35E-01	4.54E-03	3.63E-05	1.06E-01
Crew	515.59	3.18E-03	2.47E-02	1.97	9.18	3.33E-01	2.55E-01	2.47E-01	4.77E-03	3.82E-05	1.11E-01

Annual Operating Emissions

	CO_2	CH_4	N_2O	CO	NO_X	PM	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Total:	9,533.62	5.89E-02	4.57E-01	34.20	150.74	4.87	4.56	4.41	1.74E-01	6.70E-04	2.12

[1] BOEM emission factors for PM are not provided. It is assumed that PM emissions from main engines are 103% of PM_{10} emissions, based on page 3-35 of US Environmental Protection Agency (EPA). 2009. Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines. (EPA-420-R-09-019)

[2] BOEM emission factors for PM are not provided. It is assumed that PM emissions from auxiliary engines are 131% of PM_{10} emissions, based on page 3-35 of US Environmental Protection Agency (EPA). 2009. Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines. (EPA-420-R-09-019)

Phase	Emission Unit	Number of Units	Engine Capacity	Number of Hours Each Unit Used	Rate Each Engine Used	CO_2	CH_4	N_2O	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	Total HAP
			hp	hours/year	hp-hr/year	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
O&M	Jackup Vessel Generator - Small	1	5	8732	43,662	9.05	3.67E-04	7.34E-05	1.46E-01	6.77E-01	4.80E-02	4.80E-02	2.65E-04	5.49E-02	2.15E-04
	Jackup Vessel Generator - Large	1	100	8732	873,242	181.01	7.34E-03	1.47E-03	2.92	13.54	9.61E-01	9.61E-01	5.30E-03	1.10E+00	4.30E-03
	Jackup Vessel Cherry Picker	1	6	8732	52,395	10.86	4.41E-04	8.81E-05	1.75E-01	8.12E-01	5.76E-02	5.76E-02	3.18E-04	6.59E-02	2.58E-04
	Feeder Barge Crane Type 1	1	760	6605	5,019,424	1,040.44	4.22E-02	8.44E-03	1.38E+01	60.23	1.76E+00	1.76E+00	3.05E-02	1.61E+00	1.00E-02
					Total:	**1,241.35**	**5.04E-02**	**1.01E-02**	**17.04**	**75.26**	**2.82E+00**	**2.82E+00**	**3.63E-02**	**2.83E+00**	**1.48E-02**

Pollutant	Emission Factor	Unit	Source
Engines 600 hp or Greater			
CO_2	163.05	lb/MMBtu	41 CFR Part 98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
CO	5.50E-03	lb/hp-hr	AP-42 Table 3.4-1
NO_X	2.40E-02	lb/hp-hr	AP-42 Table 3.4-1
PM_{10}	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
$PM_{2.5}$	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.4-1
VOC	6.42E-04	lb/hp-hr	AP-42 Table 3.4-1
Acetaldehyde	2.52E-05	lb/MMBtu	AP-42 Table 3.4-3
Acrolein	7.88E-06	lb/MMBtu	AP-42 Table 3.4-3
Benzene	7.76E-04	lb/MMBtu	AP-42 Table 3.4-3
Formaldehyde	7.89E-05	lb/MMBtu	AP-42 Table 3.4-3
Naphthalene	1.30E-04	lb/MMBtu	AP-42 Table 3.4-4
PAH, other than Napthalene	8.20E-05	lb/MMBtu	AP-42 Table 3.4-4
Toluene	2.81E-04	lb/MMBtu	AP-42 Table 3.4-3
Xylene	1.93E-04	lb/MMBtu	AP-42 Table 3.4-3
Total HAP	**1.57E-03**	**lb/MMBtu**	

Pollutant	Emission Factor	Unit	Source
Engines Less Than 600 hp			
CO_2	163.05	lb/MMBtu	40 CFR Part 98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
CO	6.68E-03	lb/hp-hr	AP-42 Table 3.3-1
NO_X	3.10E-02	lb/hp-hr	AP-42 Table 3.3-1
PM_{10}	2.20E-03	lb/hp-hr	AP-42 Table 3.3-1
$PM_{2.5}$	2.20E-03	lb/hp-hr	AP-42 Table 3.3-1
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.4-1
VOC	2.51E-03	lb/hp-hr	AP-42 Table 3.3-1
1,3-Butadiene	3.91E-05	lb/MMBtu	AP-42 Table 3.3-2
Acetaldehyde	7.67E-04	lb/MMBtu	AP-42 Table 3.3-2
Acrolein	9.25E-05	lb/MMBtu	AP-42 Table 3.3-2
Benzene	9.33E-04	lb/MMBtu	AP-42 Table 3.3-2
Formaldehyde	1.18E-03	lb/MMBtu	AP-42 Table 3.3-2
Napthalene	8.48E-05	lb/MMBtu	AP-42 Table 3.3-2
PAH, other than Napthalene	8.32E-05	lb/MMBtu	AP-42 Table 3.3-2
Toluene	4.09E-04	lb/MMBtu	AP-42 Table 3.3-2
Xylenes	2.85E-04	lb/MMBtu	AP-42 Table 3.3-2
Total HAP	**3.87E-03**	**lb/MMBtu**	

Phase	Emission Unit	Number of Units	Engine Capacity	Engine Capacity	Number of Hours Each Unit Used	Rate Each Engine Used	Applicable Emission Standard[1]			CO_2	CH_4	N_2O	CO	NO_X	PM	PM_{10} [2]	$PM_{2.5}$ [2]	SO_2	VOC	Total HAP
							NO_X	PM	CO											
			hp	kW	hours/year	hp-hr/year	g/kW-hr	g/kW-hr	g/kW-hr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
O&M	Substation Emergency Generator	3	800	600	1000	800,000	0.67	0.03	3.5	497.48	2.02E-02	4.04E-03	6.90	1.32	5.92E-02	8.07E-02	8.07E-02	1.46E-02	0.77	4.80E-03

[1] Applicable emission standard based on LAER determination, which is Tier 4 emission standards from 40 CFR 1039.101. The Tier 4 emission standard was used to estimate PTE for the following pollutants: NO_x, PM, PM_{10}, $PM_{2.5}$ and CO. All other pollutants (CO_2, CH_4, N_2O, SO_2, and VOC) were estimated using AP-42 emission factors from Tables 3.4-1 and 3.3-1. See footenote [2] for an explanation of how PM_{10} and $PM_{2.5}$ emissions were estimated from the PM standard.

[3] It is conservatively assumed that the PM emission standard is equal to the filterable portion of PM_{10} and $PM_{2.5}$. The condensable portion of PM_{10} and $PM_{2.5}$ was added using the AP-42 emission factor of 0.0077 lb/MMBtu from AP-42 Table 3.4-2 and converting to lb/hp-hr using the conversion factor 7,000 Btu/hp-hr from footnote 'e' of AP-42 Table 3.4-1, resulting in a condensable emission factor of 0.0000539 lb/hp-hr.

Pollutant	Emission Factor	Unit	Source
Engines 600 hp or Greater			
CO_2	163.05	lb/MMBtu	41 CFR Part 98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
CO	5.50E-03	lb/hp-hr	AP-42 Table 3.4-1
NO_X	2.40E-02	lb/hp-hr	AP-42 Table 3.4-1
PM_{10}	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
$PM_{2.5}$	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.4-1
VOC	6.42E-04	lb/hp-hr	AP-42 Table 3.4-1
Acetaldehyde	2.52E-05	lb/MMBtu	AP-42 Table 3.4-3
Acrolein	7.88E-06	lb/MMBtu	AP-42 Table 3.4-3
Benzene	7.76E-04	lb/MMBtu	AP-42 Table 3.4-3
Formaldehyde	7.89E-05	lb/MMBtu	AP-42 Table 3.4-3
Naphthalene	1.30E-04	lb/MMBtu	AP-42 Table 3.4-4
PAH, other than Napthalene	8.20E-05	lb/MMBtu	AP-42 Table 3.4-4
Toluene	2.81E-04	lb/MMBtu	AP-42 Table 3.4-3
Xylene	1.93E-04	lb/MMBtu	AP-42 Table 3.4-3
Total HAP	**1.57E-03**	**lb/MMBtu**	

Pollutant	Emission Factor	Unit	Source
Engines Less Than 600 hp			
CO_2	163.05	lb/MMBtu	98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	98 Subpart C Table C-2
CO	6.68E-03	lb/hp-hr	42 Table 3.3-1
NO_X	3.10E-02	lb/hp-hr	42 Table 3.3-1
PM_{10}	2.20E-03	lb/hp-hr	42 Table 3.3-1
$PM_{2.5}$	2.20E-03	lb/hp-hr	42 Table 3.3-1
SO_2	1.21E-05	lb/hp-hr	42 Table 3.4-1
VOC	2.51E-03	lb/hp-hr	42 Table 3.3-1
1,3-Butadiene	3.91E-05	lb/MMBtu	42 Table 3.3-2
Acetaldehyde	7.67E-04	lb/MMBtu	42 Table 3.3-2
Acrolein	9.25E-05	lb/MMBtu	42 Table 3.3-2
Benzene	9.33E-04	lb/MMBtu	42 Table 3.3-2
Formaldehyde	1.18E-03	lb/MMBtu	42 Table 3.3-2
Napthalene	8.48E-05	lb/MMBtu	42 Table 3.3-2
PAH, other than Napthalene	8.32E-05	lb/MMBtu	42 Table 3.3-2
Toluene	4.09E-04	lb/MMBtu	42 Table 3.3-2
Xylenes	2.85E-04	lb/MMBtu	42 Table 3.3-2
Total HAP	**3.87E-03**	**lb/MMBtu**	

Paint Usage Information

Equipment	Number of Lifetime Events	Volume Paint Used per Event [3] gallons	Total Volume of Paint gallons/lifetime	Type of Paint Used (Representative)
WTG Repair Painting [1]	347	3	1041	RAL 7035
OSS Foundation Painting [2]	3	3	9	Interzone 9545
WTG Foundation Painting [2]	347	3	1041	Interzone 9545

[1] It is assumed WTGs will be repainted at the same rate as WTG Foundations. Representative type of paint obtained from page 155 of Volume I of Ocean Wind COP (dated March 2021).

[2] Maximum number of times foundations will be repainted obtained from Table 6.1.2-7 of Volume I of Ocean Wind's COP (dated March 2021).

[3] Volume of paint based on other offshore wind permit applications (Vineyard Wind assumed 50 gallons of marine paint per year for all touch ups).

Paint Data

Paint [1]	VOC Content % by Weight	HAP Content [2] % by Weight	Density lb/gal
RAL 7035	44.07	16.2	6.69
Interzone 9545	3.88	0	13.90
Interzone 9545	3.88	0	13.90

[1] Data from Custom-Pak Products RAL 7035 SDS and Interzone 9545 SDS.

[2] HAP content of Interzone 9545 not provided on SDS.

Emissions [1]

Equipment	VOC tons/year	VOC tons/lifetime	HAP tons/year	HAP tons/lifetime
WTG Painting	3.84E-02	1.54	1.41E-02	0.56
OSS Foundation Painting	6.07E-05	2.43E-03	0.00E+00	0.00E+00
WTG Foundation Painting	7.02E-03	0.28	0.00E+00	0.00E+00
Total:	**4.55E-02**	**1.82**	**1.41E-02**	**0.56**

[1] Conservatively assuming that all VOC/HAP content is emitted.

SF_6 Project Usage Rates

Equipment	SF_6 per Equipment	Unit	Equipment Number	Total SF_6	Unit
WTG Switchgear [1]	243	lbs	99	24,057	lbs
OSS Switchgear [2]	793	gallons	4	3,172	gallons

[1] SF_6 per WTG obtained from Table 8.1-1 of Volume I of Ocean Wind's COP (dated March 2021).

[2] SF_6 per OSS obtained from Table 8.1-2 of Volume I of Ocean Wind's COP (dated March 2021).

Density of SF_6 0.0535 lbs/gal

Total Mass of SF6

WTG Switchgear	24057	lbs
OSS Switchgear	169.6831028	lbs
Total:	**24,226.68**	**lbs**

Mass of SF_6 Leaked

Total Mass of SF_6	24,226.68	lbs
Annual Leakage Rate [1]	0.50%	
Total Mass Leaked per Year	121.13	lbs
Total Mass Leaked over 35-Year Life	4845.34	lbs

[1] Annual leakage rate obtained from: Blackman, J., Averyt, M., & Taylor, Z. SF_6 Leak Rates from High Voltage Circuit Breakers - U.S. EPA Investigates Potential Greenhouse Gas Emissions Source. Retrieved April 15, 2021, from https://www.epa.gov/sites/production/files/2016-02/documents/leakrates_circuitbreakers.pdf

GHG Emissions due to SF_6 Leakage

Global Warming Potential (GWP) of SF_6 [1]	22,800	Unitless
Annual GHG Emissions	1,380.92	tons/year
Lifetime GHG Emissions	55,236.84	tons

[1] GWP of SF_6 obtained from 40 CFR Part 98 Subpart A Table A-1.

Marine Vessel HAP Profiles [1]			Category 1 & 2 Vessel Engines		Category 3 Vessel Engines		
			In-port Maneuvering	Underway	In-port Hoteling	In-port Maneuvering	Underway
Pollutant Code	Pollutant	Fraction of	Fraction				
130498292	POM as 7-PAH	PM	NA	NA	4.50E-07	4.90E-07	4.90E-07
NH3	Ammonia	PM10	1.00E-02	2.00E-02	1.08E-02	2.38E-03	4.77E-03
7440382	Arsenic	PM10	1.75E-05	3.00E-05	4.00E-04	8.74E-05	1.75E-04
50328	Benzo[a]Pyrene	PM10	2.50E-06	5.00E-06	2.00E-06	4.37E-07	8.74E-07
205992	Benzo[b]Fluoranthene	PM10	5.00E-06	1.00E-05	4.00E-06	8.74E-07	1.75E-06
207089	Benzo[k]Fluoranthene	PM10	2.50E-06	5.00E-06	2.00E-06	4.37E-07	8.74E-07
7440417	Beryllium	PM10	NA	NA	5.46E-07	5.46E-07	5.46E-07
7440439	Cadmium	PM10	2.83E-06	5.15E-06	5.90E-06	2.26E-05	2.26E-05
7440473	Chromium	PM10	NA	5.00E-05	NA	NA	1.92E-04
16065831	Chromium III	PM10	1.65E-05	3.30E-05	3.96E-04	1.27E-04	1.27E-04
18540299	Chromium VI	PM10	8.50E-06	1.70E-05	2.04E-04	6.53E-05	6.53E-05
7440484	Cobalt	PM10	NA	NA	2.92E-04	5.94E-05	1.54E-04
	Copper	PM10	9.58E-04	1.75E-03	9.08E-04	1.91E-04	3.48E-04
628	Dioxin	PM10	2.50E-09	5.00E-09	2.00E-09	4.37E-10	8.74E-10
118741	HCB	PM10	2.00E-08	4.00E-08	1.60E-08	3.50E-09	6.99E-09
193395	Indeno[1,2,3-c,d]Pyrene	PM10	5.00E-06	1.00E-05	4.00E-06	8.74E-07	1.75E-06
7439921	Lead	PM10	7.50E-05	1.50E-04	6.00E-05	1.40E-05	2.62E-05
7439965	Manganese	PM10	1.53E-06	1.28E-06	5.73E-05	5.73E-05	5.73E-05
7439976	Mercury	PM10	2.50E-08	5.00E-08	1.40E-06	2.71E-07	5.24E-07
7440020	Nickel	PM10	5.00E-04	1.00E-03	1.54E-02	3.25E-03	5.89E-03
1336363	PCB	PM10	2.50E-07	5.00E-07	2.00E-07	4.37E-08	8.74E-08
7723140	Phosphorous	PM10	NA	NA	4.38E-03	1.79E-03	5.73E-03
7782492	Selenium	PM10	2.83E-08	5.15E-08	9.08E-06	1.91E-06	3.48E-06
	Zinc	PM10	5.00E-04	1.00E-03	6.00E-04	1.31E-04	2.62E-04
	Total Fraction of PM10:		**1.21E-02**	**2.41E-02**	**3.35E-02**	**8.18E-03**	**1.78E-02**
83329	Acenaphthene	PM2.5	1.80E-05	1.50E-05	3.40E-07	3.40E-07	3.40E-07
208968	Acenaphthylene	PM2.5	2.78E-05	2.31E-05	5.25E-07	5.25E-07	5.25E-07
120127	Anthracene	PM2.5	2.78E-05	2.31E-05	5.25E-07	5.25E-07	5.25E-07
56553	Benz[a]Anthracene	PM2.5	3.00E-05	2.50E-05	5.67E-07	5.67E-07	5.67E-07
191242	Benzo[g,h,I,]Perylene	PM2.5	6.75E-06	5.63E-06	1.28E-07	1.28E-07	1.28E-07
218019	Chrysene	PM2.5	5.25E-06	4.38E-06	9.93E-08	9.93E-08	9.93E-08
53703	Dibenzo[a,h]Anthracene	PM2.5	NA	NA	0.00E+00	0.00E+00	0.00E+00
206440	Fluoranthene	PM2.5	1.65E-05	1.38E-05	3.12E-07	3.12E-07	3.12E-07
86737	Fluorene	PM2.5	3.68E-05	3.06E-05	6.95E-07	6.95E-07	6.95E-07
91203	Naphthalene	PM2.5	1.05E-03	8.76E-04	1.99E-05	1.99E-05	1.99E-05
85018	Phenanthrene	PM2.5	4.20E-05	3.50E-05	7.94E-07	7.94E-07	7.94E-07
130498292	POM as 16-PAH	PM2.5	NA	NA	2.49E-05	2.49E-05	2.49E-05
129000	Pyrene	PM2.5	2.93E-05	2.44E-05	5.53E-07	5.53E-07	5.53E-07
	Total Fraction of PM2.5:		**1.29E-03**	**1.08E-03**	**4.93E-05**	**4.93E-05**	**4.93E-05**
540841	2,2,4-trimethylpentane	VOC	3.00E-04	2.50E-04	NA	NA	NA
75070	Acetaldehyde	VOC	5.57E-02	4.64E-02	2.29E-04	2.29E-04	2.29E-04
107028	Acrolein	VOC	2.63E-03	2.19E-03	NA	NA	NA
71432	Benzene	VOC	1.53E-02	1.27E-02	9.80E-06	9.80E-06	9.80E-06
100414	Ethylbenzene	VOC	1.50E-03	1.25E-03	NA	NA	NA
50000	Formaldehyde	VOC	0.11	9.35E-02	1.57E-03	1.57E-03	1.57E-03
110543	n-Hexane	VOC	4.13E-03	3.44E-03	NA	NA	NA
123386	Propionaldehyde	VOC	4.58E-03	3.81E-03	NA	NA	NA
100425	Styrene	VOC	1.58E-03	1.31E-03	NA	NA	NA
108883	Toluene	VOC	2.40E-03	2.00E-03	NA	NA	NA
1330207	Xylene	VOC	3.60E-03	3.00E-03	NA	NA	NA
	Total Fraction of VOC:		**0.20**	**0.17**	**1.81E-03**	**1.81E-03**	**1.81E-03**

[1] HAP emissions from marine vessel engines estimated using fractions of VOC and PM/PM_{10}/$PM_{2.5}$ estimates, in accordance with Appendix F of Draft 2014 National Emissions Inventory, version 1 Technical Support Document (2015).

Phase	Activity	Vessel Description	Vessel Type [1]	Number of Vessels	Main Engine Rating (kW)	Assumed Engine Type [2]	Auxiliary Engine Rating (kW)	Assumed Engine Type [2]	Transit Total HAP - Main Engine (tons/year)	Transit Total HAP - Auxiliary Engine (tons/year)	On-site Manuevering Total HAP - Main Engine (tons/year)	On-site Manuevering Total HAP - Auxiliary Engine (tons/year)
Construction	Array Cable Installation	Pre-lay Survey Vessel	Crew	1	2,060.00	Cat1/2	201.05	Cat1/2	3.78E-04	1.47E-05	1.93E-02	1.92E-03
Construction		Pre-lay Grapnel Run (PLGR) Vessel	Dredging	1	3,233.66	Cat3	963.82	Cat1/2	1.51E-04	8.10E-05	2.03E-03	5.76E-03
Construction		Boulder Clearance Vessel	Multi-Purpose Service Vessel	1	3,131.92	Cat3	1,006.68	Cat1/2	1.46E-04	8.46E-05	2.82E-03	8.60E-03
Construction		Sandwave Clearance Vessel	Dredging	1	3,233.66	Cat3	963.82	Cat1/2	1.51E-04	8.10E-05	2.03E-03	5.76E-03
Construction		Cable Laying Vessel	Cable Laying	1	6,657.62	Cat3	3,025.77	Cat3	1.38E-03	2.23E-04	1.12E-02	4.54E-03
Construction		Cable Burial Vessel	Cable Laying	1	6,657.62	Cat3	3,025.77	Cat3	1.38E-03	2.23E-04	1.69E-02	6.82E-03
Construction		Crew Transport Vessel	Crew	2	2,060.00	Cat1/2	201.05	Cat1/2	1.91E-02	7.42E-04	9.40E-02	9.36E-03
Construction		Walk to Work Vessel	Multi-Purpose Service Vessel	1	3,131.92	Cat3	1,006.68	Cat1/2	4.82E-03	2.79E-03	6.54E-03	2.00E-02
Construction		Post-Lay Inspection Survey Vessel	Crew	1	2,060.00	Cat1/2	201.05	Cat1/2	6.30E-03	2.44E-04	3.48E-02	3.46E-03
Construction		DP2 Construction Vessel - Jack of All Trades	Multi-Purpose Service Vessel	1	3,131.92	Cat3	1,006.68	Cat1/2	2.48E-03	1.44E-03	3.90E-03	1.19E-02
Construction	Offshore Export Cable & Interconnection Cable Installation	Cable Lay and Burial Vessel	Cable Laying	1	6,657.62	Cat3	3,025.77	Cat3	1.96E-03	3.18E-04	2.25E-02	9.09E-03
Construction		Cable Burial Vessel	Cable Laying	1	6,657.62	Cat3	3,025.77	Cat3	2.06E-03	3.34E-04	1.59E-03	6.43E-04
Construction		Anchor Handling Tug	Tug	1	2,053.16	Cat1/2	238.13	Cat1/2	5.31E-03	2.00E-04	2.54E-02	2.40E-03
Construction		Pull tug to move barges	Tug	1	2,053.16	Cat1/2	238.13	Cat1/2	1.52E-02	5.73E-04	7.29E-02	6.87E-03
Construction		Pull ahead export cable tug for assist CLV	Anchor Tug	1	1,230.00	Cat1/2	357.00	Cat1/2	7.42E-03	7.00E-04	3.42E-02	8.07E-03
Construction		Pre-lay Grapnel Run (PLGR) Vessel	Dredging	1	3,233.66	Cat3	963.82	Cat1/2	5.53E-04	2.97E-04	3.47E-03	9.83E-03
Construction		Boulder Clearance Vessel	Multi-Purpose Service Vessel	1	3,131.92	Cat3	1,006.68	Cat1/2	2.44E-04	1.41E-04	1.68E-03	5.14E-03
Construction		Crew Transport Vessel	Crew	2	2,060.00	Cat1/2	201.05	Cat1/2	2.12E-03	8.24E-05	8.68E-02	8.64E-03
Construction		Guard Vessel	Guard Vessel	5	2,460.00	Cat1/2	357.00	Cat1/2	1.92E-01	7.50E-03	3.17E+00	3.04E-01
Construction		Post-Lay Inspection Survey Vessel	Crew	2	2,060.00	Cat1/2	201.05	Cat1/2	5.64E-03	2.19E-04	2.19E-02	2.19E-03
Construction		General Work Vessel	Multi-Purpose Service Vessel	1	3,131.92	Cat3	1,006.68	Cat1/2	7.31E-04	4.23E-04	3.75E-03	1.14E-02
Construction	OSS Topside	Heavy Transport Vessel	Heavy Transport Vessel	2	10,022.00	Cat3	0.00	Cat1/2	5.30E-03	0.00E+00	1.60E-03	0.00E+00
Construction	WTG & Platform Foundation Installation	Heavy Lift Installation Vessel	Heavy Transport Vessel	1	10,022.00	Cat3	0.00	Cat1/2	1.29E-02	0.00E+00	3.03E-02	0.00E+00
Construction		Secondary Steel Installation	Jackup	1	3,214.91	Cat3	895.08	Cat1/2	4.13E-03	2.48E-03	0.00E+00	0.00E+00
Construction		Feeder Barge Tug	Feeder Barge Tug	2	8,113.00	Cat3	340.00	Cat1/2	4.47E-02	3.77E-03	4.45E-02	2.03E-02
Construction		Rock Dumping Vessel	Multi-Purpose Service Vessel	1	3,131.92	Cat3	1,006.68	Cat1/2	4.82E-03	2.79E-03	5.77E-03	1.76E-02
Construction		Bubble Curtain Vessel	Platform Support Vessel	1	4,516.00	Cat3	1,618.00	Cat1/2	6.06E-03	4.48E-03	1.02E-02	4.08E-02
Construction		Heavy Transport Vessel	Heavy Transport Vessel	1	10,022.00	Cat3	0.00	Cat1/2	1.29E-02	0.00E+00	0.00E+00	0.00E+00
Construction		Crew Transport Vessel	Crew	1	2,060.00	Cat1/2	201.05	Cat1/2	5.63E-03	2.19E-04	6.69E-02	6.67E-03
Construction		Noise Monitoring Vessel	Noise Monitoring Vessel	2	970.00	Cat1/2	0.00	Cat1/2	3.31E-02	0.00E+00	8.36E-02	0.00E+00
Construction		Platform Support Vessel	Platform Support Vessel	2	4,516.00	Cat3	1,618.00	Cat1/2	2.43E-02	1.79E-02	2.83E-02	1.13E-01
Construction	WTG Construction	Installation Vessel	Jackup	1	3,214.91	Cat3	895.08	Cat1/2	7.10E-04	4.26E-04	0.00E+00	0.00E+00
Construction		Towing Tug	Tug	2	2,053.16	Cat1/2	238.13	Cat1/2	1.17E-02	4.40E-04	8.58E-02	8.09E-03
Construction	Construction Package	Safety Vessel	Supply Ship	1	3,842.65	Cat3	873.99	Cat1/2	6.19E-03	2.90E-03	3.81E-02	9.69E-02
Construction		Crew Transport Vessel	Crew	6	2,060.00	Cat1/2	201.05	Cat1/2	4.00E+00	1.55E-01	5.69E+00	5.66E-01
Construction		Service Operation Vessel	Multi-Purpose Service Vessel	1	3,131.92	Cat3	1,006.68	Cat1/2	2.89E-03	1.67E-03	2.77E-02	8.45E-02
								Total Construction HAP:	4.44	0.21	9.75	1.40
									15.80			
Operations	Annual O&M	Crew Transport Vessel - Minor Repairs	Crew	2	2,060.00	Cat1/2	201.05	Cat1/2	2.75E-02	1.04E-03	6.47E-02	1.39E-02
Operations		Crew Transport Vessel	Crew	1	2,060.00	Cat1/2	201.05	Cat1/2	5.74E-03	2.16E-04	6.74E-03	1.45E-03
Operations		Jackup - Major Repairs	Jackup	1	3,214.91	Cat3	895.08	Cat1/2	5.96E-05	3.58E-05	0.00E+00	0.00E+00
Operations		Feeder Barge Tug	Tug	1	2,053.16	Cat1/2	238.13	Cat1/2	2.54E-02	1.13E-03	9.71E-02	2.48E-02
Operations		Crew Transport Vessel	Crew	3	2,060.00	Cat1/2	201.05	Cat1/2	1.03E-01	3.88E-03	3.64E-01	7.82E-02
								Total Annual Operation and Maintenance HAP:	1.62E-01	6.30E-03	5.33E-01	1.18E-01
									8.19E-01			

[1] Vessel specifications for offshore substation construction, foundation installation and WTG construction are representative of vessels likely to be used for installation activities and are not BOEM default factors but are from installation vessel spec sheets.

[2] It is assumed that Category 1 and 2 engines are smaller than 3,000 kW and Category 3 engines are larger than 3,000 kW, based on Browning and Bailey: Browning, ICF Consulting and Bailey, USEPA. Current Methodologies and Best Practice for Preparing Port Emission Inventories. https://www3.epa.gov/ttnchie1/conference/ei15/session1/browning.pdf

Project Emissions - Sulfuric Acid (H_2SO_4)

Assumption

3.00% of fuel sulfur forms H_2SO_4 [1]

[1] EPA, 2008. *Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder*

Given

MW SO_2	64.06	g/mol
MW SO_3	80.06	g/mol
MW H_2SO_4	98.08	g/mol

	SO_2	H_2SO_4
	tons/yr	
Year 1 - Transit OCS	0.94	0.04
Year 1 - Onsite Maneuvering	5.69	0.26
Year 1 Total	6.63	0.30
Operations - Annual	0.22	0.01
Operations - 35-Yr Total	7.87	0.36

Project Emissions Summary

Construction

	CO2	CH4	N2O	CO2e	CO	NOX	PM	PM10	PM2.5	SO2	Lead	VOC	HAP
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
Vessel Transit	30,256	0.19	1.45	30,693	107.40	343.75	11.13	10.66	10.43	0.94	2.12E-03	7.33	4.65
Vessel Onsite Maneuvering	100,179	0.62	4.83	101,634	357.08	1,332	47.26	43.85	42.48	5.69	6.85E-03	28.03	11.15
Vessel Total - Construction	**130,435**	**0.81**	**6.28**	**132,327**	**464.48**	**1,676**	**58.40**	**54.51**	**52.91**	**6.63**	**8.97E-03**	**35.36**	**15.80**
Auxiliary Equipment	5,301	0.22	4.30E-02	5,319	75.15	17.28	0.52	0.52	0.66	0.16	0.00E+00	29.44	0.12
Generators	4,155	0.17	3.37E-02	4,169	62.24	21.23	0.45	0.45	0.57	0.12	0.00E+00	15.17	6.74E-02

Operations

	CO2	CH4	N2O	CO2e	CO	NOX	PM	PM10	PM2.5	SO2	Lead	VOC	HAP
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
Vessels	9,533.62	5.89E-02	0.46	9,671.17	34.20	150.74	4.87	4.56	4.41	1.74E-01	6.70E-04	2.12	0.82
Auxiliary Equipment	1,241.35	5.04E-02	1.01E-02	1,245.61	17.04	75.26	2.82	2.82	2.82	3.63E-02	0.00E+00	2.83	1.48E-02
Generators	497.48	2.02E-02	4.04E-03	499.18	6.90	1.32	5.92E-02	5.92E-02	8.07E-02	1.46E-02	0.00E+00	0.77	4.80E-03
Fugitive (SF6 Leakage and Paint)	0.00E+00	0.00E+00	0.00E+00	1,380.92	0.00E+00	0.00E+00	1.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.55E-02	1.41E-02

	CO2	CH4	N2O	CO2e	CO	NOX	PM	PM10	PM2.5	SO2	Lead	VOC	HAP
	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr	ton/yr
Construction - Total	139,891	1.19	6.36	141,815	601.87	1,714	59.36	55.48	54.14	6.90	8.97E-03	79.97	15.98
Operations - Annual Total	11,272	0.13	0.47	12,797	58.14	227.32	8.75	7.44	7.32	0.22	6.70E-04	5.76	0.85
Operations - 35 Year Total	394,536	4.53	16.48	447,891	2,034.97	7,956.16	306.40	260.33	256.07	7.87	2.34E-02	201.62	29.86

Ocean Wind
An Ørsted & PSEG project

Ocean Wind Offshore Wind Farm

Modeling Protocol

OCS Air Permit Application

Revised July 15, 2022

Table of Contents

1. Introduction 6
2. Introduction to the Project 6
3. Project Description 6
3.1 Project Location 6
3.2 Project OCS Sources and Modeled Emission Units 8
3.3 Ports 8
3.4 Tentative Schedule 9
4. EPA and NJDEP Comment on Modeling Protocol and Ocean Wind Responses 9
5. Regulatory Requirements 15
5.1 Source Impact Analysis 15
5.1.1 Applicable Ambient Air Standards 16
5.1.2 Secondary Formation of $PM_{2.5}$ and PM_{10} 17
5.1.3 Significant Impact Levels (SILs) 18
5.1.4 Cumulative Impact Analysis 18
5.2 Air Quality Analysis 21
5.3 Additional Impact Analysis 21
5.4 Nonattainment New Source Review (NNSR) 22
5.5 State Requirements 23
6. Proposed Class I Impact, Source Impact and Additional Impact Analysis 24
6.1 Meteorological Data 24
6.2 Shoreline Geometry and Fumigation 24
6.3 Downwash 25
6.4 Facility Layout and Emission Points 25
6.4.1 Annual Averaging Period 25
6.4.1.1 WTG and OSS Foundations 26
6.4.1.2 WTG Construction 26
6.4.1.3 OSS Construction 26
6.4.1.4 Offshore Export Cable Installation 27
6.4.1.5 Array Cable Installation 27
6.4.1.6 HDD Installation 27

6.4.1.7 Transit 27
6.4.1.8 Fisheries Monitoring and Marine Mammal Mitigation....28
6.4.1.9 Commissioning Generators....28
6.4.2 Short-term (24-hour and shorter) Averaging Periods 37
6.4.2.1 WTG and OSS Foundations 37
6.4.2.2 WTG Construction....38
6.4.2.3 OSS Construction 38
6.4.2.4 Offshore Export Cable Installation 38
6.4.2.5 Array Cable Installation 38
6.4.2.6 HDD Installation 38
6.4.2.7 Transit 38
6.4.2.8 Fisheries Monitoring and Marine Mammal Mitigation....38
6.4.2.9 Commissioning Generators....38
6.5 Vessel Stack Parameters 46
6.6 Receptors 46
6.6.1 NAAQS, PSD Class I Increment Analysis and Additional Impact Analysis 46
6.6.2 PSD Class I Increment Analysis....46
6.7 NO_2 Impacts – One-hour NAAQS Analysis 46
6.7.1 Ozone Limiting Method....48
6.7.2 Background One-Hour NO_2 Concentrations....49
7. Proposed AQRV Analysis....50
8. Operations & Maintenance Phase....50

List of Tables

Table 5-1. WTA Potential-to-Emit During Construction....16
Table 5-2. NAAQS. 16
Table 53-3. PSD Increment – Class I and Class II....17
Table 3-4. SILs....18
Table 5-5. Soils and Vegetation Screening Values....21
Table 5-6. Nonattainment Status of Counties Nearest Project. 22
Table 5-7. NJDEP Major Facility Thresholds. 23
Table 5-8. NJDEP Significant New Emission Increases. 23
Table 6-1. Ports Utilized by Vessels. 27
Table 8-1. WTA Potential-to-Emit During Operations and Maintenance....50
Table 8-2. WTA Potential-to-Emit During Operations and Maintenance – Alternate Approach....51

List of Figures

Figure 3-1. Project Location and Layout. 7
Figure 3-2. Indicative Construction Schedule. 9

Figure 5-1. Annual Average NO_2 Concentrations - Chester, PA. 20
Figure 5-2. Annual Average and 24-Hour (2nd High) $PM_{2.5}$ Concentrations – Brigantine, NJ. 20
Figure 5-3. 24-Hour (2nd High) PM_{10} Concentrations – Atlantic City, NJ. 21
Figure 6-1. Annual Averaging Period Modeled Emission Points Overview. 29
Figure 6-2. Annual Averaging Period Modeled Emission Points - WTG and OSS Foundation Installation. 30
Figure 6-3. Annual Averaging Period Modeled Emission Points - WTG Construction. 31
Figure 6-4. Annual Averaging Period Modeled Emission Points - OSS Construction. 32
Figure 6-5. Annual Averaging Period Modeled Emission Points - Offshore Export Cable Installation - BL England Route. 33
Figure 6-6. Annual Averaging Period Modeled Emission Points - Offshore Export Cable Installation - Oyster Creek Route. 34
Figure 6-7. Annual Averaging Period Modeled Emission Points - Array Cable Installation. 35
Figure 6-8. Annual Averaging Period Modeled Emission Points - HDD Installation. 36
Figure 6-9. Short-term Averaging Period Modeled Emission Points Overview. 39
Figure 6-10. Short-term Averaging Period Modeled Emission Points - WTG and OSS Foundation Installation. 40
Figure 6-11. Short-term Averaging Period Modeled Emission Points - WTG Construction. 41
Figure 6-12. Short-term Averaging Period Modeled Emission Points - OSS Construction. 42
Figure 6-13. Short-term Averaging Period Modeled Emission Points - Offshore Export Cable Installation - Oyster Creek Route. 43
Figure 6-14. Short-term Averaging Period Modeled Emission Points - Array Cable Installation. 44
Figure 6-15. Short-term Averaging Period Modeled Emission Points - HDD Installation. 45
Figure 6-16. Receptor Grid. 47

Appendices

Appendix A Meteorological Data and Air Dispersion Modeling Comparisons

Appendix B Pre-Application Air Quality Analysis and Request for Exemption from Pre-Construction Monitoring

Appendix C Ozone Limiting Method FORTRAN Post-processing Code

Appendix D 2018-2020 Ozone Hourly Meteorological Data (electronic Excel file)

Appendix E 2018-2020 NO2 Hourly Meteorological Data (electronic Excel file)

Table of Abbreviations

AQRV	Air Quality Related Values
BOEM	Bureau of Ocean Energy Management
CO	Carbon Monoxide
CO_2e	Carbon Dioxide Equivalent
COA	Corresponding Onshore Area
CTV	Crew Transfer Vessel
EAB	Environmental Appeals Board
EPA	Environmental Protection Agency
FLM	Federal Land Manager
GHG	Greenhouse Gas
GUI	Graphical User Interface
HDD	Horizontal Directional Drilling
H_2SO_4	Sulfuric Acid
NH_3	Ammonia
NO_x	Nitrogen Oxides

NAAQS	National Ambient Air Quality Standards
NSR	New Source Review
NJAAQS	New Jersey Ambient Air Quality Standards
N.J.A.C.	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NM	Nautical Mile
NNSR	Nonattainment New Source Review
NO_x	Nitrogen Oxides
NSR	New Source Review
NWS	National Weather Service
OCD	Offshore and Costal Dispersion Model
OCS	Outer Continental Shelf
O&M	Operations and Maintenance
OSS	Offshore Substations
Pb	Lead
PM	Particulate Matter
PM_{10}	Particulate Matter with Diameter 10 Micrometer or Less
$PM_{2.5}$	Particulate Matter with Diameter 2.5 Micrometer or Less
PSD	Prevention of Significant Deterioration
PTE	Potential to Emit
SCRAM	Support Center for Regulatory Atmospheric Modeling
SO_2	Sulfur Dioxide
TPY	Tons per Year
VOC	Volatile Organic Compounds
WRF	Weather Research and Forecasting Model
WTA	Wind Turbine Array
WTG	Wind Turbine Generator

1. Introduction

This revised Modeling Protocol provides updates to the Ocean Wind Modeling Protocol submitted to EPA and NJDEP on November 18, 2021, in response to comments provided by EPA and NJDEP on February 16, 2022. Comments from EPA and NJDEP are provided in Section 4, along with a brief response to each comment. In the remaining sections, additional information is provided in response to one or more EPA comments, as well as relevant information from the Ocean Wind Modeling Protocol submitted on November 18, 2021.

2. Introduction to the Project

Ocean Wind, LLC is proposing to install wind turbine generators (WTGs) and offshore infrastructure required to transmit power generated by the WTGs to onshore interconnection point(s). The offshore components of Ocean Wind (Project) include WTGs, three offshore substations installed on platforms (OSSs), array cabling connecting WTGs, substation interconnector cable linking two OSSs to each other, offshore export cabling connecting OSSs to land, and emergency generators installed on a portion of the WTGs. The Project will install up to 98 WTGs which will be constructed on monopile support structures anchored to the ocean floor. The Project will be located approximately 13 nautical miles (nm) southeast of the Atlantic City, New Jersey shoreline.

Federal regulations promulgated in 40 CFR Part 55 regulate air emissions from outer continental shelf (OCS) sources and differ from onshore stationary source air regulations in that 40 CFR Part 55 requires that construction emissions, including emissions from marine vessels, be included when determining applicability of major source permitting requirements. Due to this requirement, and the estimated emissions, the Project is subject to 40 CFR Part 55 and must obtain a preconstruction air permit prior to commencing construction of the Project.

The Project includes a construction phase, an operations and maintenance phase, and a decommissioning phase. The construction phase includes commissioning activities. The OCS air permit application and this modeling protocol address the construction phase and the operations phase. Because it is expected that marine vessel technology and construction technologies will substantially change over the operating life of the Project (35 years), the decommissioning phase is not addressed in the OCS air permit application. If the decommissioning phase of the Project is subject to 40 CFR Part 55, a separate permit will be applied for at that time.

The purpose of this modeling protocol is to respond to EPA comment on the initial Ocean Wind Modeling Protocol dated November 12, 2021, and to describe how Ocean Wind intends to demonstrate that the proposed Project will not adversely impact a Clean Air Act designated Class I area and will not cause or contribute to an exceedance of the National Ambient Air Quality Standards (NAAQS) or prevention of significant deterioration (PSD) increment.

3. Project Description

3.1 Project Location

The Project will be located on the OCS with the nearest edge of the wind farm area approximately 13 nm southeast of the Atlantic City, New Jersey shoreline. The Bureau of Ocean Energy Management (BOEM) lease area is approximately 75,525 acres and is depicted in Figure 3-1 as Ocean Wind Lease Area (OCS-A0498). The WTGs will occupy the portion labeled Wind Farm Area on the figure; this area is referred to as the Wind Turbine Array (WTA) in this modeling protocol. All offshore components of the Project

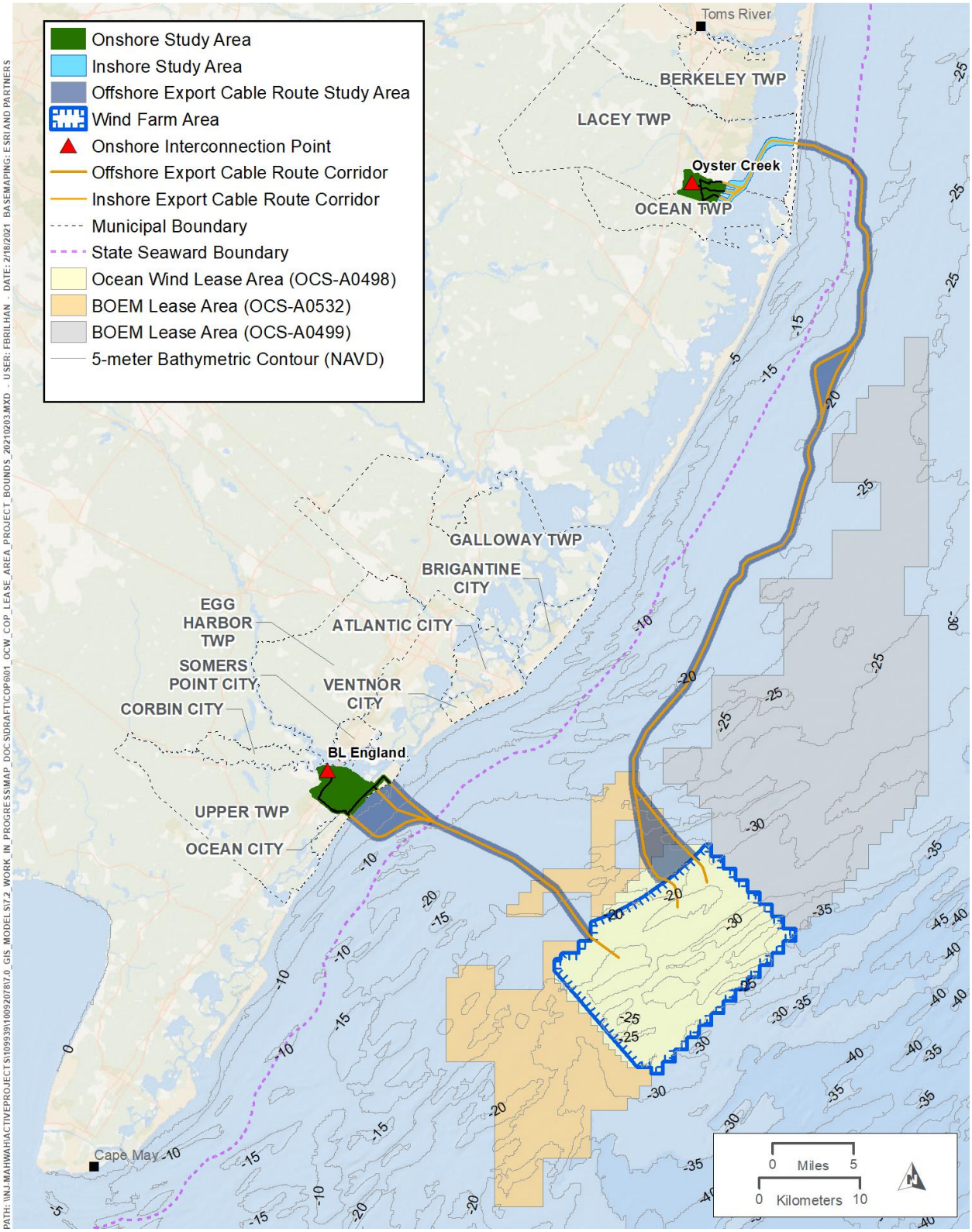


Figure 3-1. Project Location and Layout.

will be located within the WTA, except for the offshore export cabling, which will run from the OSSs to two onshore interconnection points, also shown on Figure 3-1.

3.2 Project OCS Sources and Modeled Emission Units

All emission units considered OCS sources and all potential emissions associated with the OCS source(s) will be included in the modeling. See Section 2.3, 2.4, and 2.5 of the OCS Air Permit Application dated March 29, 2022, for a detailed explanation of the Project OCS source(s) and potential emissions.

Additionally, as requested by EPA, the Project will also model emissions from horizontal directional drilling (HDD) activities occurring within the 25-nm radius OCS air permit circle

3.3 Ports

During construction, the Project will involve temporary construction laydown areas and construction ports. The primary ports that are expected to be used during construction, but which have independent utility and are not dedicated to the Project, are as follows:

- Atlantic City, NJ - construction management base. The site area is intended to offer an opportunity for a combined base for crew transfer vessel (CTV) operations for the construction phase.
- Paulsboro, NJ, Gibbstown (Repauno), NJ, or Europe (directly) - for foundation scope. The port area is intended to offer an opportunity for both foundation fabrication facilities as well as staging and load-out operations in collaboration with a key subcontractor.
- Norfolk, VA or Hope Creek, NJ - for WTG scope. The port area is intended to offer an opportunity for WTG pre-assembly and load-out facility without any air draft clearance restrictions covering jack-up installation vessel assets.
- Port Elizabeth, NJ, Charleston, SC, or Europe (directly) - cable staging (unless transported directly from the cable supplier). The intended terminal area and quay infrastructure will be used for various cable staging and operation, if required.

When calculating time spent in transit for the purpose of estimating emissions, the longest route was selected for each vessel as a conservative assumption.

All CTVs and vessels in the construction support package will utilize Atlantic City, New Jersey during the construction and commissioning phase. Ocean Wind has narrowed down the list of potential ports other vessels will use during all other construction activities. The list of potential ports is presented in Table 3-1.

Table 3-1. Ports During Construction.

Construction Activity	Ports Vessels Will Utilize
Array Cable, Offshore Export Cable, and Interconnection Cable Installation	Port Elizabeth, New Jersey
	Charleston, South Carolina
	Europe (directly)
OSS	Atlantic City, New Jersey
WTG and Platform Foundation Installation	Paulsboro, New Jersey
	Europe (directly)
WTG Construction	Hope Creek, New Jersey
	Norfolk, Virginia

3.4 Tentative Schedule

For the dispersion modeling air quality analysis, the most aggressive (shortest) construction schedule is assumed as a conservative assumption. It is conservative because the Project is modeling against 24-hour and annual air quality standards and assuming that the Project will complete all offshore construction within a one-year timeframe maximizes the potential 24-hour and annual emission rates. The construction schedule is displayed in Figure 3-2.

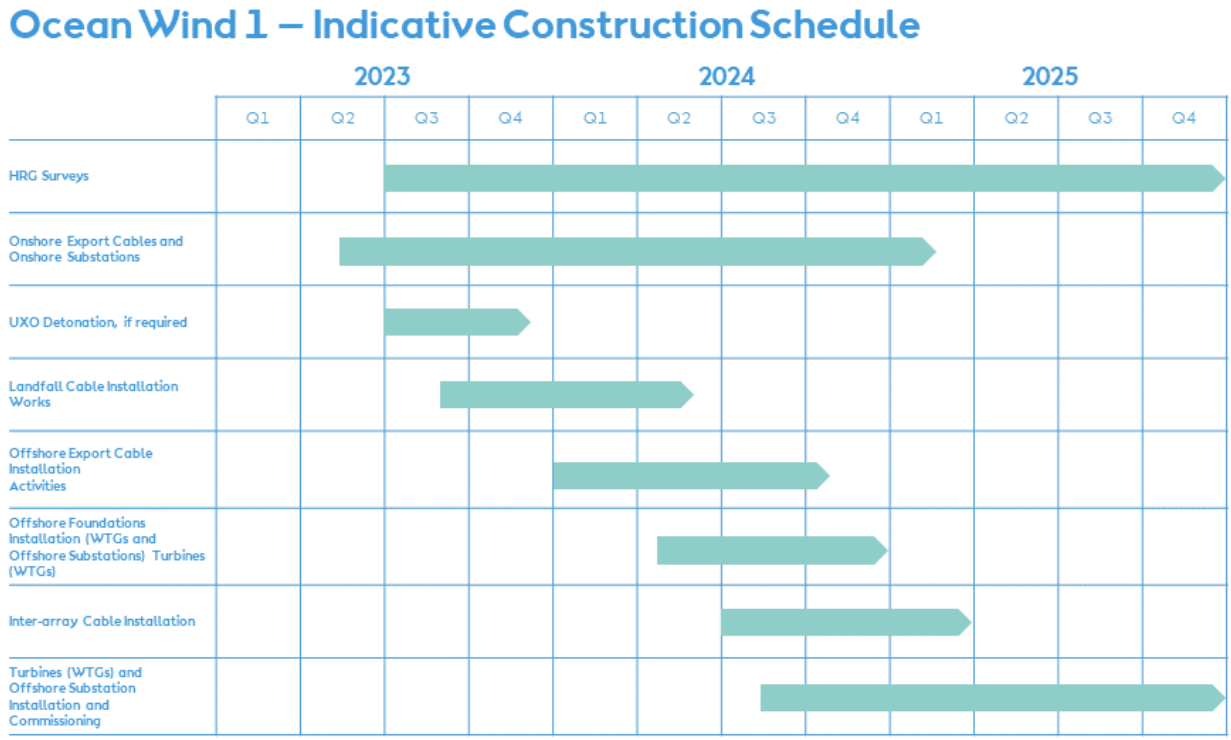


Figure 3-2. Indicative Construction Schedule.

4. EPA and NJDEP Comment on Modeling Protocol and Ocean Wind Responses

This section presents comments from EPA Region 2 on the Ocean Wind Modeling Protocol dated November 12, 2021. The EPA Region 2 modeling comments are dated February 16, 2022. EPA's comments are provided below along with Ocean Wind's response to each comment.

<u>Meteorological Data</u>

EPA Comment 1

As stated above the protocol proposes to use 5 years of meteorological measurements (2015-1019) taken at the National Weather Service's (NWS) Virginia Beach Buoy for overwater surface conditions, the NWS in Atlantic City for coast effects, and the NWS site in Brookhaven for the upper air parameters. Given the reasons below, EPA does not find that the data is representative of the project area. The Virginia Beach buoy is 175 km away and its representativeness is questionable. However, it also does not meet EPA's minimum data capture criteria of 90% data capture per quarter for each parameter: in this case most notably the relative humidity parameters. The Brookhaven upper air data is measured from an on land location. Therefore, it is not representative of the overwater environment. In particular, the mixing heights overwater would not be as variable on a daily basis or as high as overland.

If pursuing measured observations, it should be noted that other [Offshore and Coastal Dispersion Model (OCD)] windfarm applications have proposed using the mechanical mixing heights generated by AERMET and assumed a minimum of 25 meters as a conservative surrogate to measured overwater mixing heights. Please let us know if you still prefer to use observed measured data for this project.

Ocean Wind Response 1

Ocean Wind proposes to use three years of Weather Research and Forecasting Model (WRF) data, as described below in response to Comment 2.

EPA Comment 2

EPA's Guideline on Air Quality Modeling, Appendix W, recommends the use of either NWS, site specific measurements, or data obtained from use of prognostic models. These alternatives were discussed during the virtual meetings. We understand that you are now considering the use of the prognostic data and have contacted our Office of Air Quality Planning and Standards (OAQPS) for these data sets. As such we have the following recommendations:

Please follow the guidelines regarding the use of prognostic met data in Appendix W Section 8.4.5. Section 8.4.5.2 lists recommendations related to prognostic model evaluation and representativeness. The modeling data should be compared to NWS observational data or other comparable data to show that the data are adequately replicating the observed met conditions of the time periods modeled. Evaluation methods can include quantitative statistical methods using mean bias, mean error, or other appropriate statistical technique to determine adequacy and graphical analysis using spatial plots, time series, wind roses etc. AMET and METSTAT can be used to aid in the evaluations.

At least three consecutive years are required to be modeled and the most recent data is preferred. While this guidance is for use of MMIF with AERMOD, it can also be used to inform OCD applications as appropriate: Guidance on the Use of MMIF for AERMOD Applications

The following document can be used to inform approaches for evaluation of prognostic met data: Evaluation of Prognostic Meteorological Data in AERMOD Applications

Additionally, you may refer to the prognostic met data evaluation provided as part of the South Fork Wind LLC's permit application. If you need more examples of WRF/MMIF protocols and evaluations, we can provide some, but these are for overland applications.

Ocean Wind Response 2

Please refer to Appendix A of this Revised Modeling Protocol for an evaluation of the prognostic met data set.

Proposed Modeling Approaches

EPA Comment 3

The protocol includes discussion on the 24 hour and annual Class I increments only. Perhaps this is because of the premise that the increment was the threshold for the 'no impact' determination. However, given that EPA is recommending the SILs as this criterion, the air quality analyses need to address Class I and Class II increments and all the applicable NAAQS including the 1-hour NO2 and 1-hour SO2 NAAQS if the exemption criteria cannot be met.

Ocean Wind Response 3

Please refer to Section 5 and Section 6 of this Revised Modeling Protocol for a discussion of applicable Class I increment, Class II increment and NAAQS.

EPA Comment 4

Please clarify if emissions that are not part of the OCS source will be modeled. For example, it is stated that none of the vessels associated with the horizontal directional drilling (HDD) installation at landfall or offshore export cable installations outside of the 25-mile radius are OCS sources. While these may not be OCS sources they are emitting and affecting the NAAQS and increment. Therefore, these emissions need to be assessed for the air quality demonstration.

Ocean Wind Response 4

Ocean Wind acknowledges that emission sources that are not considered part of the OCS source under 40 CFR Part 55 may impact NAAQS and or PSD increment. Ocean Wind suggests that these sources are more likely to impact NAAQS or PSD increment when they are located near other Project emission sources which are concentrated within the 25-nm radius air permit circle. Therefore, the Project will include emission sources associated with HDD installation at BL England and vessels associated with fisheries monitoring and marine mammal mitigation. Emissions from vessels associated with HDD at Oyster Creek and the offshore export cable route will not be included. Because these sources are a considerable distance from other modeled sources these emission sources are not likely to significantly contribute to the Project's predicted impacts at receptors in the Class I area or receptors in the nearfield.

EPA Comment 5

The protocol states that the offshore substations will be constructed in 24 hours. Please clarify this time period since this timeframe is out of range from other offshore substations.

Ocean Wind Response 5

The modeling protocol stated that 1-2 OSS or WTG foundations will be installed in a 24-hour time period. This modeling protocol clarifies that the monopile installation will be installed in a 24-hour time period and then the secondary steel installation, which is part of the foundation activity, will take place in the following 16-hour time period, to be followed by commissioning and potentially rock dumping in the next 6-12 hours. The modeling protocol does not state that OSS topside structures will be constructed in 24 hours. The vessels associated with OSS topside structures will be included in both the annual modeling and the short-term modeling.

EPA Comment 6

Tables 4-3 and 4-4 present grouped emissions from various vessels. Will the protocol continue to group the vessels in this manner?

Ocean Wind Response 6

Ocean Wind does not propose to continue grouping vessels for the Class I increment modeling as described in the original Ocean Wind Modeling Protocol. The vessels will be modeled at separate locations, given the need to do so for the near-field NAAQS and PSD Class II increment modeling. Please refer to Section 6.3 for the proposed modeling methodology, including vessel layout, for the NAAQS analysis and PSD increment analysis.

EPA Comment 7

The protocol should address how the total emission will be characterized. In other words, will all the emission be assumed to occur in one location? Or will there be a temporally and spatially varying aspect

that will be considered? You may want to note that the OCD model has the capability of accounting for this variability. In either case, the full meteorological set would need to be used to capture the complete dispersion at all locations over time rather than the proposed month of August.

Ocean Wind Response 7

In the Ocean Wind Modeling Protocol dated November 12, 2021, the Class I increment analysis proposed analyzing emissions over the entire 3-year meteorological period. The reference to the month of August was to explain that this was the projected timeframe when the most activities could be occurring at the same time. Not all construction activities are proposed to overlap in time during the one-year offshore construction period. As such, an analysis was undertaken to determine when the highest emissions would occur because of overlapping construction activities; this happened to be in the month of August. Then only those activities which occur during the month of August would have been included in the short-term modeling (all activities would have been included in the annual modeling).

However, this Revised Modeling Protocol proposes to include emission sources associated with all construction activities for both the short-term and annual modeling periods, as a conservative assumption. Please see Section 6.3 of this Revised Modeling Protocol for discussion on the proposed modeling methodology with respect to space and time variations.

EPA Comment 8

The protocol needs to address impacts due to both the commissioning and decommissioning phase.

Ocean Wind Response 8

The modeling protocol included impacts due to commissioning. Emissions resulting from commissioning activities, which is generator use on WTGs and OSS, were included in the modeling for annual averaging periods. The generators for commissioning are not included in the short-term modeling because the commissioning activities will not overlap the construction of the offshore components.

The air permit application is not addressing the decommissioning phase as marine vessel technology is anticipated to significantly change over the next 35 years. Additionally, a conservative assumption is that the decommissioning process will resemble the construction process. Therefore, if the Project demonstrates that the modeled impacts from the construction and commissioning phase will not cause or contribute to an exceedance of the NAAQS or PSD Class II increment, then it is reasonable to assume that the decommissioning phase will not cause or contribute to an exceedance of the NAAQS or PSD Class II increment.

EPA Comment 9

The protocol states that the total emission will be assumed to occur in 1 year. This is conservative and therefore acceptable.

Ocean Wind Response 9

Ocean Wind acknowledges and concurs.

EPA Comment 10

Impacts from the testing and maintenance of the emergency generators and fire pumps need to be included unless they meet criteria provided in the March 2011 EPA clarification memo on intermittent sources.

Ocean Wind Response 10

Testing and maintenance of the generators was not included in the modeling conducted for the short-term standards (24-hr or shorter) because the generators used during commissioning will not be operated within the same 24-hour period as the other modeled construction activities. Emissions from the generators are included in the annual modeling. Note there are no emergency generators associated with the construction and commissioning phase, only non-emergency generators.

EPA Comment 11

The increment consumption or expansion of existing sources was shown qualitatively by plotting ambient data over time for NO2, PM10, PM2.5, and SO2. EPA recommends this to be a modeling demonstration. Ambient monitors are not the best measure of the increment since they measure concentrations from non-increment consuming/expanding sources as well and only at their locations. However, if you prefer you may include the ambient data to provide supplemental support of the trends on a qualitative basis provided the ambient data is representative of both the baseline concentrations and of the current concentrations.

Regardless of the increment analysis, preconstruction ambient air monitoring is a requirement under the Clean Air Act to evaluate the status of the air quality with respect to the NAAQS. Existing data may be used as a surrogate to installing site-specific monitors provided the data is representative, current, and meets QA/QC requirements (Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD) EPA-450/4-87-007 May 1987). The protocol should include 3 years of measured ambient data that is representative of the background concentrations.

Ocean Wind Response 11

Please see the analysis of existing ambient air monitoring and a request for an exemption from pre-construction monitoring contained in Appendix B.

EPA Comment 12

The protocol states that the NO2 modeling will use the Tier 2 modeling method. However, it further states that an ambient ratio of 0.9 will be used to convert all NOx to NO2 impacts. This may be overly conservative. The Tier 2 method, namely the ARM2, applies a polynomial equation to obtain the ambient ratios. A default minimum ratio is 0.5 and the maximum default is 0.9. This equation should be used to obtain NO2 impacts using Tier 2. See section 4.2.3.4 of Appendix W. We understand that the protocol would be revised in case Tier 3 (e.g., PVMRM) is requested.

Ocean Wind Response 12

This revised modeling protocol is requesting a Tier 3 approach to NO_2 modeling. See Section 6.6.1.

EPA Comment 13

When modeling for PM2.5, the protocol proposes to use the EPA Model Emission Rate for Precursors (MERPs) guidance to determine secondary formation. Please note that EPA recommends that PM2.5 precursors include both NOx and SO2 regardless of their applicability threshold per EPA's draft O3 and PM2.5 Permit Modeling Guidance dated September 20, 2021.

Ocean Wind Response 13

Ocean Wind acknowledges and concurs.

EPA Comment 14

Currently OCD limits the number of significant point sources to 25. Since each individual turbine may have to be modeled as a point source, you may look into increasing the array size in the code to handle more

sources. In doing so, please ensure that nothing else in the science formulation is inadvertently changed. If this path is pursued, please include a consequence analysis to show with a limited number of sources that both sets of code (original and updated) give the same results. And please submit the updated code.

Ocean Wind Response 14

While OCD limits the number of significant point sources to 25, the model allows up to 8,500 point sources. Using the methodology proposed in this Revised Modeling Protocol, the number of points sources will be below 8,500 for each pollutant and averaging period.

EPA Comment 15

Please be advised that if the construction, or operation and maintenance emissions overlap in time with other proposed projects nearby, that a cumulative modeling analysis may be necessary to account for the simultaneous impacts.

Ocean Wind Response 15

Ocean Wind acknowledges and asks EPA to notify the Project if such analysis is necessary.

EPA Comment 16

Please confirm with NJDEP whether modeling for minor sources as the operation and maintenance phase of the project is required under their regulations.

Ocean Wind Response 16

Ocean Wind corresponded with NJDEP to confirm that modeling for the operations and maintenance (O&M) phase of the Project is not required. Ocean Wind sent the following email to Mr. Greg John of NJDEP on April 5, 2022:

> *The basis for not proposing to model O&M phase emissions is that potential emissions in the O&M phase do not exceed PSD major source or NJDEP major source thresholds. Additionally, the net emission increase of the Project is not significant, as defined in N.J.A.C. 7:27-18.7, therefore the Project is not required to submit an air quality impact analysis per N.J.A.C. 7:27-8.5(a)(2). Finally, the Project is conducting modeling for the construction and commissioning phase of the Project, which have much greater emissions (appx. 130x more than the O&M phase) from similar sources (primarily vessel engines), so it is very unlikely that any modeling conducted for the O&M phase would result in higher modeled impacts than the construction and commissioning phase. For these reasons, the Project is not planning to conduct modeling for the O&M phase.*

Ocean Wind received the following response from Mr. Greg John of NJDEP on April 7, 2022:

> *Your explanation for not including certain sources in the modeling evaluation is acceptable. I suggest that you include it in the modeling protocol with specifics and references to the regulations that support your determinations.*
>
> *However, applicability of modeling is not just my decision. Please be aware that U.S. EPA and the DEP's Bureau of Stationary Sources are also involved in this determination. In other words, some of the modeling proposals/decisions may change after a closer look at the permit application(s).*

EPA Comment 17

Typo on Table 3-6: The lead NAAQS is 0.15 ug/m3 rather than 1.5 ug/m3. The ozone NAAQS of 0.07 ppm converts to 137 ug/m3 under STP (defined in part 50 as 75 degree C and 1 atm).

Ocean Wind Response 17

Ocean Wind acknowledges and concurs.

EPA Comment 18

To assist in the protocol development, we also recommend referring to the Air Quality Checklist on EPA SCRAM website.

Ocean Wind Response 18

Ocean Wind has generally included the items in the checklist, to the extent applicable. For example, one checklist item is "Plant layout on a topographic map . . ." which is not applicable to this over water development.

EPA Comment 19

Lastly the air modeling analysis should address Environmental Justice and impacts on Climate Change.

Ocean Wind Response 19

The Project addressed Environmental Justice in the air permit application submitted March 29, 2022. The Project will revise the Environmental Justice section of the revised air permit application anticipated to be submitted in July 2022, and expand it to include impacts on climate change (which are expected to be positive), in accordance with the following Executive Orders:

- Executive Order 13985, Advancing Racial Equity and Support for Underserved Communities Through the Federal Government, January 20, 2021
- Executive Order 14008, Tackling the Climate Crisis at Home and Abroad, January 27, 2021:
- Executive Order 13990, Protecting Public Health and the Environment and Restoring Science To Tackle the Climate Crisis, January 20, 2021

Local predicted impacts of criteria air pollutants will be discussed in the air quality report with respect to any EJ community areas identified in the nearest onshore areas that may show non-negligible predicted air pollutant concentrations.

5. Regulatory Requirements

This section describes additional regulatory requirements that apply to the Project due to comments from EPA and NJDEP on the Ocean Wind Modeling Protocol submitted on November 18, 2021. The comments were received February 16, 2022. The additional regulatory requirements are a result of not qualifying for an exemption in the Prevention of Significant Deterioration (PSD) rules for temporary sources which demonstrate they do not impact a Class I area or an area where increment is known to be violated. The resulting applicable additional modeling requirements are 40 CFR 52.21(k), (m) and (o).

5.1 Source Impact Analysis

The Project must conduct a source impact analysis for each regulated NSR pollutant with a potential to emit in the construction and commissioning phase equal to or exceeding the significant emission rate threshold in 40 CFR § 52.21(b)(23) for which there is a NAAQS and/or PSD increment (Class I and Class II). Based on the emission estimates provided in Table 3-1, the Project must conduct a source impact analysis for PM_{10}, $PM_{2.5}$, NO_2 and CO. Although PM and CO_2e also trigger PSD review, there is no applicable NAAQS or PSD increment for these pollutants, so they don't require analysis through air quality modeling. Note that the emission estimates presented in this table are different than those presented in the OCS air permit application dated

March 29, 2021. The Project will submit a revised air permit application with updated air emission estimates that match the values provided in Table 3-1.

Table 5-1. WTA Potential-to-Emit During Construction.

Pollutant	Potential to Emit	Significant Emission Rate	PSD Review Required [1]
	tons/year	tons/year	
Carbon Monoxide (CO)	601.9	100	**YES**
Nitrogen Oxides (NO_x)	1,714	40	**YES** [1]
Particulate Matter	59.4	25	**YES**
Particulate Matter (PM_{10})	55.5	15	**YES**
Particulate Matter ($PM_{2.5}$)	54.1	10	**YES**
Sulfur Dioxide (SO_2)	6.9	40	No
Volatile Organic Compounds (VOC)	80.0	40	No [1]
Sulfuric Acid (H_2SO_4)	0.30	7	No
Lead (Pb)	0.009	0.6	No
GHG (as CO_2e) [2]	139,891	75,000	**YES**

[1] In accordance with 40 CFR 52.21(i)(2), the substantive PSD requirements [paragraphs (j) through (r)] shall not apply to a major stationary source with respect to a particular pollutant if the source is located in an area designated as nonattainment under section 107 of the Act. Such areas are subject to nonattainment new source review (NNSR) if emissions are major under that program. Because the corresponding onshore area (COA) is designated nonattainment for ozone, 40 CFR 52.21 paragraphs (j) through (r) do not apply to NO_x or VOC as ozone precursor emissions. However, NO_x emissions need to be treated as both PSD-regulated emissions for purposes of NO_2 impacts, and as NNSR-regulated emissions for purposes of ozone impacts.

[2] The significant emission rate for GHG applies to sources subject to PSD for another pollutant, also known as "anyways sources".

5.1.1 Applicable Ambient Air Standards

The NAAQS for which the Project must demonstrate compliance are presented in Table 3-2.

Table 5-2. NAAQS.

Pollutant	Primary	Secondary
CO		
1-Hour Average [a]	35 parts per million (ppm) [b]	NA
8-Hour Average [a]	9 ppm [b]	NA
NO_2		
1-Hour Average [c]	100 ppb (188 µg/m^3)	NA
Annual Average	0.053 ppm (100 µg/m^3)	0.053 ppm (100 µg/m^3)
PM_{10}		
24-Hour Average [a]	150 µg/m^3	150 µg/m^3
$PM_{2.5}$		
24-Hour Average [d]	35 µg/m^3	35 µg/m^3
Annual Average	12 µg/m^3	15 µg/m^3

[a] Not to be exceeded more than once per year.
[b] Equivalent to 40 and 10 milligrams/m^3 for the 1-hour and 8-hour averages, respectively.
[c] Attained when the 98th percentile value of daily maximum 1-hour concentrations, averaged over a 3-year period is less than or equal to the standard.
[d] Attained when the 98th percentile value, averaged over a 3-year period, is less than or equal to the standard.

The Class I and Class II impact analysis will be conducted for pollutants subject to PSD review for which there are Class I and Class II increment limits. The pollutants for which modeling will be conducted are NO_2, PM_{10},

and $PM_{2.5}$. Table 3-3 presents the applicable Class I and Class II PSD increments as established in 40 CFR 51.166(c)(1).

Table 5-3. PSD Increment – Class I and Class II.

Pollutant	Class I	Class II
NO_2		
Annual Average [a]	2.5 µg/m^3	25 µg/m^3
PM_{10}		
24-Hour Average [b]	8 µg/m^3	30 µg/m^3
Annual Average [a]	4 µg/m^3	17 µg/m^3
$PM_{2.5}$		
24-Hour Average [b]	2 µg/m^3	9 µg/m^3
Annual Average [a]	1 µg/m^3	4 µg/m^3

[a] The form of the standard is the annual arithmetic mean.

[b] The 24-hour increment may be exceeded during one 24-hour period per year at any one location. In other words, the highest second highest (H2H) 24-hour concentration is compared to the increment.

5.1.2 Secondary Formation of $PM_{2.5}$ and PM_{10}

The $PM_{2.5}$ and PM_{10} Class I and Class II PSD increment analysis will consider both primary (modeled) impacts as well as the secondary formation of $PM_{2.5}$ and PM_{10} for both the annual and 24-hour averaging periods. Primary $PM_{2.5}$ impacts will be predicted by the OCD model. The secondary formation of $PM_{2.5}$ will be estimated in accordance with EPA memo *Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program*, dated April 30, 2019. The Project proposes the use of a Tier 1 demonstration tool. Tier 1 involves the use of appropriate and technically credible relationships between emissions and ambient impacts developed from existing modeling studies that relate precursor emissions and secondary pollutant impacts from specific or hypothetical modeled sources. The EPA guidance memo refers to five factors to consider when determining whether existing modeled sources may be considered representative of the project. The five factors are:

1. Nearby sources of emissions
2. Ambient concentrations of relevant pollutants
3. Nearby topography and rural/urban nature of the area
4. Meteorology, including temperature, humidity, and wind direction
5. Source characteristics (stack height, emission rate)

The referenced MERPs guidance includes four hypothetical modelled sources surrounding the Ocean Wind project area that could be used to represent the Project. The four modeled sources are at the following locations

- Kent County, Delaware;
- Chester County, Pennsylvania;
- Warren County, New Jersey; and
- Bronx County, New York.

Each of these sources was evaluated for representativeness according to the five factors listed above. It was determined that the Kent, DE site is the most representative of the Project, based on the ambient concentrations of SO_2, NO_x, and NH_3, topography, meteorology, and source characteristics. Kent, DE is also

the most conservative among the four options as it results in the highest predicted secondary formation of $PM_{2.5}$.

In accordance with NJDEP Modeling Guidance, which states, "For sources modeling PM_{10}, sulfate and nitrate formed during plume transport to the Class I area should be added to the predicted impact due to direct PM_{10} emissions", the secondary formation of PM_{10} will be added to the primary impacts predicted by OCD. The secondary formation of PM_{10} will be estimated through the Tier 1 demonstration tool referenced above. The results of the MERPs analysis for $PM_{2.5}$ described in Section 5.1.1. will be used to represent the secondary formation of PM_{10}.

5.1.3 Significant Impact Levels (SILs)

EPA has established significant impact levels (SILs) as a compliance demonstration tool to show whether a proposed PSD source will cause or contribute to a violation of the NAAQS or PSD increments. SILs are also used to determine which pollutants/averaging periods require a refined air quality modeling analysis. EPA has established SILs for some of the NAAQS and PSD increments. The SILS for pollutants which require analysis for the Project are presented in Table 3-4.

Table 3-4. SILs.

Pollutant	Class I	NAAQS/Class II
CO		
1-Hour Average	NA	2000 µg/m^3
8-Hour Average	NA	500 µg/m^3
NO_2		
1-Hour Average	NA	7.5 µg/m^3
Annual Average	0.1[a] µg/m^3	1 µg/m^3
PM_{10}		
24-Hour Average	0.3[a] µg/m^3	5 µg/m^3
Annual Average	0.2[a] µg/m^3	1 µg/m^3
$PM_{2.5}$		
24-Hour Average	0.27 µg/m^3	1.2 µg/m^3
Annual Average	0.05 µg/m^3	0.2 µg/m^3

[a] These SILs were not officially promulgated but have been "used in practice" (Technical Support Document for AMS/EPA Regulatory Model (AERMOD)-Based Assessments of Long-Range Transport Impacts for Primary Pollutants, Publication EPA-454/B-15-003 (page 9), July 2015).

Direct modeled impacts will be added to secondary impacts and the total impact will be compared against the Significant Impact Levels (SILs) presented in EPA guidance. If the combined primary and secondary impact of a pollutant exceeds the applicable SIL, then the facility will be modeled with any appropriate nearby facilities, as described in the next section. The combined primary impact, including the impact from nearby facilities, and secondary impact will be added to the background concentration. This total will be compared against the NAAQS presented in Table 3-2.

5.1.4 Cumulative Impact Analysis

The combined primary impact (modeled impacts from the Project and appropriate nearby facilities) will be added to the secondary impact and the background concentration. This total will be compared against the PSD Class I increments presented in Table 3-3. To determine which nearby facilities should be included in the cumulative impact analysis, the Project will determine the significant impact area (SIA) for each pollutant and averaging period where the Project exceeded the SIL. Onshore facilities within the SIA which are significant (over 50 tons per year of the relevant pollutant) and new (have been permitted but operating for less than three

years) and are inside the SIA will be included in the cumulative impact analysis. This is because, as detailed below, ambient monitoring data shows that PSD increment has been expanding in southern New Jersey, meaning that background concentrations have been decreasing since the baseline dates for increment tracking of the applicable pollutants. Facilities that are new and operating less than 3 years may not yet be reflected in the monitored ambient concentrations.

A review of ambient monitoring data obtained from monitors designated as Federal Reference Method (FRM) has shown that for the pollutants of interest ($PM_{2.5}$, PM_{10}, and NO_2) for PSD increment purposes, the concentration trends in Brigantine Wilderness Class I area and the surrounding Class II areas have been generally downward since the respective increment baseline dates for each pollutant. Thus, the changes in other emissions sources in the region (decreased emissions) have been expanding the available increments, rather than consuming them. These data are presented in this section to demonstrate that, apart from any newer (past 3 years) sources that may have recently started operation, there is no cumulative increment consumption that would add to the temporary project-related increment consumption.

The PSD increment baseline dates for the pollutants of interest are as follows for the project region (Atlantic County):

- NO_2: February 8, 1988
- PM_{10}: November 17, 1988
- $PM_{2.5}$: April 16, 2014

As shown in Figures 5-1 through 5-3 below, the monitored NO_2, $PM_{2.5}$ and PM_{10} concentrations, respectively, for Brigantine and the surrounding region are generally trending downward for the applicable increment tracking periods for each pollutant. As explained below, there are some minor exceptions to the general downward trends for some of the pollutants, but the overall downward trend is apparent from these figures.

There are no NO_2 monitoring data from within the Brigantine Class I area or in Atlantic County. The nearest site with nearly complete NO_2 data going back almost to the baseline date is from a site in the southern Philadelphia metro area, in the city of Chester, PA, approximately 55 miles NW of Brigantine. That site has data from 1991 through 2020, and as shown in Figure 5-1, the data clearly show that annual average NO_2 concentration has decreased by more than a factor of two over that period. Some of the decrease is likely due to nitrogen oxides (NO_x) emission controls imposed on power plants and industrial sources in the region, and a significant portion of the decrease in the past one to two decades is likely due to EPA emission limitations applied to new onroad and nonroad vehicles. Given the regional nature of the emissions decreases, it is expected that NO_2 concentrations have also decreased at Brigantine over the period since the Class I increment baseline date. Therefore, there has not been NO_2 increment consumption, but rather, NO_2 increment expansion in the region.

$PM_{2.5}$ monitoring data are available in Brigantine, near the visitor center for the wildlife refuge. These data, shown in Figure 5-2, show a general downward trend, with the main exception being the 2nd highest 24-hour concentration for 2019. That value increased from prior years and occurred on February 2, 2019. That value may have been influenced by a large house fire that occurred in the Philadelphia area early that morning. The Atlantic City airport reported haze early that morning and winds were from the northwest during that time, which would have brought the plume over the Brigantine area. Thus, in terms of routine (non-accidental) emissions, it is expected that there has been $PM_{2.5}$ increment expansion, rather than $PM_{2.5}$ increment consumption, during the period from the baseline date (in April 2014) to the present. Note that data for 2020 from the FRM monitor in Brigantine does not satisfy minimum EPA completeness criteria; however, available data suggests that the 24-hour 2nd high for 2020 would be around 11 ug/m^3 which continues the downward trend from years before 2019.

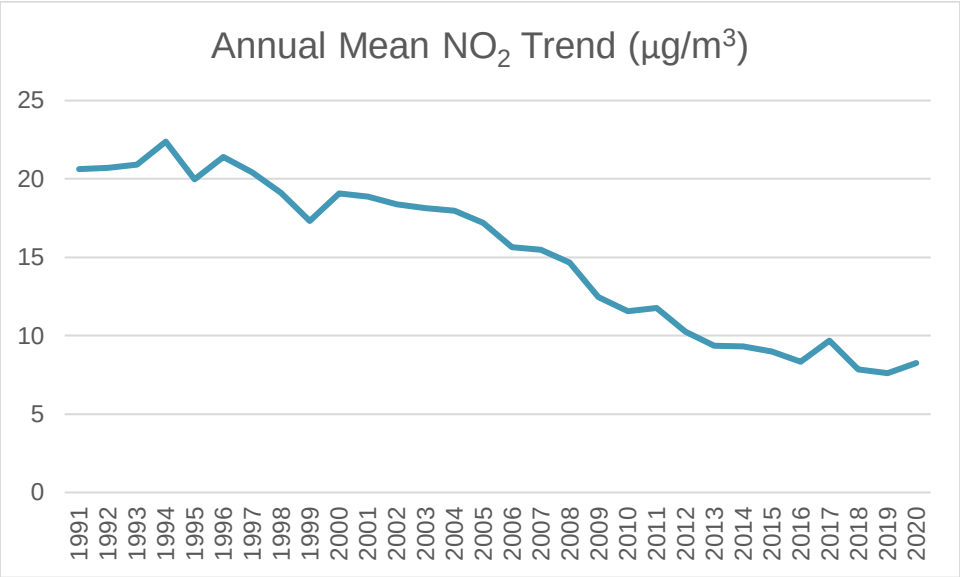


Figure 5-1. Annual Average NO_2 Concentrations - Chester, PA.

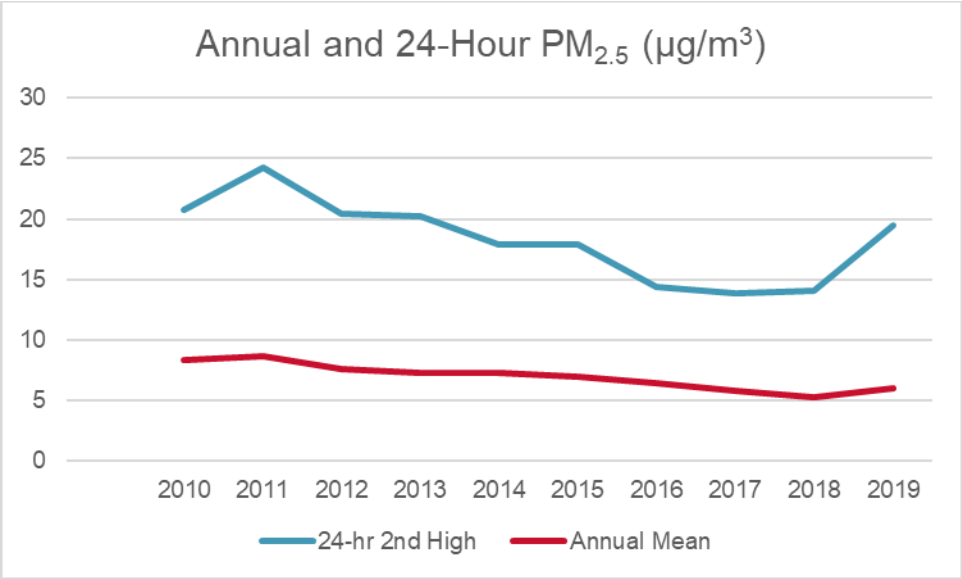


Figure 5-2. Annual Average and 24-Hour (2nd High) $PM_{2.5}$ Concentrations – Brigantine, NJ.

The PM_{10} data are from downtown Atlantic City, as there have been no PM_{10} data collected in Brigantine since the 11/17/1988 baseline date. The PM_{10} monitoring in Atlantic City was done at one location from 1990-1996, and moved to another location from 1997-2001, and then to a third location from 2002-2010, after which PM_{10} monitoring ceased in Atlantic City. The three PM_{10} monitoring locations are all in the business district of the city, within approximately a half mile of each other. The 24-hour (2nd high each year) PM_{10} data for the two decades after the baseline date show a general downward trend, although there was an upward spike in concentrations in 2008-2009. A review of historical Google Earth images for Atlantic City indicates that there was major demolition involving several structures only a couple of blocks south of the monitor location during that period. New infrastructure has now been put in place on these parcels. Thus, it appears that the spike in concentrations those years was temporary and would not change the conclusion of an overall downward trend

in PM_{10} concentrations in Atlantic City, and presumably in the region as a whole. Thus, with respect to PM_{10}, it is expected that PSD increment has expanded at Brigantine and in the surrounding region, rather than being consumed. This is expected, as emission controls on PM_{10} and precursor pollutant emissions over this period should be reducing the PM_{10} impact regionwide, as shown by the monitoring data.

Understanding that the monitored concentration trends are downward for the applicable pollutants and given that there are no new large emissions sources near Brigantine and the surrounding region, it is apparent that Class I and Class II allowable increments have expanded (rather than being consumed) in the region, subsequent to the baseline dates for each affected pollutant. This means that there is no need to attempt a cumulative impact dispersion analysis considering other sources, given the local and regional air monitoring data show that there has been no increment consumption, but rather, increment expansion, after the respective baseline dates.

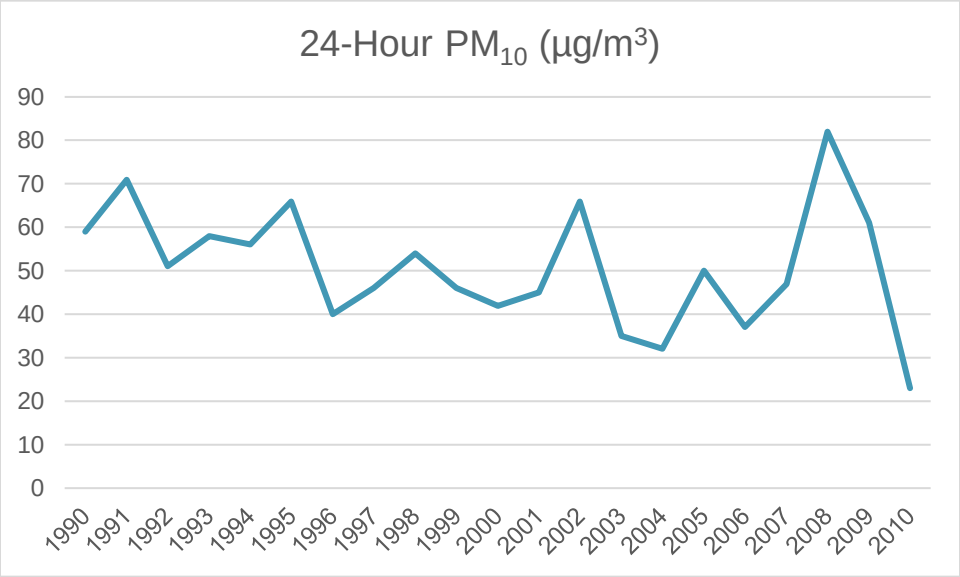


Figure 5-3. 24-Hour (2nd High) PM_{10} Concentrations – Atlantic City, NJ.

5.2 Air Quality Analysis

PSD rule 40 CFR § 52.21(m)(1) requires that applicants establish existing air quality at the Project site for each pollutant it has the potential to emit in a significant amount. The Project has developed for EPA review and approval a pre-application air quality analysis. It is included in Appendix B.

5.3 Additional Impact Analysis

An additional impact analysis is required by 40 CFR § 52.21(o). Per NJDEP modeling guidance, screening for SO_2 at the 3-hour and 12-month intervals is required to protect commercially grown crops in New Jersey that are classified as sensitive vegetation. The Project will model SO_2 emissions for the averaging periods and standards presented in Table 5-5.

Table 5-5. Soils and Vegetation Screening Values.

Pollutant	Screening Value [a]
SO_2	
3-Hour Average	786 µg/m^3

Pollutant	Screening Value [a]
SO_2	
Annual Average	18 µg/m^3

[a] The screening value is based on the sensitive vegetation screening value in the USEPA document 450/2-81-078. This value should be compared to the maximum average ambient air concentration plus background for the specified averaging period.

If the emission impact is greater than the screening values presented in Table 5-5, the Project will follow USEPA guidance in the *New Source Review Workshop Manual (USEPA 1990)* to assess potential impacts on vegetation, as described in NJDEP modeling guidance.

5.4 Nonattainment New Source Review (NNSR)

40 CFR Part 55 requires that for an OCS source within 25 miles of a state's seaward boundary, the OCS source must comply with the state or local air emissions requirements of the COA. Therefore, although the Project is not located onshore, it must comply with the Nonattainment New Source Review (NNSR) rules of the presumed COA, New Jersey.

Atlantic County is located within the Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE nonattainment area that is currently classified as marginal nonattainment for the newest ozone standard, the 2015 8-hour standard of 0.07 parts per million (ppm), which came into effect as of December 28, 2015. Initial attainment designations for the 2015 standard became effective January 16, 2018. Previously, the Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE nonattainment area was classified as moderate nonattainment for ozone under the 1997 8-hour standard of 0.08 ppm. This standard was replaced, effective in 2008, with an 8-hour standard of 0.075 ppm. The 1997 8-hour standard was officially revoked on April 6, 2015. Under the 2008 8-hour ozone standard, the Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE nonattainment area is designated marginal nonattainment, the same as its classification under the stricter 2015 standard.

Although the Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE nonattainment area is classified as nonattainment, ozone pollution has steadily been decreasing in this area since 1997, when it was classified as moderate nonattainment. Attainment designations for Atlantic County are summarized in Table 5-6. Pb, NO_2, PM (including $PM_{2.5}$ and PM_{10}) and SO_2 are not included in the table since the Project is not projected to result in emissions in a nonattainment area for these pollutants.

Table 5-6. Nonattainment Status of Counties Nearest Project.

	Ozone			
	2015 8-Hr Std	2008 8-Hr Std	1997 8-Hr Std	1979 1-Hr Std
Status of NAAQS	Current	Replaced by 2015 std	Revoked	Revoked
Philadelphia-Wilmington-Atlantic City	Marginal NA	Marginal NA	Moderate NA	--
Atlantic City	--	--	--	Moderate NA
New York-N. New Jersey-Long Island	Project Emissions will not Occur in this Designated Area	Project Emissions will not Occur in this Designated Area	Project Emissions will not Occur in this Designated Area	Severe NA

New Jersey regulations for Nonattainment New Source Review (NNSR) are found in N.J.A.C. 7:27-18 Control and Prohibition of Air Pollution from New or Altered Source Affecting Ambient Air Quality (Emission Offset Rules). An application must comply with this subchapter if it meets the following criteria:

1. the facility has the potential to emit any of the air contaminants equal to or exceeding the thresholds listed in Table 5-7; and
2. any allowable emissions proposed in the application would result in a significant net emission increase of any contaminant listed in Table 3 of N.J.A.C. 7:27-18.7, shown in Table 5-8; and
3. the facility is located at an area which is nonattainment for the respective criteria pollutant(s) corresponding to that air contaminant.

The COA of the Project is designated nonattainment for ozone. As shown in Tables 5-7 and Table 5-8, the Project exceeds the listed significant net emission increase thresholds for NO_x and VOC (as well as PM_{10}, $PM_{2.5}$ and CO). Therefore, the Project is subject to NNSR for the ozone precursor pollutants NO_x and VOC. However, pursuant to N.J.A.C. 7:27-18.4(a), ozone is excluded from the requirement to conduct an air quality impact analysis. Therefore, there is no required air quality impact analysis specific to NNSR requirements.

Table 5-7. NJDEP Major Facility Thresholds.

Air Contaminant	Potential to Emit tons/year	Threshold tons/year	Exceeds Threshold?
SO_2	6.9	100	No
SO_2 (as $PM_{2.5}$ precursor)	6.9	100	No
TSP	59.4	100	No
PM_{10}	55.5	100	No
$PM_{2.5}$	54.1	100	No
CO	601.9	100	**YES**
NO_x	1,714	25	**YES**
NO_x (as $PM_{2.5}$ precursor)	1,714	100	**YES**
VOC	80.0	25	**YES**
Pb	0.009	10	No

Table 5-8. NJDEP Significant New Emission Increases.

Air Contaminant	Potential to Emit tons/year	Threshold tons/year	Exceeds Threshold?
SO_2	6.9	40	No
SO_2 (as $PM_{2.5}$ precursor)	6.9	40	No
TSP	59.4	25	**YES**
PM_{10}	55.5	15	**YES**
$PM_{2.5}$	54.1	10	**YES**
NO_x	601.9	25	**YES**
NO_x (as $PM_{2.5}$ precursor)	1,714	40	**YES**
CO	1,714	100	**YES**
Pb	80.0	0.6	No
VOC	0.009	25	**YES**

5.5 State Requirements

Health risk assessments are required by NJDEP for all source operations that emit air toxics above its reporting thresholds for which the Department has designated an inhalation unit risk factor (URF) or a reference concentration (RfC). In certain cases, the Department may require submittal of an air quality modeling and risk

assessment protocol. It is assumed that the Project will not be subject to such modeling, because there are no sensitive receptors with respect to health risk within many miles of the project. Furthermore, most emissions will occur during construction, which is temporary, and the greatest concern with health risks is due to long term (e.g., lifetime) pollutant exposures.

6. Proposed Class I Impact, Source Impact and Additional Impact Analysis

The Project has made a good-faith effort to estimate emissions and model Project impacts using conservative assumptions where aspects of the construction activities are uncertain. For example, the Project assumes the most aggressive construction schedule when determining annual and short-term emission rates to be modeled. Additionally, where multiple port options exist for a construction activity, the longest route was selected. Specific vessels are dependent upon global availability of the unique vessels required to construct large offshore wind farms. Therefore, the specific vessel type cannot be known until construction is underway. The Project has assumed worst-case vessel characteristics (e.g., engine size, duration of use) in an effort to model a conservative emissions scenario. Final construction vessels and activity schedules may differ as the Project construction effort is continually refined and optimized

6.1 Meteorological Data

Please refer to Appendix A for a discussion on the proposed source and preparation method of meteorological data and the representativeness of these data to the WTA. The proposed WRF meteorological dataset will span 2018-2020 and will likely provide all combinations of meteorological conditions that would give rise to worst-case modeled impacts.

6.2 Shoreline Geometry and Fumigation

Shoreline data required by the OCD model will be prepared using MAKEGEO, a shoreline data processor adapted from the TOPO-MAP program. The TOPO-MAP program was developed by the Minerals Management Service to automate the generation of shoreline data. The Project will use *east.bin*, which is a MAKEGEO default binary shoreline database for the Atlantic Coast. MAKEGEO requires the user to define the model domain by entering coordinates for the four corners of the Project area. The following coordinates will be used to define the Project area:

- Minimum Latitude – 38.5 N
- Maximum Latitude – 40.0 N
- Minimum Longitude – 73.5 W
- Maximum Longitude – 76.0 W

The OCD model includes algorithms that account for overwater plume transport and dispersion, as well as changes that take place as the plume crosses the shoreline. The algorithms account for two distinct boundary layer environments (over water and over land), which in turns enables OCD to account for plume fumigation. The OCD User's Guide[1] describes plume fumigation as vertical plume dispersion after the plume passes through the thermal internal boundary layer, which is created by the interaction of the over land and over water boundary layer environments. The Project will account for plume fumigation using OCD's plume fumigation algorithms.

[1] *User's Guide for Offshore and Coastal Dispersion (OCD) Model, Version 5*. November 1997. Retrieved from https://gaftp.epa.gov/Air/aqmg/SCRAM/models/preferred/ocd/ocdug.pdf.

6.3 Downwash

When jack-up vessels are jacked up, the jack-up vessel platforms and structures on top of them can cause downwash similar to downwash for on-land stationary sources affected wakes from nearby structures. To account for the platform downwash from jack-up vessels, the following model inputs will be included for each jack-up vessel:

- Elevation of platform base (m) – height of the top of the vessel deck, relative to the sea surface (includes thickness of vessel deck)
- Building height (m) – height of largest structure on vessel deck, relative to top of vessel deck
- Building width (m) – diameter for round structures and diagonal length for rectangular structures to represent the maximum building width that could influence downwash

Ocean Wind does not know the specific jack-up vessels that will be used for construction at the time of submittal of this modeling protocol. Therefore, a representative vessel was used to determine the above parameters for each jack-up rig. There will not be a platform structure in place for the OSS until the very end of the OSS installation activity (which will have lower emissions and therefore was not modeled as a worst-case emissions scenario), so no platform downwash was included to represent the OSSs construction emissions.

6.4 Facility Layout and Emission Points

Ocean Wind proposes to use the same facility layout and set of emissions points for the NAAQS analysis and the PSD Class II and Class I increment analysis and the additional impact analysis. The set of emission points for the annual standards will include all emission sources associated with the construction and commissioning phase which are required to be included in the OCS air permit application. The set of emission points for the annual standard will also include emission sources associated with the construction and commissioning phase which are not required to be included in the OCS air permit application but could impact NAAQS or increment, including vessels associated with HDD at BL England, fisheries monitoring, and marine mammal mitigation. The set of emission points for the short-term standards (24-hour and shorter) will include all emission points included in the modeling for the annual standard except for vessels that will not be operating during the same 24-hour period. Both the set of emission points for the annual standard and the set of emission points for the short-term standards are described in more detail in this section.

6.4.1 Annual Averaging Period

For the annual averaging period, the Project will model emissions from all anticipated vessels associated with construction of the WTGs, OSSs, array cables, interconnection cables, and offshore export cables. The Project will also model emissions from auxiliary equipment located on board vessels and temporary generators located on OSS and WTGs during commissioning. Annual emissions are based on projected durations of use for each individual vessel and piece of equipment. The Project will model one set of vessels for each construction activity:

- WTG and OSS foundation installation
- WTG construction
- OSS construction
- Array cable installation
- Offshore export cable installation
- HDD
- Transit
- Fisheries Monitoring and Marine Mammal Mitigation
- Commissioning Generators

The Project will conservatively assume that all emissions associated with construction and commissioning will be emitted from the one set of vessels. For example, instead of modeling vessels at each WTG location, the Project will model one set of vessels at a single WTG location to represent WTG construction. All the anticipated emissions from constructing all 98 WTGs will be modeled from the vessels at the single WTG location. The same procedure will be conducted for each construction activity identified above. The location of the set of vessels will be grouped in the same corner of the array area closest to the Class I area, as displayed in Figure 6-1.

Emissions from equipment that will be located on some of the vessels but powered independently from the vessel engines are also included in the model. The equipment will be modeled at the same location as the vessel on which it will be located but with its own exhaust characteristics.

The Project is making the following conservative assumptions:

- The Project will install a WTG foundation and construct a WTG at neighboring WTG locations.
- The Project will construct an OSS at the location nearest the two neighboring WTGs.
- All annual emissions from WTG commissioning activities will be emitted from the WTG nearest the two neighboring WTGs.
- All annual emissions from OSS commissioning activities will be emitted from the OSS nearest to the OSS under construction.
- All annual emissions from array cable installation activities will be emitted from a location along the array cable routes close to the foundation, WTG, and OSS construction activities.
- Finally, the fisheries monitoring vessels and marine mammal mitigation vessels will be modeled at the location nearest to the other construction activities in the array area.

The offshore wind development construction process is a dynamic process; most vessels move around during the construction process. Nevertheless, the Project will make every attempt to create a reasonable and conservative layout of vessels in space based on engineering knowledge of the construction process. The following presents a discussion of the vessel layout for each construction activity and describes assumptions.

6.4.1.1 WTG and OSS Foundations

The layout of vessels for the WTG and OSS foundation installation is presented in Figure 6-2. The heavy transport vessel associated with foundation installation is modeled at the edge of the 25-nm circle because this vessel will only be transporting components from Europe to port and will not be on-site in the WTA. The Project will make the following conservative assumption:

- All emissions from the installation of all 98 WTG and 3 OSS foundations are emitted from the vessels situated around a single foundation location for each of the WTG and OSS foundation install activities.

6.4.1.2 WTG Construction

The layout of vessels for the WTG construction is presented in Figure 6-3. The Project will make the following conservative assumption:

- All emissions from the construction of all 98 WTGs is emitted from the vessels at a single tower location.

6.4.1.3 OSS Construction

The layout of vessels for the OSS construction is presented in Figure 6-4. The Project will make the following conservative assumption:

- All emissions from the construction of all 3 OSSs is emitted from the vessels at a single OSS location.

6.4.1.4 Offshore Export Cable Installation

The layout of vessels for offshore export cable installation is presented in Figure 6-5 for the path to BL England and in Figure 6-6 for the path to Oyster Creek. The Project will make the following conservative assumptions:

- All emissions from the installation of offshore export cable are emitted from the vessels at two locations; one on the BL England cable route and one on the Oyster Creek cable route.
- The emissions from the entire activity (offshore export cable installation to both BL England and Oyster Creek) are divided between the two locations.
- For each offshore export cable route, the location chosen to represent offshore export cable installation for the annual averaging period is the location along the export cable pathways closest to the Class I area.

6.4.1.5 Array Cable Installation

The layout of vessels for the array cable installation is presented in Figure 6-7. The Project will make the following conservative assumption:

- All emissions from the installation of all the array cable in the WTA is emitted from the vessels at a single array cable location.

6.4.1.6 HDD Installation

The vessels associated with HDD installation to bring the export cable onshore at BL England will generally remain in fixed locations for the duration of the activity. Some vessels, such as support vessels, will likely move around but will not travel significant distances. The layout of vessels for the HDD activity is presented in Figure 6-8. The Project will make the following conservative assumption:

- The location chosen to represent HDD installation is the location closest to shore (approximately 487 meters from shore).

6.4.1.7 Transit

The emissions from vessels while in transit are included in the model at a series of point sources along each potential vessel route displayed in Figure 6-1. If vessels associated with a construction activity could go to multiple ports, the port with the longest route was selected. Ports assumed for each construction activity are displayed in Table 6-1.

Table 6-1. Ports Utilized by Vessels.

Construction Activity	Port [1]
Array Cable Installation	Charleston, SC
Offshore Export Cable Installation	Charleston, SC
Interconnection Cable Installation	Charleston, SC
OSS Topside Construction	Atlantic City, NJ
WTG and OSS Foundation Installation	Europe
WTG Construction	Norfolk, VA
HDD Installation	Paulsboro, NJ Atlantic City, NJ
Fisheries Monitoring and Marine Mammal Mitigation	Paulsboro, NJ
Construction Package	Atlantic City, NJ

Construction Activity	Port [1]
Crew Vessels, all Activities	Atlantic City, NJ

6.4.1.8 Fisheries Monitoring and Marine Mammal Mitigation

Vessels associated with fisheries monitoring and marine mammal mitigation will be included in the model. The vessels will be placed at a location conservatively close to the construction activities. See Figure 6-1 for the location of these vessels.

6.4.1.9 Commissioning Generators

Generators located on the WTG and OSS will be used on a temporary basis during the commissioning phase. Emissions from this equipment is included in the model. See Figure 6-1 for the location of these generators. The Project will make the following conservative assumptions:

- All generators planned to be used on an OSS will be modeled on a single OSS closest to the OSS included in the model as under construction.
- All generators planned to be used on the WTGs will be modeled on a single WTG closest to the neighboring WTG locations under construction.

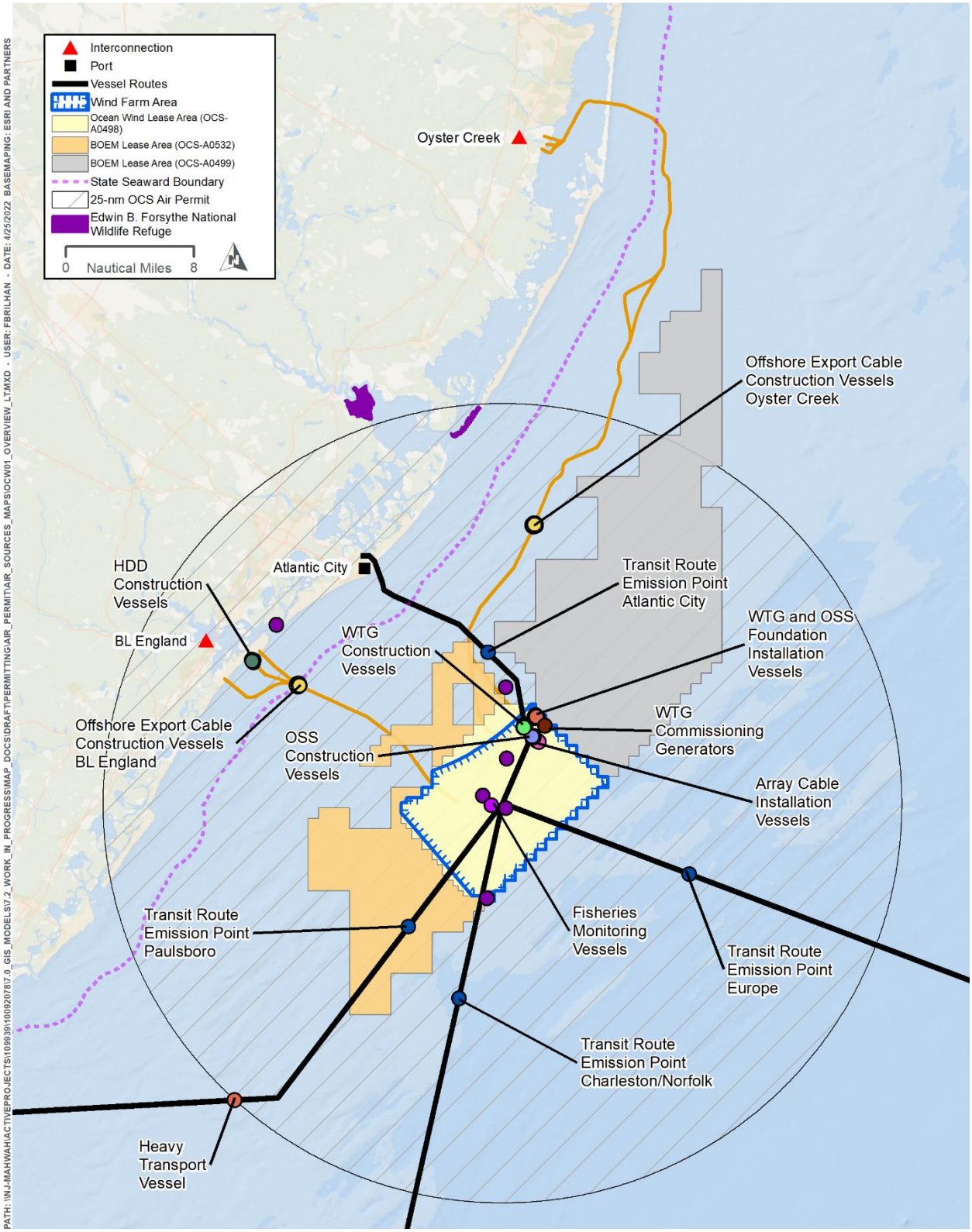


Figure 6-1. Annual Averaging Period Modeled Emission Points Overview.

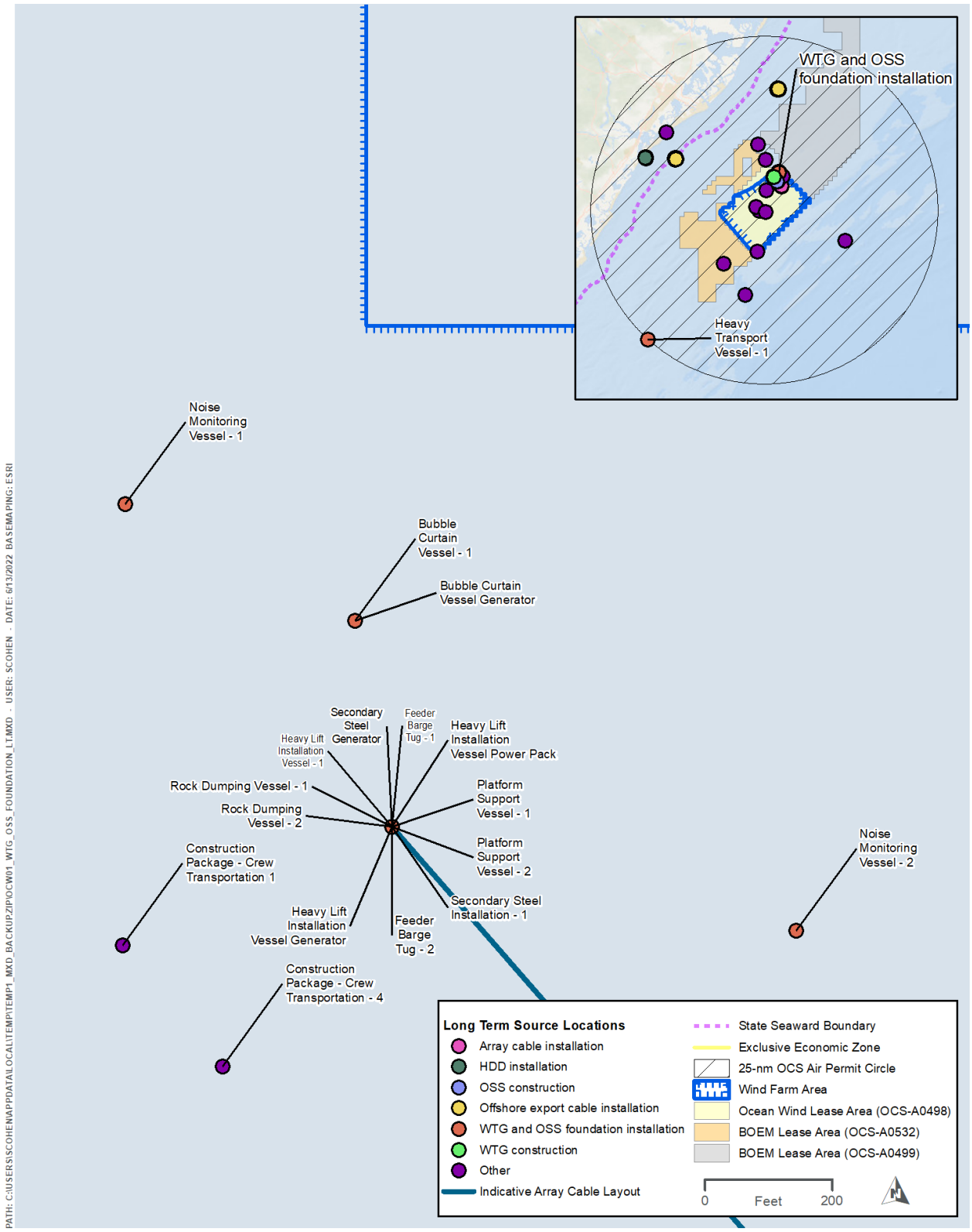


Figure 6-2. Annual Averaging Period Modeled Emission Points - WTG and OSS Foundation Installation.

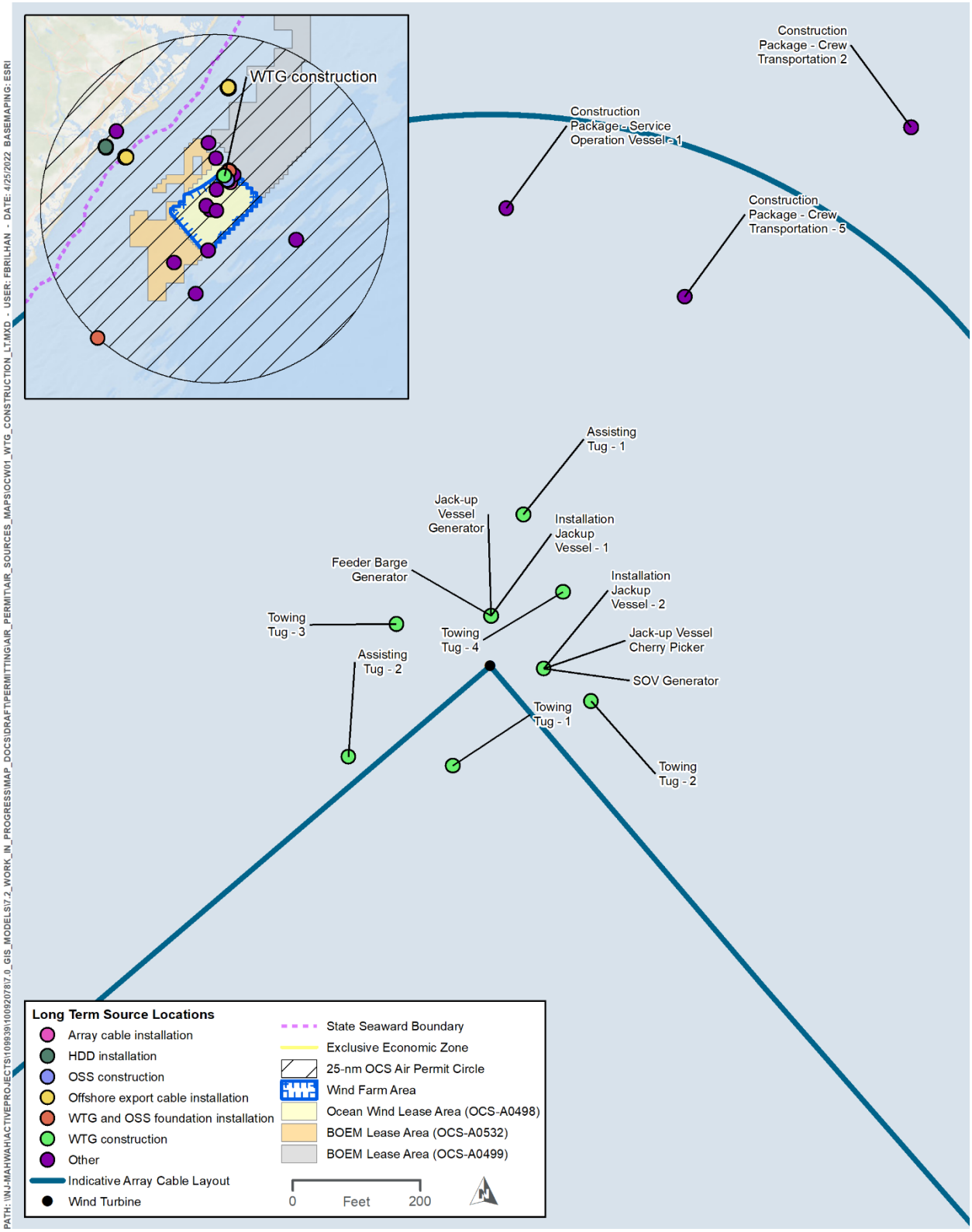


Figure 6-3. Annual Averaging Period Modeled Emission Points - WTG Construction.

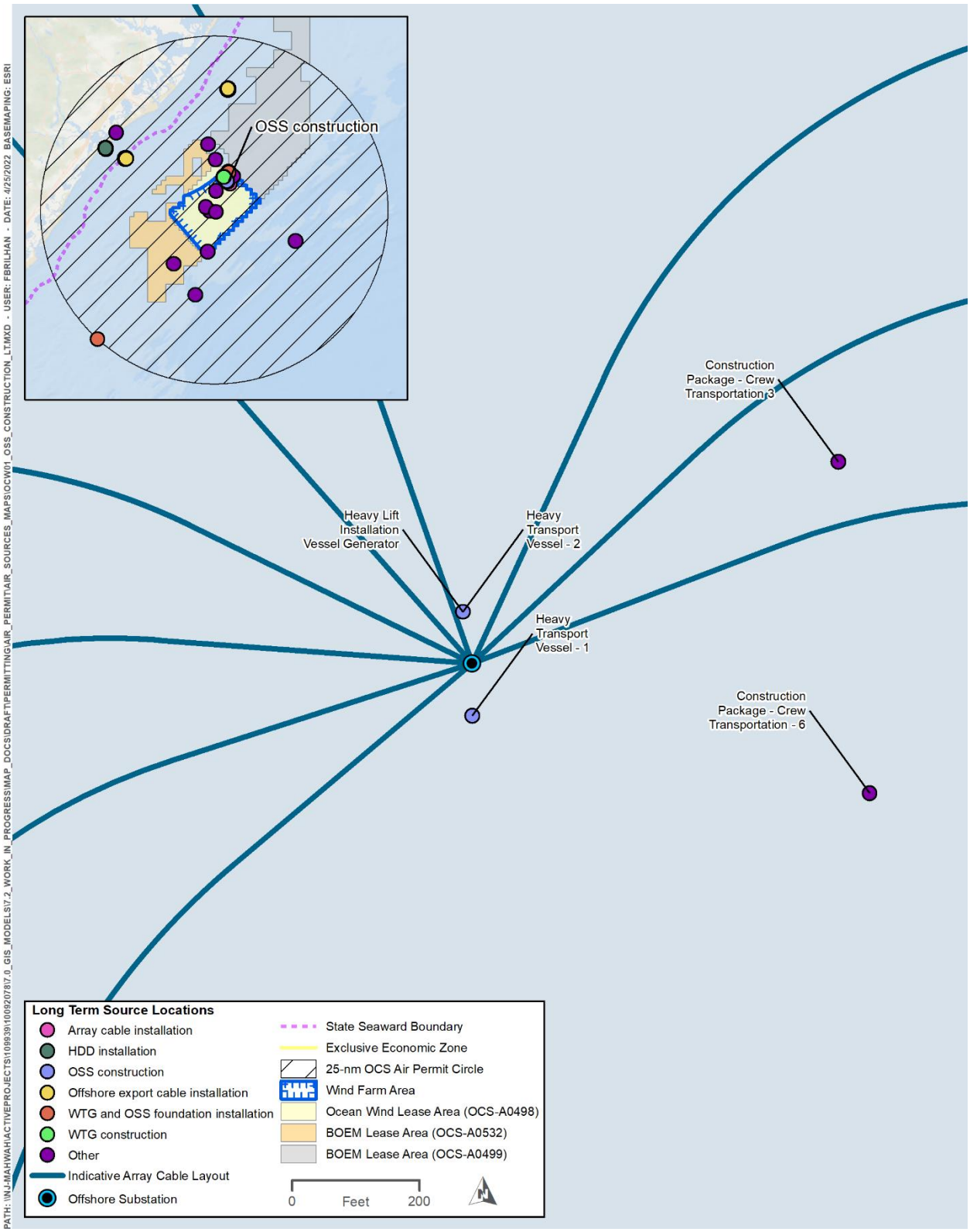


Figure 6-4. Annual Averaging Period Modeled Emission Points - OSS Construction.

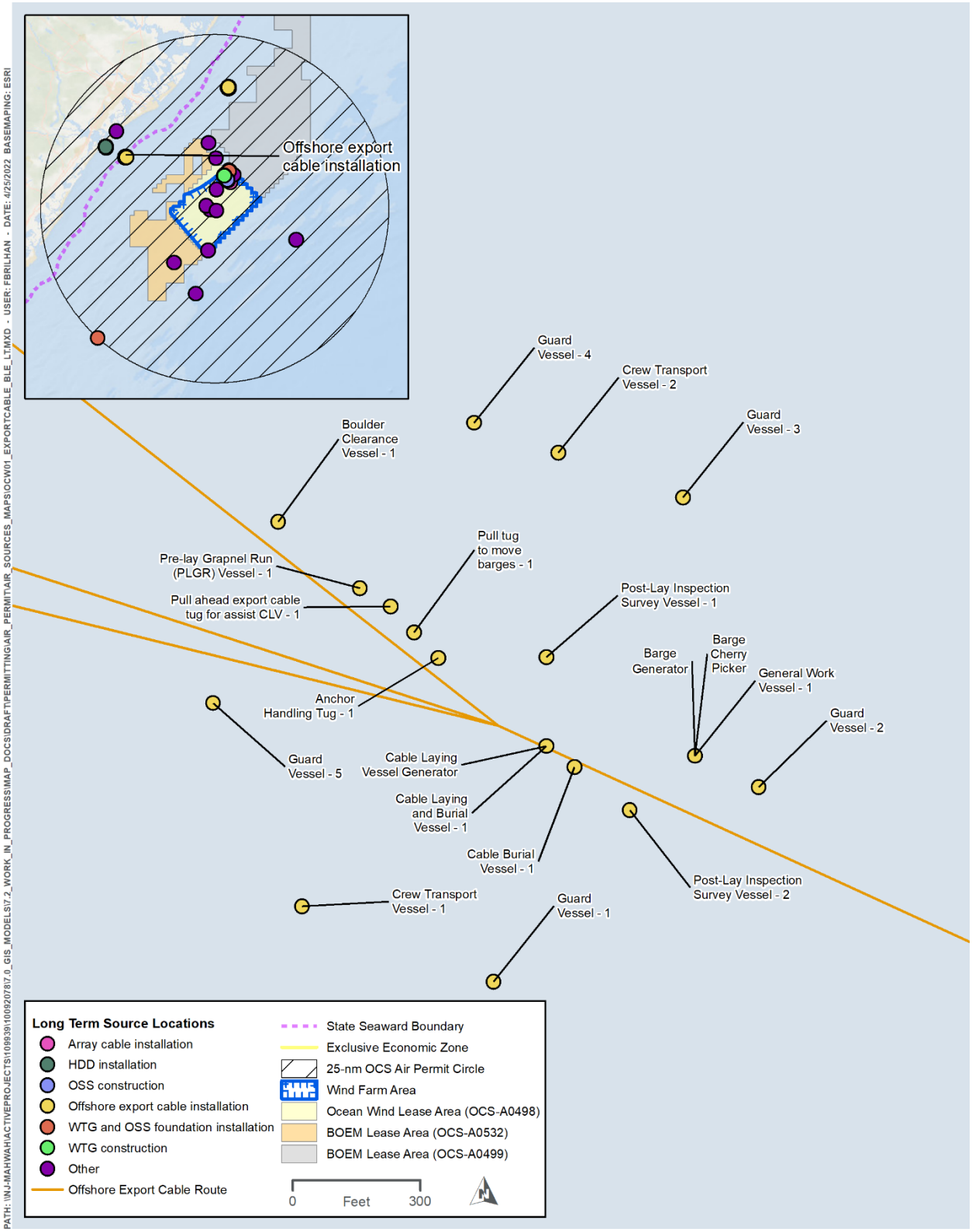


Figure 6-5. Annual Averaging Period Modeled Emission Points - Offshore Export Cable Installation - BL England Route.

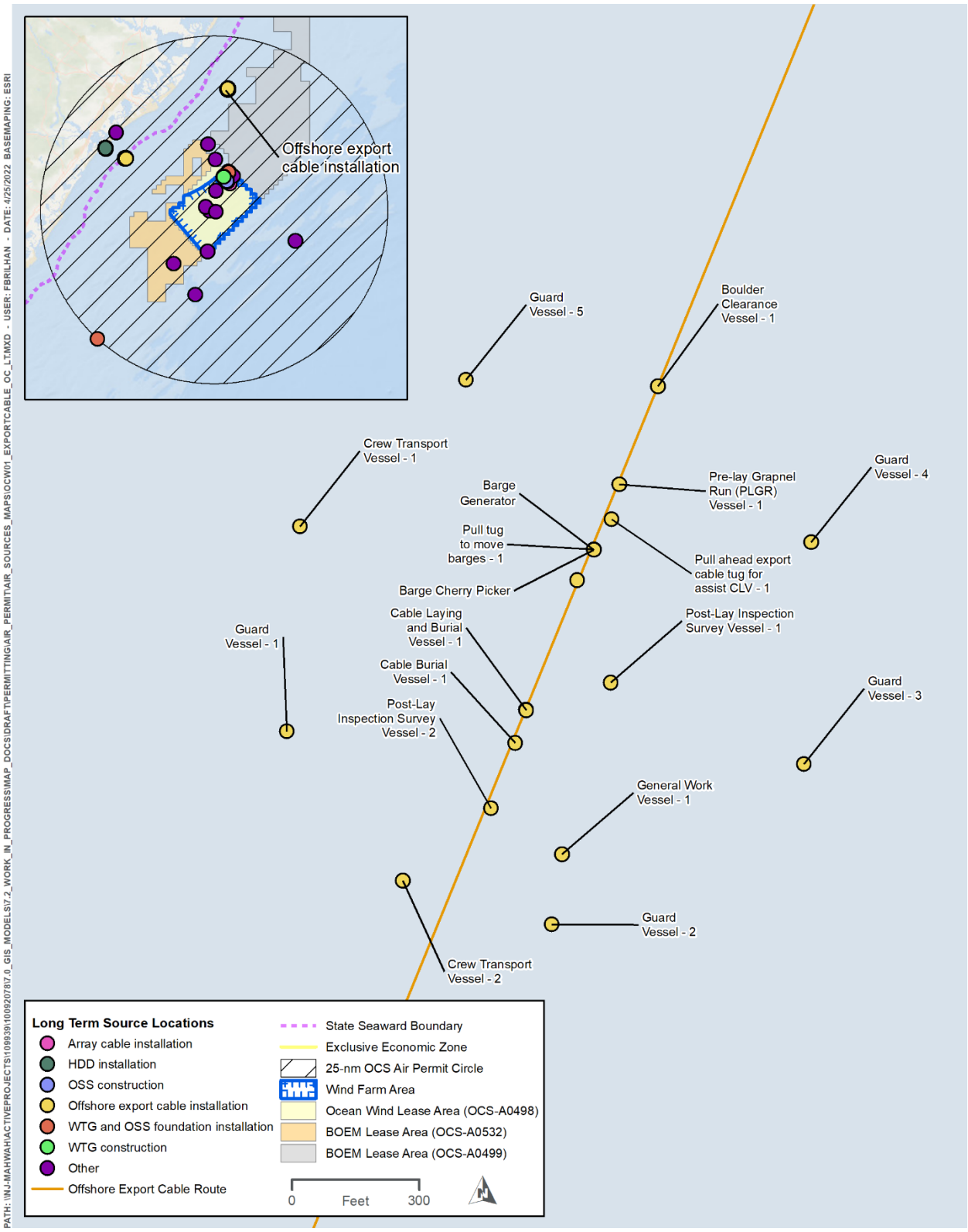


Figure 6-6. Annual Averaging Period Modeled Emission Points - Offshore Export Cable Installation - Oyster Creek Route.

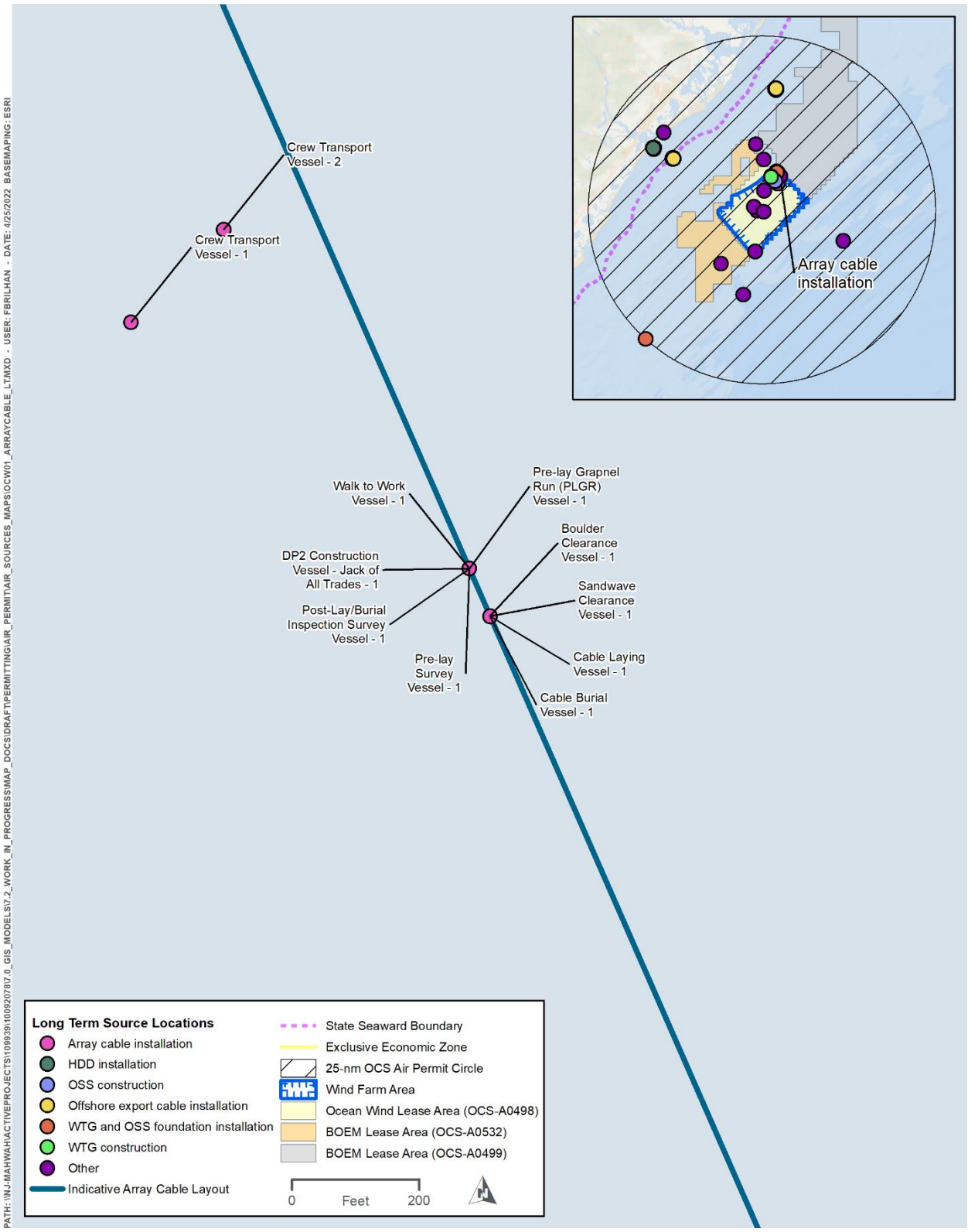


Figure 6-7. Annual Averaging Period Modeled Emission Points - Array Cable Installation.

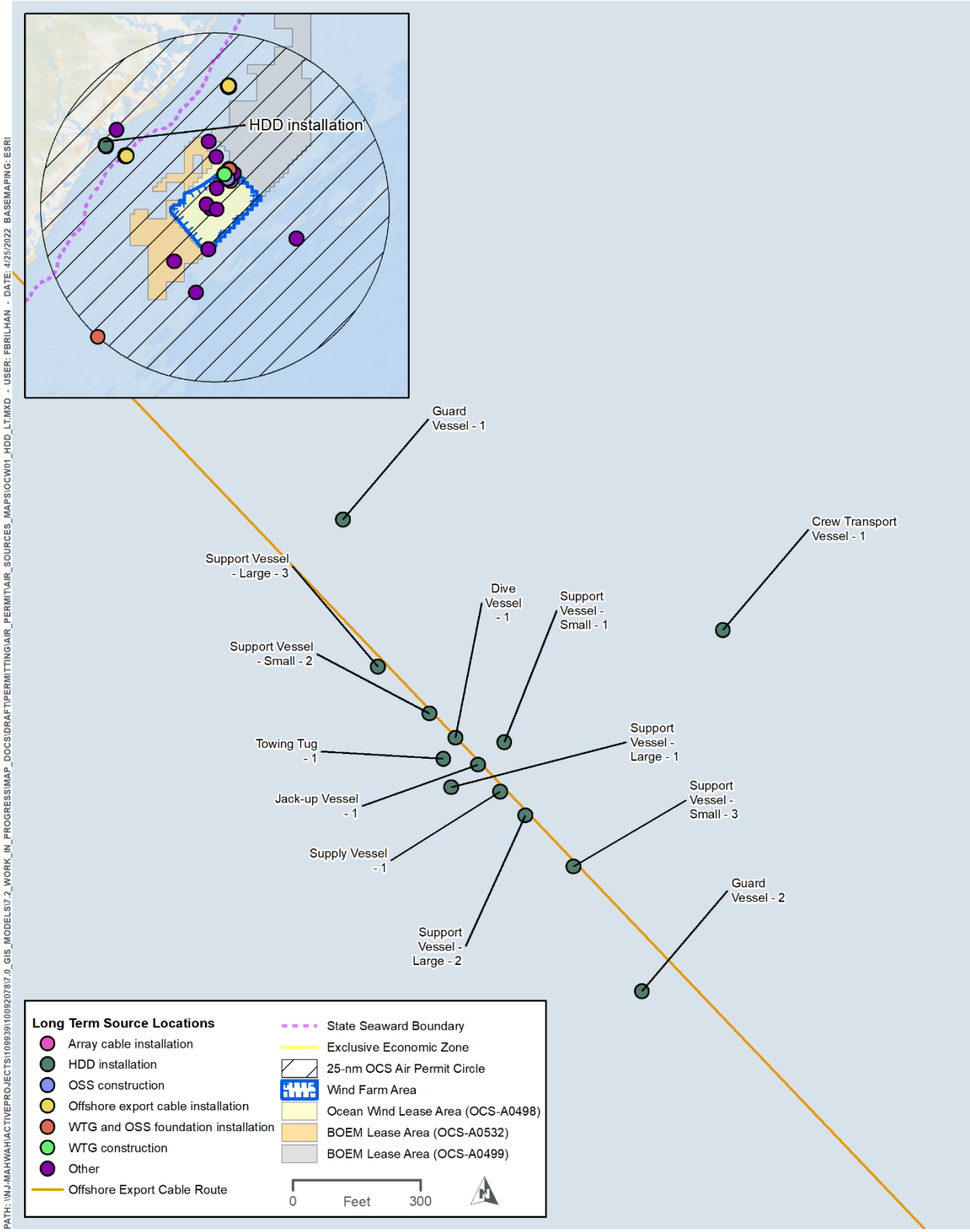


Figure 6-8. Annual Averaging Period Modeled Emission Points - HDD Installation.

6.4.2 Short-term (24-hour and shorter) Averaging Periods

For the short-term averaging periods, the Project will model emissions from vessels that could be operating within the same 24-hour period for each activity. Not all vessels included in the annual modeling will be included in the short-term modeling because not all vessels will be used during the same 24-hour period. For each vessel included in the short-term modeling, the Project will also model emissions from auxiliary equipment located on board vessels, if present. The Project will conservatively assume that all construction activities (foundation installation, construction of the WTGs, OSSs, array cables, interconnection cables, and offshore export cables) could occur on the same day even though that is not likely or anticipated. The maximum short-term emission rate will be modeled for each emission source, assuming that each emission source will be operated continuously for 24 hours, except as noted in this section. The Project will model vessels for the following construction activities:

- WTG and OSS foundation installation
- WTG construction
- OSS construction
- Array cable installation
- Offshore export cable installation
- HDD
- Transit

The Project will generally use the same vessel layout for the short-term modeling as the annual modeling, with the exception that some vessels will be removed from the short-term modeling, as previously discussed. It is conservatively assumed that all construction activities which occur within the WTA will occur on the same day within close proximity to each other in the northern corner of the array, closest to the Class I area. It is unlikely that the construction will actually occur that close together spatially. The activities included in the short-term model and their general locations in the WTA are presented in Figure 6-9.

The Project is making the following conservative assumptions:

- The Project will install a WTG foundation and construct a WTG at neighboring WTG locations.
- The Project will construct an OSS at the location nearest the two neighboring WTGs.
- The Project will install array cables at a location near to the foundation and, WTG, and OSS activity in the northern corner of the array.
- Finally, the fisheries monitoring vessels and marine mammal mitigation vessels will be modeled at the location nearest to the other construction activities in the array area.

6.4.2.1 WTG and OSS Foundations

Foundation installation will occur in three consecutive stages: monopile installation, secondary steel installation, and commissioning. The maximum anticipated duration of monopile installation is 1.7 days and the maximum anticipated duration of secondary steel installation is 1 day. Rock dumping (up to 1.5 days) and commissioning activities (up to 12 hours) would then occur. Of these activities, the combined 24-hour emission rate from vessels associated with monopile installation is the greatest. Therefore, all vessels associated with monopile installation will be included in the short-term modeling. The feeder barge tugs that will pull the feeder barge (the feeder barge has no engines) carrying the WTG components will only be on-site while WTG components are offloaded to the main installation vessel. The barge and tugs will then move away to a stand-off location more than 500 meters away from the foundation installation activity. The duration of offloading the WTG components is anticipated to be approximately 6 hours. Therefore, the emission rate of the feeder barge tugs is modeled at

6 out of 24 hours of use. All other vessels associated with monopile installation will be modeled assuming 24 hours of use. The layout of vessels for WTG and OCS foundation installation is presented in Figure 6-10.

6.4.2.2 WTG Construction

All vessels associated with WTG construction will be included in the short-term modeling. The layout of vessels for WTG construction is presented in Figure 6-11.

6.4.2.3 OSS Construction

All vessels associated with OSS construction will be included in the short-term modeling. The layout of vessels for OSS construction is presented in Figure 6-12.

6.4.2.4 Offshore Export Cable Installation

For the short-term modeling, it is assumed that only one set of vessels will be operating during a 24-hour period for the offshore export cable installation. The route that passes closest to the Class I area was selected (Oyster Creek). The location along the route to Oyster Creek that is closest to the Class I area was selected to be modeled. The layout of vessels for offshore export cable installation is presented in Figure 6-13.

6.4.2.5 Array Cable Installation

A conservative location (near to the foundation, WTG, and OSS construction activity) for the array cable installation was chosen to represent array cable installation activities. The layout of vessels for array cable installation is presented in Figure 6-14.

6.4.2.6 HDD Installation

The vessels associated with HDD will be modeled at the location closest to the shoreline, which is approximately 487 meters from shore. HDD is comprised of three consecutive activities: dredging, drilling and pipe pulling. The maximum anticipated duration of dredging is five days, and the maximum anticipated duration of drilling is 26 days. The maximum anticipated duration of pipe pulling is 24 hours. Of these activities, the combined 24-hour emission rate of vessels associated with pipe pulling is the greatest. Therefore, all vessels associated with pipe pulling will be included in the short-term modeling. The layout of vessels for HDD is presented in Figure 6-15.

6.4.2.7 Transit

Emissions from transit will be modeled at a series of point sources, as in the annual modeling. The transit emission points will be spread out among the vessel routes displayed in Figure 6-9.

6.4.2.8 Fisheries Monitoring and Marine Mammal Mitigation

The vessels associated with fisheries monitoring will be included at the same locations as described above for the annual modeling. The research vessel associated with marine mammal mitigation will only travel to the wind array area to deploy a buoy and then return to port. It will not remain onsite during construction; therefore, it is not included in the short-term on-site maneuvering modeling.

6.4.2.9 Commissioning Generators

The Project will not model emissions from generators associated with commissioning because commissioning activities are not anticipated to occur on the same day as other construction activities.

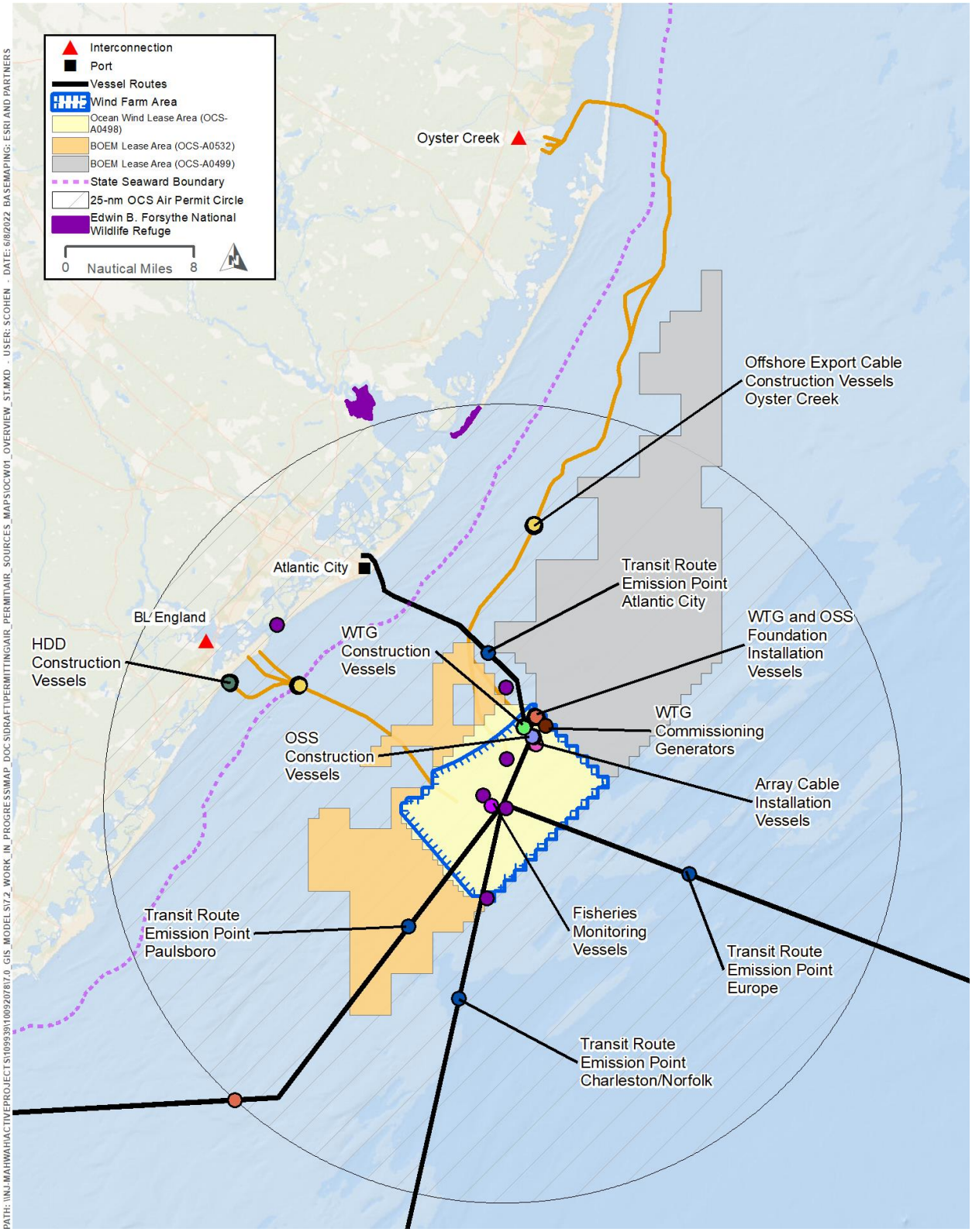


Figure 6-9. Short-term Averaging Period Modeled Emission Points Overview.

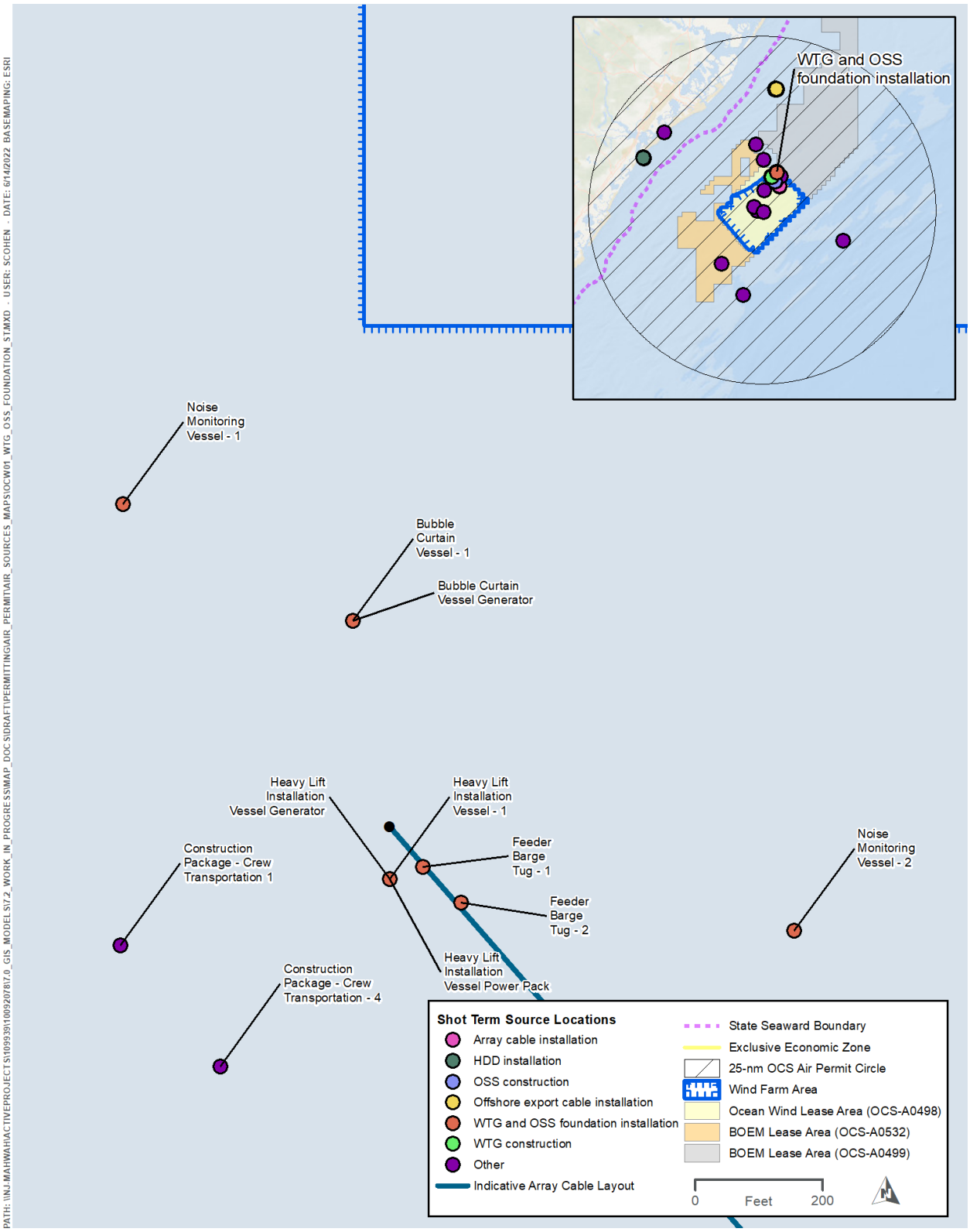


Figure 6-10. Short-term Averaging Period Modeled Emission Points - WTG and OSS Foundation Installation.

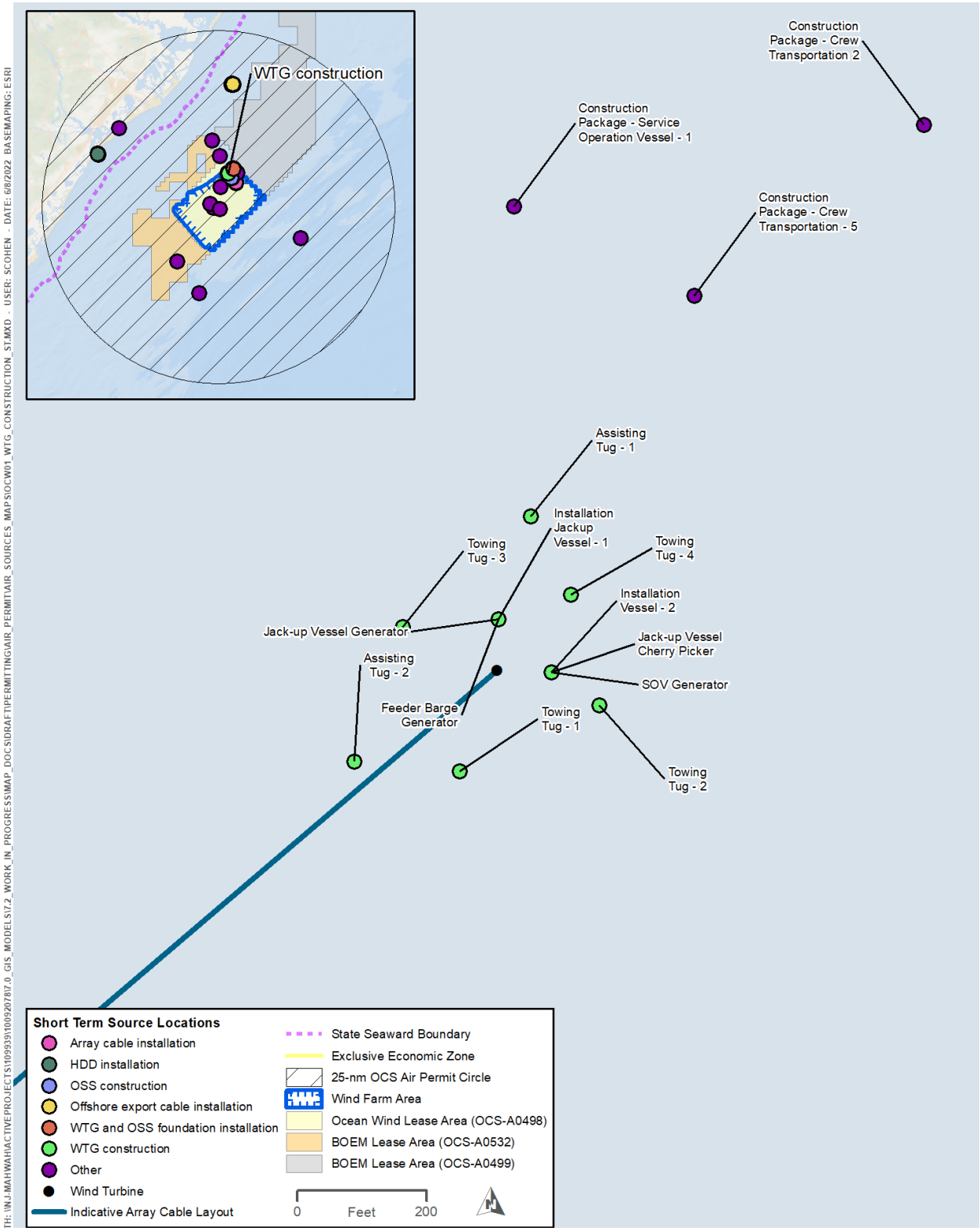


Figure 6-11. Short-term Averaging Period Modeled Emission Points - WTG Construction.

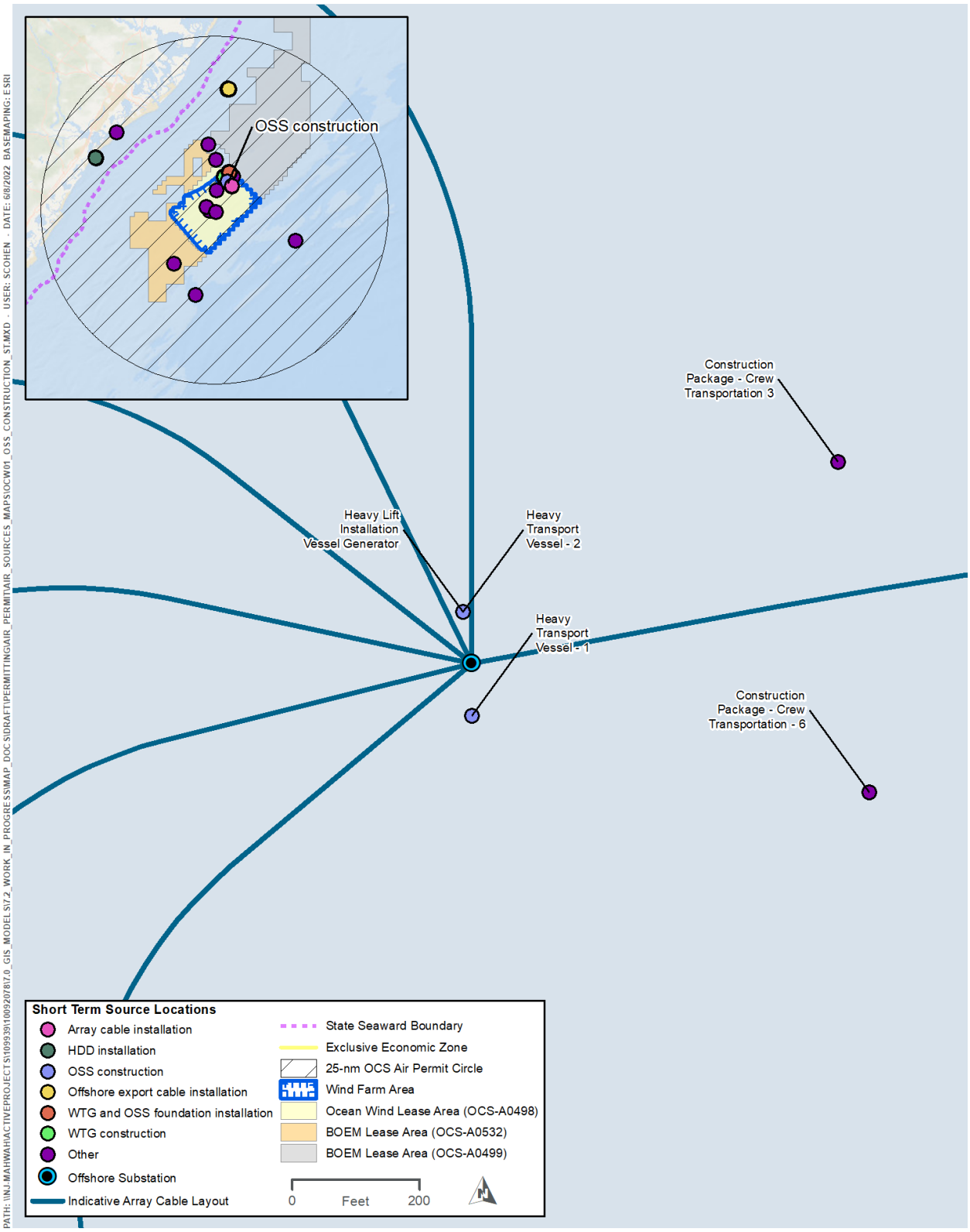


Figure 6-12. Short-term Averaging Period Modeled Emission Points - OSS Construction.

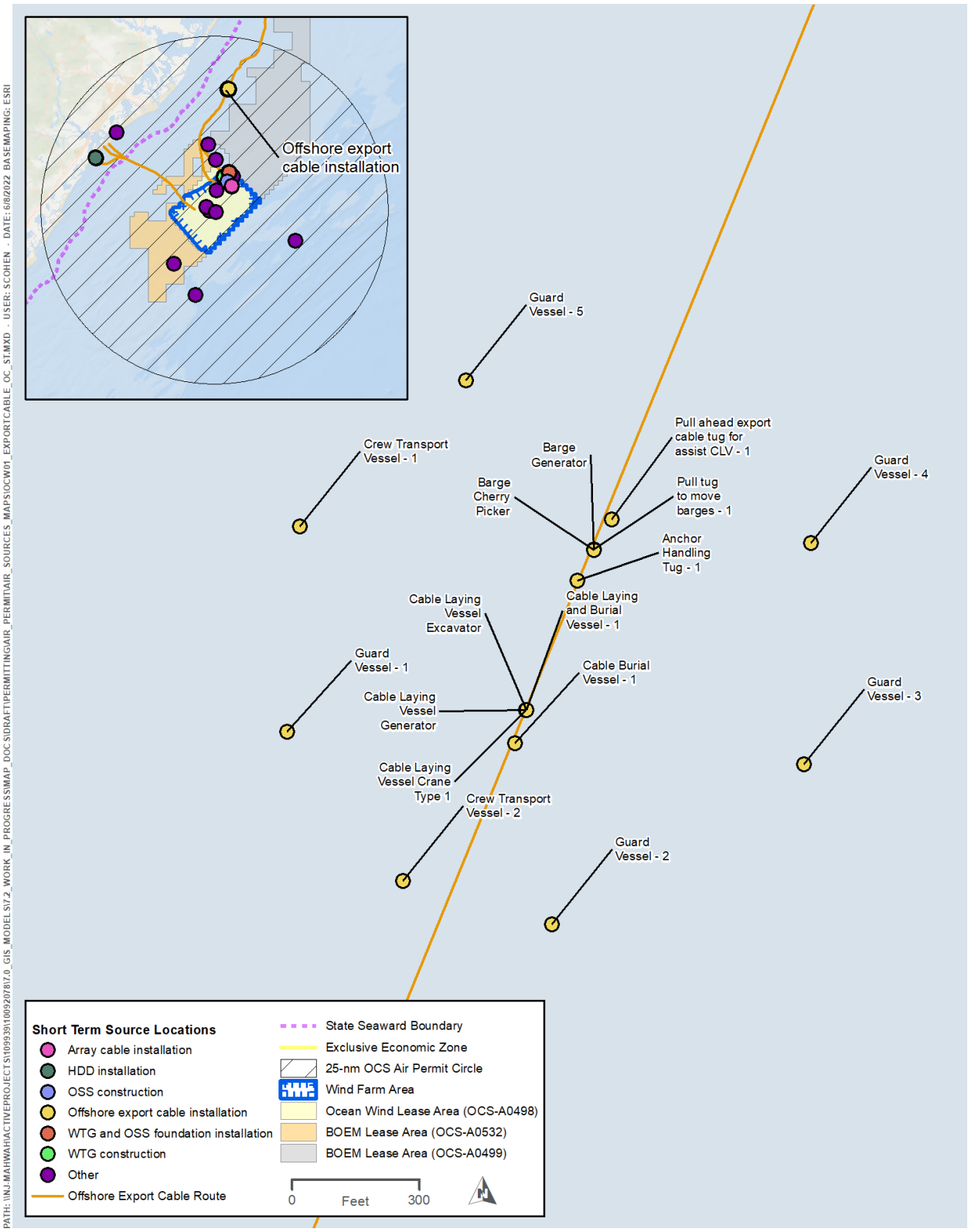


Figure 6-13. Short-term Averaging Period Modeled Emission Points - Offshore Export Cable Installation - Oyster Creek Route.

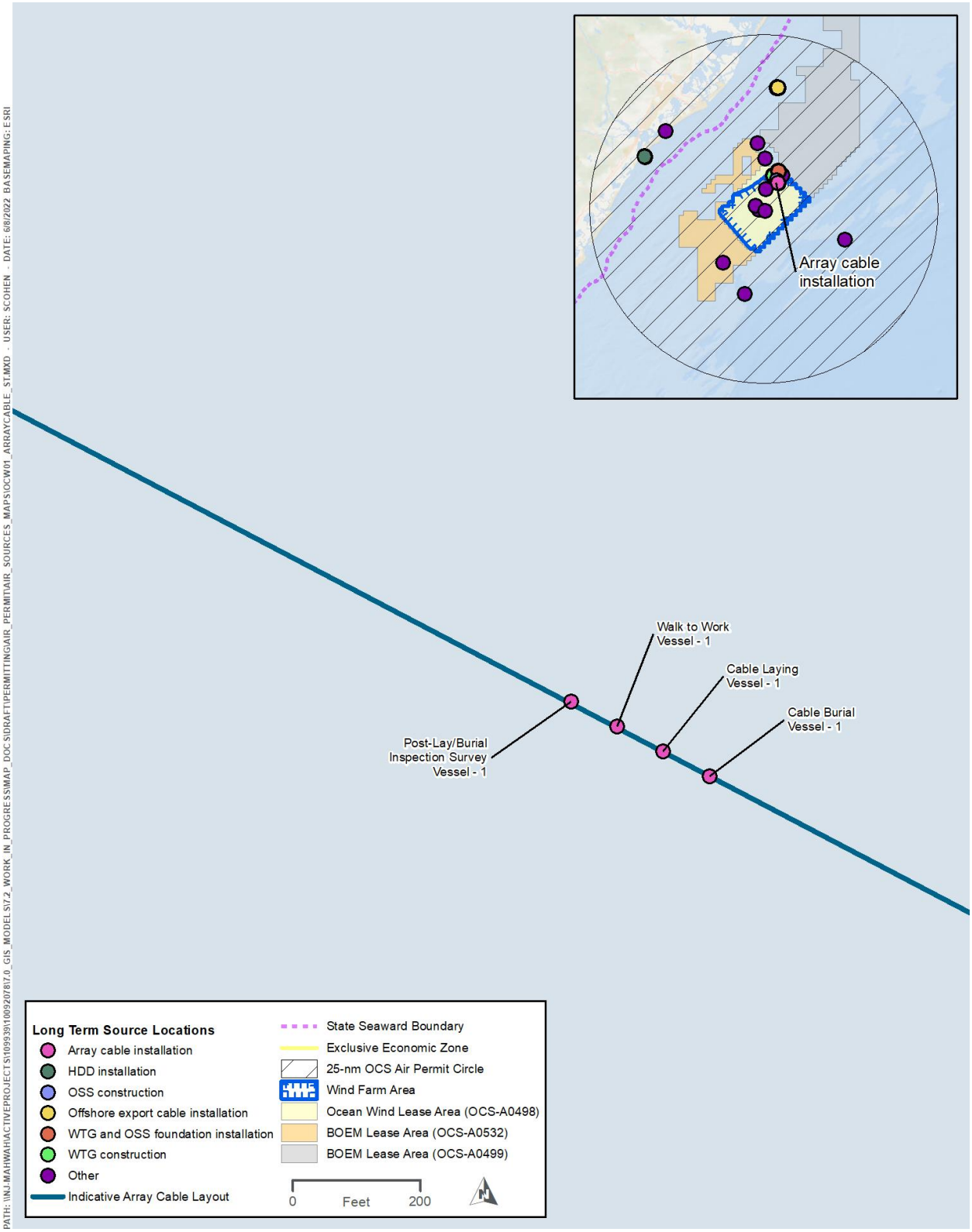


Figure 6-14. Short-term Averaging Period Modeled Emission Points - Array Cable Installation.

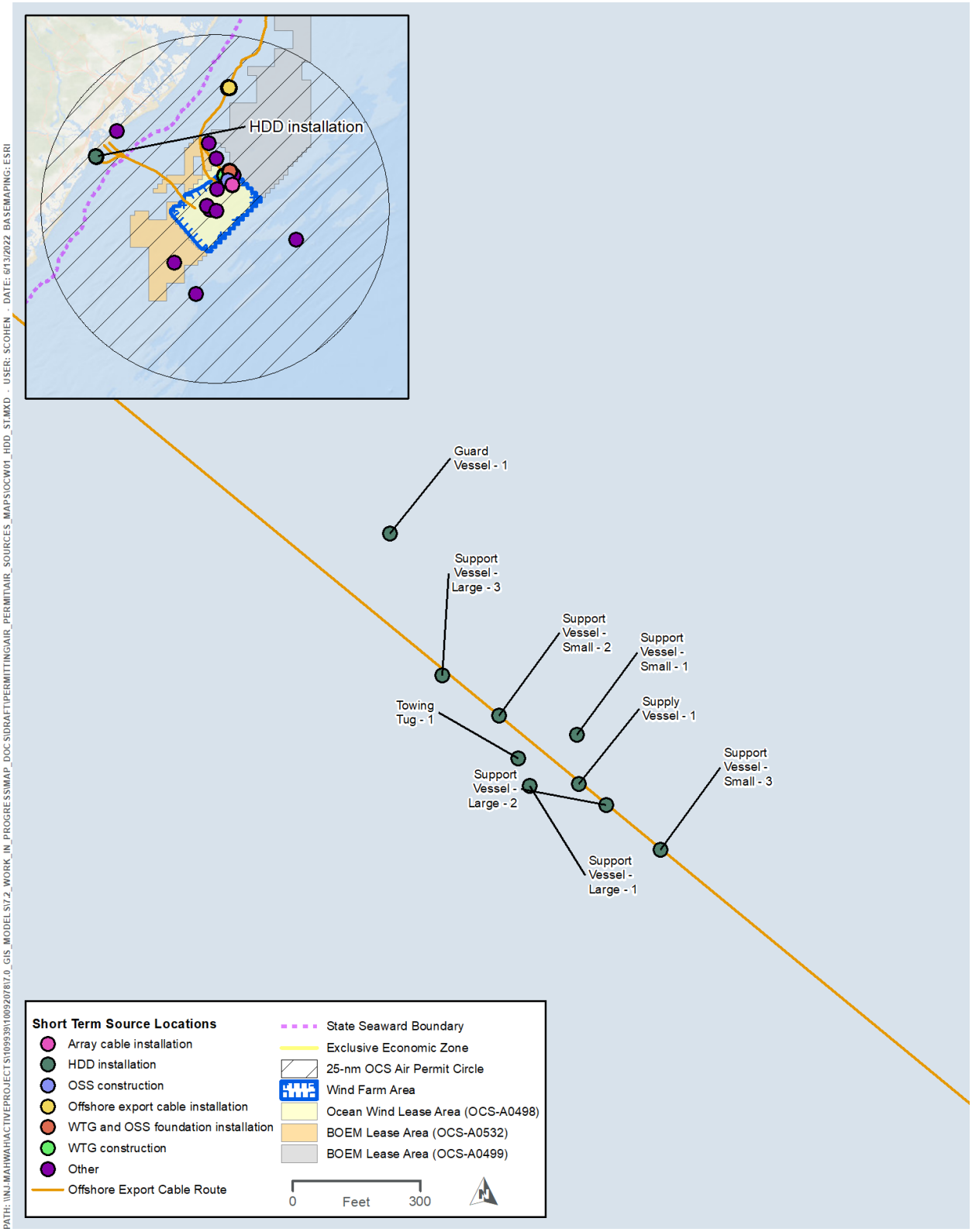


Figure 6-15. Short-term Averaging Period Modeled Emission Points - HDD Installation.

6.5 Vessel Stack Parameters

As previously described, the exact vessels to be used for construction cannot be known at this stage of the Project. Therefore, the Project has attempted to determine representative vessel stack parameters (stack height, exit velocity, exit temperature, orientation) based on known vessel types and expected characteristics of these vessels.

6.6 Receptors

6.6.1 NAAQS, PSD Class I Increment Analysis and Additional Impact Analysis

As discussed in a meeting on December 15, 2021 with EPA and NJDEP, there is a need to create a buffer around vessels during construction which represents space where public access will be temporarily limited. The Project proposes that there will be a 500-meter buffer around each vessel. Where vessels are concentrated close together, such as around a foundation location during foundation installation, the 500-meter buffer will be drawn from a polygon created by drawing a line joining each vessel buffer zone to make an enclosed polygon. Along the polygon, receptors will be placed 25 meters apart. Then, the remaining receptor grid will place receptors in a grid using 100 meter spacing out to a distance of 1.5 kilometers. Beyond that, a coarse (1 km spacing) grid will be included to provide information on lower concentrations farther downwind of the sources and over onshore areas.

The receptor spacing is presented in Figure 6-16 for the coarse grid and the nested finer grids around each area of concentrated vessel activity. The modeling report to be submitted with the revised OCS Air Permit Application in mid-July will include close-up figures for each applicable pollutant and averaging period or standard, showing the receptors with the highest modeled impact(s) and/or contour plots as appropriate.

6.6.2 PSD Class I Increment Analysis

For the Class I impact analysis, the receptors for Brigantine Wilderness as defined in the NJDEP modeling guidance will be utilized. The receptors for the Brigantine Wilderness Class I area will be downloaded from the National Park Service website. There are forty-six Brigantine Wilderness receptors. The MAKEUTM conversion processer will be utilized to convert the Brigantine Wilderness coordinates to the latitude/longitude-based coordinate system used by OCD. OCD utilizes a coordinate system based on a reference point defined by MAKEGEO as the southwest corner of the model domain defined by the four corner coordinates described in Section 6.2.

6.7 NO_2 Impacts – One-hour NAAQS Analysis

A preliminary 1-hour NO_2 NAAQS analysis was performed by running the OCD model for all project sources and receptors using the very conservative assumption of all NO_x being in the form of NO_2 as it leaves the engine exhaust stacks. This initial run showed a large number of receptors with 8th high daily maximum 1-hour NO_2 values significantly (more than a factor of 2) above the 1-hour NAAQS. Therefore, to refine the predictions, the 1-hour NO_2 analysis will use the ozone limiting method (OLM), via a custom “OLM_BKGD” post-processor (written in FORTRAN – see code in Appendix C of this modeling protocol) to read OCD’s optional binary hourly output files, and to apply the OLM at each receptor for each hour of meteorology. In addition, the post-processor will be used to add 1-hour background NO_2 concentrations, developed from conservatively representative ambient monitoring data, on the basis of 24-hour profiles varying by season of the year. The 1-hour OLM-based NO_2 predictions will also be summed and divided by the number of hours in the year to estimate annual NO_2 concentrations for comparison with the annual average NAAQS and annual PSD Class II and Class I increments. The data and procedures to be used for the OLM processing and the development and use of background NO_2 concentrations are described in the following sections.

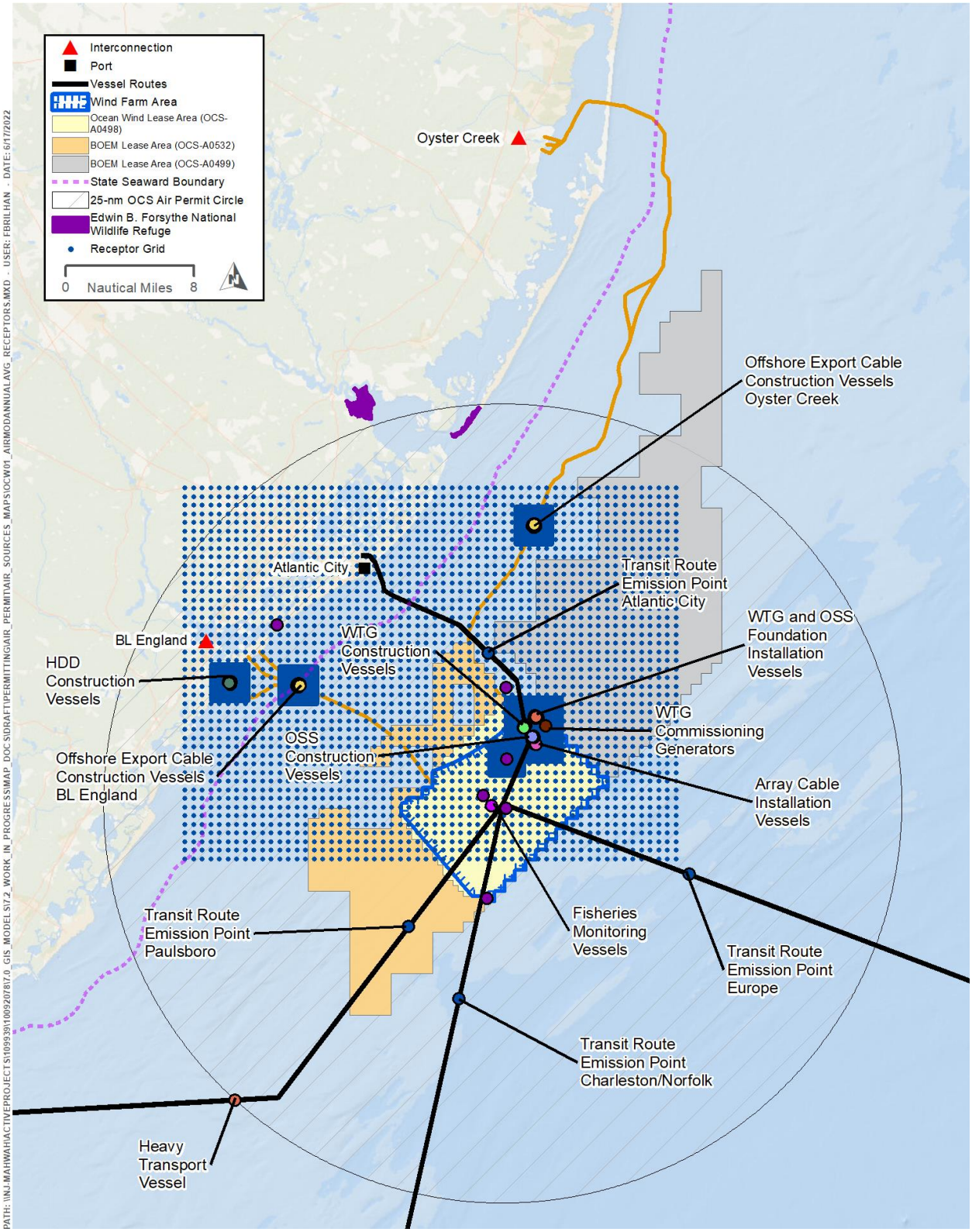


Figure 6-16. Receptor Grid.

6.7.1 Ozone Limiting Method

The OLM will be applied using 3 years of hourly ozone data to allow hour-by-hour application of the method to the OCD predictions of NO_x concentrations. The ozone data proposed for this analysis have been obtained from EPA's AirData web site, via download of the prepackaged hourly data files (Download Files | AirData | US EPA) for the same three years of meteorological data (2018-2020) used as input to OCD. From those very large EPA data files, the 2018-2020 hourly data for the "Atlantic City-Hammonton" site (Site ID = 340010006), have been extracted for the analysis. This site is located at the Edwin B. Forsythe National Wildlife Refuge (EBFNWR) Visitor Center, 800 Great Creek Road, Galloway Township, New Jersey.

The hourly ozone data for the years of 2018 through 2020 are relatively complete for the Atlantic City/EBFNWR site, with completeness percentages of 92.4%, 95.6%, and 91.1%, respectively. To obtain 100% complete data sets for application of the OLM, the missing hourly values have been filled-in using either interpolation or substitution. Most of the missing hours in 2018 and 2019 are periods of 1-3 hours per day, generally in the overnight or early morning hours. For such periods, simple linear interpolation of valid measurements from adjoining hours has been performed to fill in the gaps. In 2020, in addition to such periods, there were multiple periods of consecutive missing hours between 3-6 days long throughout the year. To fill in these gaps, the 2019 data (after completing interpolation of any needed hours that year) for these same dates and hours were substituted/copied into the 2020 data set. For each year of data, the in-filled data include a note in the "Units of Measurement" column, specifying whether the in-filled data were from interpolation or substitution, and if by substitution, from where the data were taken. The completed ozone data for this analysis are in an Excel workbook provided as Appendix D of this modeling protocol.

For application of the OLM, one must select an appropriate NO_2/NO_x in-stack ratio (ISR) for each type of emission source. All the emission sources to be assessed for the NAAQS and increment analyses for the project construction will be stacks of diesel-fired reciprocating internal combustion engines (RICE). The engines assumed in this analysis for the project construction do not include any RICE units with advanced add-on emission controls, such as selective catalytic reduction or oxidation catalysts. While the crew transport vessels are assumed to be certified to Tier 3, these are not expected to require add-on emission controls to achieve this level of emissions. Therefore, in reviewing EPA's ISR database (https://www.epa.gov/sites/production/files/2020-11/no2_isr_database.xlsx), the uncontrolled engine data were considered. The ISR values for these uncontrolled units range from approximately 0.06 to 0.11. Therefore, for this OLM analysis, a somewhat conservative ISR of 0.10 is proposed to be applied to all the engines. This will allow the OLM to be applied to the total hourly NO_x concentrations (from all emission sources) predicted by the OCD model. The total NO_2 concentration for each hour will thus be calculated as:

1-hour NO_2 = (ISR of 0.1) * total modeled NO_x (as NO_2)

+ lesser of O_3 or (0.9 * NO_x)

+ background NO_2 concentration.

The total modeled (by OCD) 1-hour NO_x (as NO_2) concentration will first be converted to parts per million (ppm), multiplied by the ISR of 0.1, and then added to the lesser of the ozone concentration (in ppm) or 0.9 times the total NO_x concentration (in ppm). After the OLM 1-hour NO_2 concentration is calculated in ppm, the background NO_2 concentration (in ppm) will be added, and then the total, in ppm, will be converted back to units of micrograms per cubic meter for reporting.

6.7.2 Background One-Hour NO_2 Concentrations

The Guideline on Air Quality Models (40 CFR 51, Appendix W) addresses the selection of background concentrations under various circumstances. In Section 8.3.2, the Guideline provides recommendations for areas with isolated single source(s), stating:

> "For short-term standards, the diurnal or seasonal patterns of the air quality monitoring data may differ significantly from the patterns associated with the modeled concentrations. When this occurs, it may be appropriate to pair the air quality monitoring data in a temporal manner that reflects these patterns (e.g., pairing by season and/or hour of day)."

This concept is developed more specifically for 1-hour NAAQS modeling for NO_2, in a March 1, 2011 memorandum from Tyler Fox of EPA's Office of Air Quality Planning and Standards, with the subject "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard." Page 19 of that memorandum states:

> ". . . an appropriate methodology for incorporating background concentrations in the cumulative impact assessment for the 1-hour NO_2 standard would be to use multiyear averages of the 98th-percentile of the available background concentrations by season and hour-of-day, excluding periods when the source in question is expected to impact the monitored concentration (which is only relevant for modified sources)."

The memorandum further states:

> ". . . we recommend that background values by season and hour-of-day used in this context should be based on the 3rd-highest value for each season and hour-of-day combination, whereas the 8th-highest value should be used if values vary by hour-of-day only."

For the Project NO_2 1-hour NAAQS modeling, the proposed procedure is to use a multi-year (3-year) average of 24-hour concentration profile, on a seasonal basis (e.g., December-January-February, etc.), for the same three years (2018-2020) of meteorology used in the OCD modeling analysis. Therefore, the third highest monitored value is used for each season and hour of day combination. This third highest value is determined for each season/hour combination in each of the three years (2018-2020), and then the values averaged across the three years to produce the needed 24-hour profiles of concentration by season (December-January-February, etc.).

The nearest NO_2 ambient air quality monitor to the project location is approximately 50 km west of Atlantic City, in the city of Millville, New Jersey. Millville had a population of 27,845 in the 2020 US Census and has a moderate amount of industry in the area, including some glass manufacturing plants. The NO_2 monitor location is just south of a freeway interchange on the north side of Millville. Given the monitor's location near a significant highway corridor and a moderately sized city, the NO_2 concentrations measured there should be conservative (high) compared to the relatively low concentrations expected in the immediate project area of the Project wind turbine array, which begins approximately 13 nm offshore.

The monitor data should also be somewhat conservative compared to NO_2 concentrations expected near the one modeled project activity near the shore, which is the horizontal directional drilling (HDD) needed to bring one of the power export cables onshore on the south side of Ocean City. The population of Ocean City was 11,065 in the 2020 US Census, but that population was mostly spread out in a narrow band along the coast, with no major highways/freeways nearby, and only minor arterials and residential streets. The nearest major roadway to the export cable intercept with the shoreline is the Garden State Parkway, over 3 km inland from the shore.

Given the above, the Millville NO_2 monitor data are proposed for determining background concentrations for this analysis. As with hourly ozone data, the NO_2 data meet EPA's minimum 90% completeness criteria, with the 2018-2020 years showing 97.9%, 96.8% and 97.5% completeness, respectively. Most of the missing periods were for 1 or 2 hours in the overnight hours, apparently for periodic calibrations and maintenance. As with the ozone data, for missing periods ranging from 1 hour to a few hours, the values were linearly interpolated from adjacent valid readings. The longest period of missing data was in 2019, when there was a stretch of nearly 4 days missing in mid-October. To complete this data set, the same hours of data were copied from this period in the 2020 data. For each year of data, all hours of in-filled data include a note in the "Units of Measurement" column, specifying whether the in-filled data were from interpolation or substitution, and if by substitution, from where the data were taken.

After filling of missing data was completed, the data were sorted by season and then by hour of day, and each third-high value for each season/hour grouping was highlighted by manual inspection. Each year of data was then sorted again, by season and then by highlighting. This put all selected third-high values for each season, for the 24 hours of the day, in order, so they could be easily pasted into a summary sheet. The data were then re-sorted into their chronological local date & time order. The completed NO_2 background data for the analysis are in an Excel workbook provided as Appendix E of this modeling protocol. The second table in the "Summary" tab shows the data (in parts per billion) to be added to the modeled OCD concentrations (after OLM processing) to determine total NO_2 concentrations.

7. Proposed AQRV Analysis

A separate protocol for the AQRV analysis will be submitted to USFWS under separate cover, with copy to EPA. The AQRV protocol will address visibility (both plume blight using the VISCREEN screening procedures, and regional haze, using the CALPUFF model) and acid deposition, as requested by the Federal Land Manager of the Edwin B. Forsythe National Wildlife Refuge in a meeting on February 23, 2022. Ocean Wind anticipates submitting the protocol for plume blight, acid deposition and regional haze analyses to USFWS in June 2022.

8. Operations & Maintenance Phase

The potential emissions of the Project during the O&M phase are presented in Table 8-1. As described in the OCS Air Permit Application dated March 29, 2022, Ocean Wind believes that WTGs should not be included in the OCS source during O&M. However, if EPA determines based on OCS rules, prior OCS air permit source determinations, and formal policy determinations that WTGs must be included in the OCS source at the O&M phase, the Project would then include emissions from all vessel traffic to and from the WTGs while within 25 nm of the WTA. Potential emissions under this alternate approach are presented in Table 8-2.

Note that the potential to emit (PTE) presented in both tables differs from the PTE presented in the OCS Air Permit Application dated March 29, 2022. The Project will submit a revised air permit application in mid-July with updated air emission estimates that match the values provided in Tables 8-1 and 8-2.

Table 8-1. WTA Potential-to-Emit During Operations and Maintenance.

Pollutant	Potential to Emit
	tons/year
Carbon Monoxide (CO)	9.2
Nitrogen Oxides (NO_x)	11.6
Particulate Matter (PM_{10})	0.4
Particulate Matter ($PM_{2.5}$)	0.4

Pollutant	Potential to Emit tons/year
Sulfur Dioxide (SO_2)	0.02
Volatile Organic Compounds (VOC)	1.1
Lead (Pb)	0.00003

Table 8-2. WTA Potential-to-Emit During Operations and Maintenance – Alternate Approach.

Pollutant	Potential to Emit tons/year
Carbon Monoxide (CO)	58.1
Nitrogen Oxides (NO_x)	227.3
Particulate Matter (PM_{10})	7.4
Particulate Matter ($PM_{2.5}$)	7.3
Sulfur Dioxide (SO_2)	0.2
Volatile Organic Compounds (VOC)	5.8
Lead (Pb)	0.0007

Regardless of which approach to the OCS source definition is taken, the PTE during O&M is significantly lower than the PTE during the construction phase. Therefore, since the Project will demonstrate compliance with all applicable NAAQS and PSD Class I and II increment during the construction phase, it is reasonable to assume that the Project will also demonstrate compliance with all applicable standards during the O&M phase.

Appendix A, Meteorological Data and Air Dispersion Modeling Comparisons

Ocean Wind Revised Modeling Protocol

Ocean Wind OCS Air Permit Application

1.0 Meteorological Data and Processing

Ocean Wind LLC (Ocean Wind), a joint venture between Orsted Wind Power North American, LLC (Orsted) and Public Service Enterprise Group Renewable Generation LLC (PSEG), is submitting herein an Outer Continental Shelf (OCS) air modeling protocol to support the construction the construction and operation of the Ocean Wind Offshore Wind Farm Project (Ocean Wind or Project).

This Appendix A provides a description of the meteorological data extraction and processing steps for the Project, and provides a data representativeness comparison of:

1) onshore and offshore Weather Research and Forecasting (WRF) prognostic model data utilized in the Project air dispersion analysis, with
2) the available "observed" data for a representative onshore station in the region (Atlantic City airport) and the limited offshore data from buoy stations.

Meteorological data for the air dispersion modeling, which was performed using EPA's Offshore and Coastal Dispersion (OCD) model, were extracted from three consecutive years of WRF prognostic model data (2018-2020) obtained through U.S. Environmental Protection Agency (EPA) Region 2 from EPA's Office of Air Quality Planning and Standards. The Mesoscale Model Interface Program (MMIF - Version 3.4) was used to extract the necessary meteorological parameters at the points listed in Table 1-1. MMIF converts prognostic meteorological model output fields to the parameters and formats required for direct input into various dispersion models, including parameters required for EPA's AERMOD (overland) and AERCOARE (overwater parameters) modeling systems. MMIF extracts the appropriate data for geographical points by determining which grid cell the point lies within, and then extracting data from that WRF grid cell. The WRF grid cells are spaced approximately 12 kilometers (km) apart, center to center.

Table 1-1 provides the geographical locations identified for the extraction of meteorological data for the OCD modeling, and for the comparative analysis in this appendix. The "overwater extraction point for OCD modeling" corresponds to the northwest corner of the Project development area. The other points shown in the table correspond to the overwater and overland points used for the data comparison discussed in Section 2, as well as the WRF extraction grid points. The overwater extraction point corresponds to the location of the Delaware Bay 26 NM buoy, such that a comparison can be made with the observations from that station. The overland station point is the Atlantic City Airport (KACY) Station number 93730. The airport data were obtained from the National Centers for Environmental Information (https://gis.ncdc.noaa.gov/maps/ncei).

Data for the overwater points were extracted using the AERCOARE option in MMIF, which extracts parameters required by OCD for overwater dispersion. The overland points were extracted using the AERMET option, which extracts parameters required for the OCD overland meteorological files and allows for the comparison of observed (OBS) and WRF-extracted data as presented in Section 2.

Table 1-1. Meteorological Extraction Points and WRF Grid Point Locations.

Data	Latitude	Longitude	Comment
Overwater extraction point for OCD modeling	39.275	-74.262	Corresponds to approximate northwest corner of Project work area.

Data	Latitude	Longitude	Comment
Overland extraction point for OCD modeling	39.538	-74.465	Corresponds to approximate location of Brigantine Visitor Center location
Delaware Bay 26 NM Buoy for overwater meteorology comparison	38.460	-74.692	~97 km southwest of overwater extraction point.
Atlantic City Airport for overland surface meteorology comparison	39.452	-74.567	~13 km southwest of overland extraction point.
WRF data location for overland meteorology comparison	39.456	-74.575	Nearest WRF node to Atlantic City Airport surface station
WRF data location for overwater meteorology comparison	39.357	-74.418	Nearest WRF node to Delaware Bay 26 NM Buoy

Figure 1-1 displays an overview of the following locations:

- MMIF extraction points for WRF data
- Buoy data locations for meteorological data comparison
- Brookhaven, NY upper air station used in OCD modeling for Meteorological Data Comparative Analysis (see Section A-2 below)
- Project development area

Figure 1-2 provides a close-up of the cluster of locations displayed in Figure 1-1 for clarity.

The Delaware Bay 26 NM buoy (Station No. 44009) was chosen for the observations comparison, as it is located in proximity to the Project work area to be used for the study. The buoy records hourly wind speed and wind direction data at a height of 3.8 meters above sea level (masl). The completeness of the parameters over the 3-year period used (2018-2020) is 38 to 64 percent for both wind speed and wind direction. Due to the poor completeness of these data, and because wind data are the most important parameters used for dispersion modeling, the Delaware Bay 26 NM buoy data was combined into a single year file to be used for the comparison. The seasonal completeness for the 2018 to 2020 buoy data was reviewed to select the most complete data for each season to use for the combined year meteorological file. This approach provided complete seasonal information for wind speed and wind direction of greater than 90% for all seasons except wind direction for summer 2018. In order to address the missing data the final 13 days of August 2018 were replaced with the final 13 days of August 2019. These buoy data were downloaded directly from the National Oceanic and Atmospheric Administration's (NOAA's) National Data Buoy Center website (2021).

The Atlantic City Airport (KACY, Station No. 93730) was selected as the overland site for comparison to extracted WRF data. This station is located 34 km northwest of the approximate center of the Project work area and contained all parameters required to process an PCRAMMET meteorological file. Wind direction data was over 90 percent complete over the 3-year period. However, because only a year of data were available for the offshore/buoy data, the exact same periods of meteorology (from multiple years) used to construct a single year of offshore/buoy data, were used to construct the comparison "year" of Atlantic City data for the "observation" land data set. Likewise, the same periods of meteorology (from the multiple years 2018-2020) from the WRF onshore and offshore data extractions were used to create a data "year" for each of these components for the comparative analysis. In this way, all four "one year" data sets (onshore and offshore observed, and WRF onshore and offshore extractions) used exactly the same calendar periods of data (pulled from multiple years) for the comparative analysis described in Section 2.

The following overwater parameters were obtained or calculated as described below:

1) Overwater mixing height – Calculated using AERCOARE for Delaware Bay 26 NM buoy

2) Humidity – Missing for Delaware Bay 26NM buoy; therefore, the default value from the OCD users guide used
3) Overwater Ambient air temperature – Monitored data by Delaware Bay 26 NM buoy
4) Overwater surface temperature – Monitored data by Delaware Bay 26 NM buoy

The model also can accept wind direction and speed, wind shear, turbulence intensities, and temperature gradients, if available.

The following overland meteorological parameters were obtained or calculated as described below:

- Wind speed and wind direction – Monitored by KACY
- Ambient air temperature – Monitored by KACY
- Rural mixing height – Calculated using MIXHT for KACY

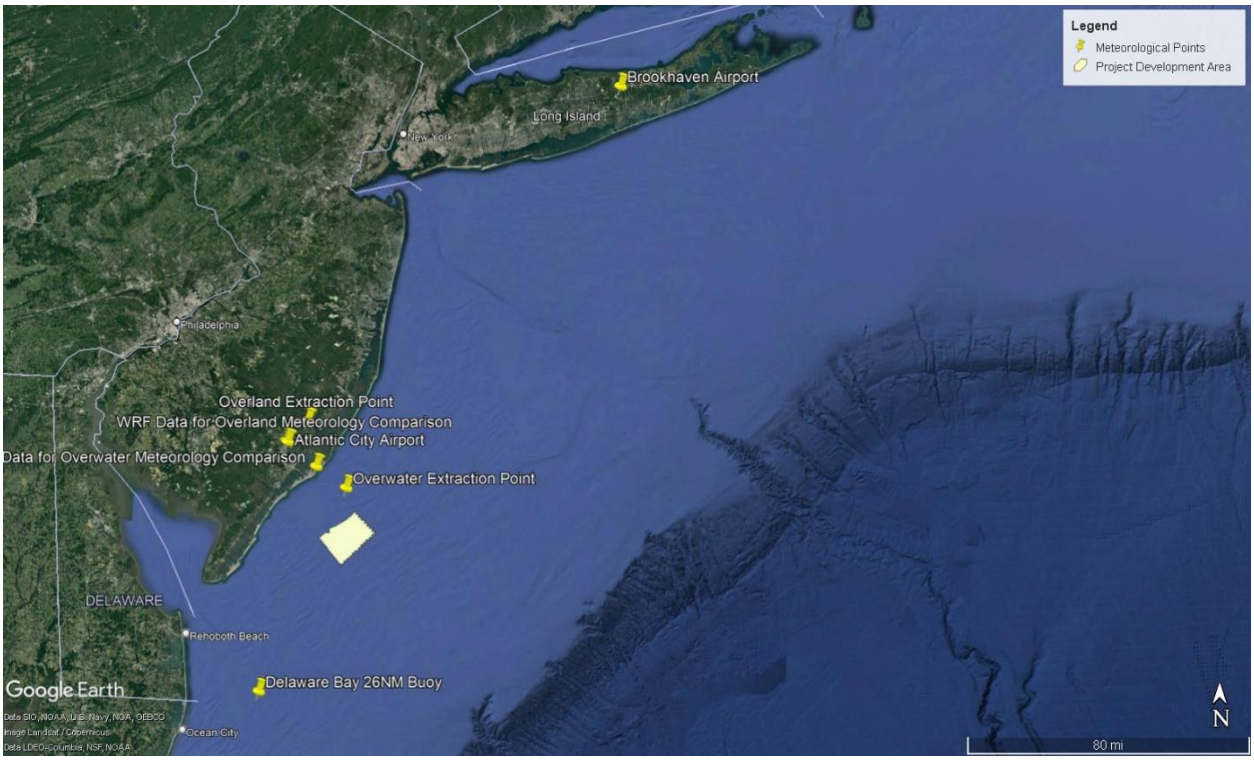


Figure 1-1. Locations of Mesoscale Model Interface Program Extraction Points for OCD Modeling, Buoy and Surface Observations, Upper Air Station for OCD Modeling, and WRF Nodes for Meteorology Comparison.

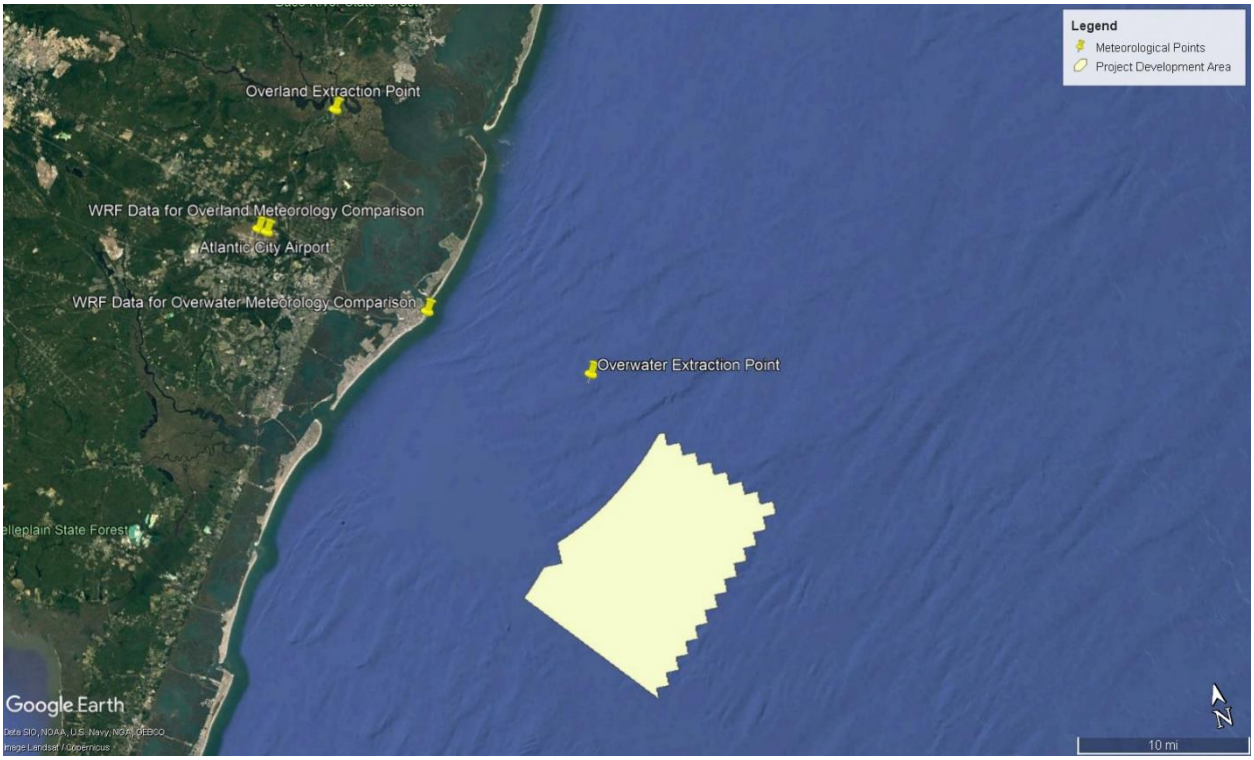


Figure 1-2. Close-up of Locations of Mesoscale Model Interface Program Extraction Points for OCD Modeling, Buoy and Surface Observations, Upper Air Station for OCD Modeling, and WRF Nodes for Meteorology Comparison.

2.0 Meteorological Data Representativeness Comparison

2.1 Comparison of Observed Meteorological Data to Weather Research and Forecasting Data

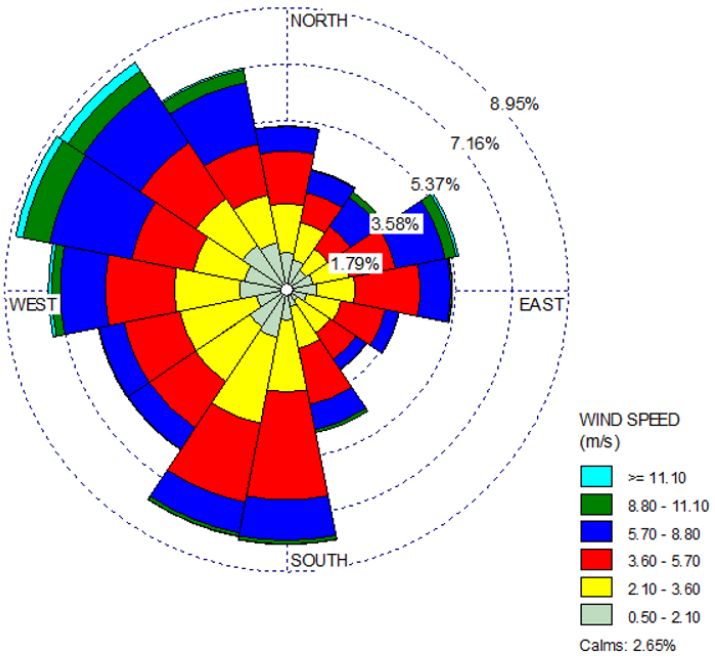
Comparisons between observed (OBS) meteorological data and those extracted from the WRF data set (see Section 1 for a description of the data used) were performed, and the results are discussed in this section. Figures and tables associated with the data comparison assessment are also presented in this section. The comparisons were developed consistent with the EPA guidance document, Evaluation of Prognostic Meteorological Data in AERMOD Applications (EPA, 2018).

2.1.1 Wind Roses

Wind roses for the OBS and WRF data sets for the over land locations are presented in Figure 2-1 for the annual period and Figure 2-2 for seasonal periods. Likewise, the wind roses for the OBS and WRF data sets for the overwater locations are presented in Figures 2-3 for the annual period and Figure 2-4 for seasonal periods. The wind roses generally indicate similar patterns of winds for these data sets.

2.1.2 Meteorological Parameter Statistical Comparison

Tables 2-2 through 2-6 present a statistical comparison of the WRF vs. OBS data sets for the onshore WRF data versus onshore observational data. Likewise, Tables 2-7 through 2-11 present a statistical comparison of the WRF vs. OBS data sets for the offshore WRF data versus onshore observational data. As might be expected, parameters such as wind direction, wind speed and ambient temperatures tend to show pretty good agreement, while mixing height for the WRF data vs. observations tends to show poorer statistical correlation.



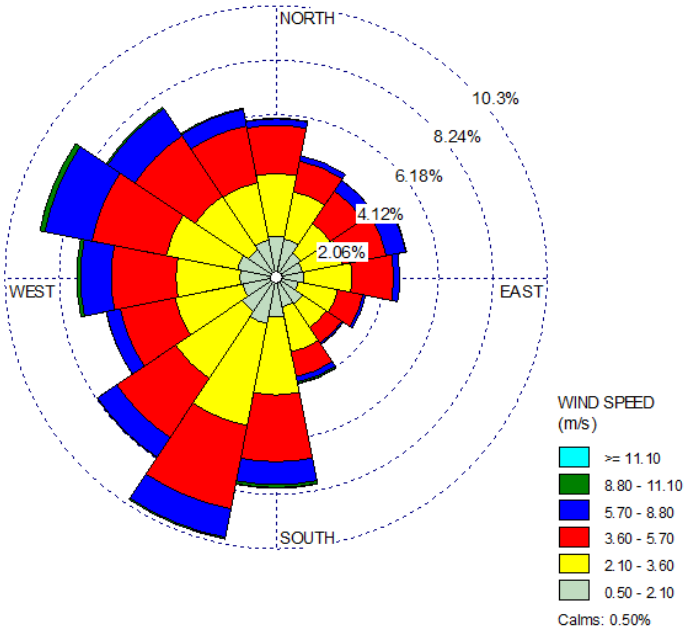
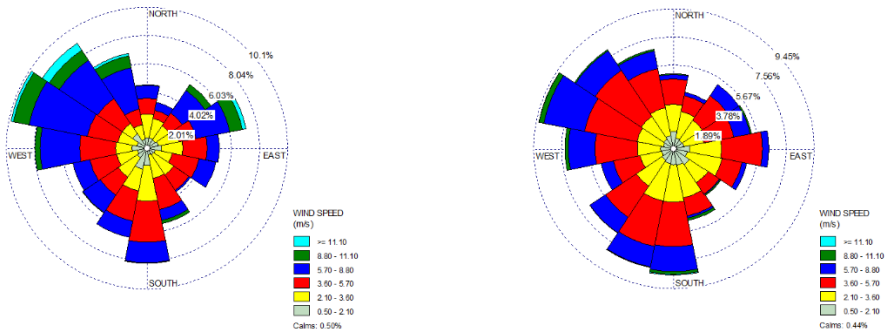
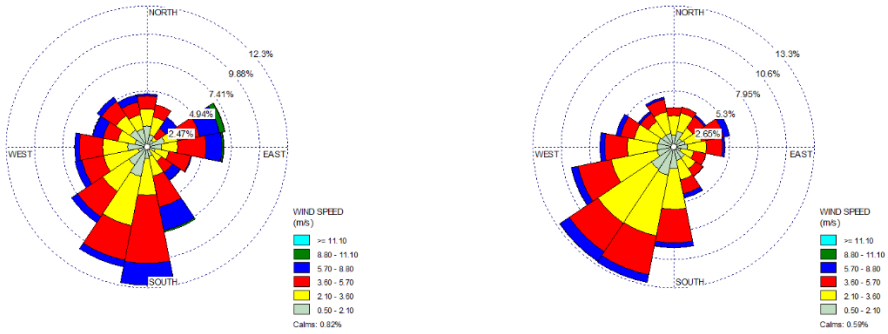


Figure 2-1. Onshore Data - Comparison of Observed and WRF Annual Wind Roses.

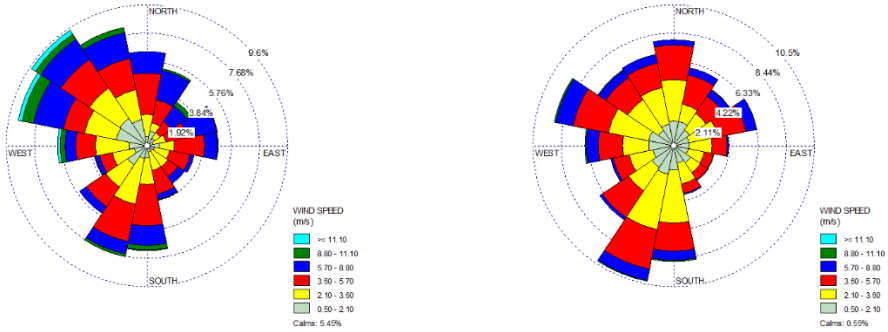
Spring: *Observed* *WRF*



Summer: *Observed* *WRF*



Autumn: *Observed* *WRF*



Winter: *Observed* *WRF*

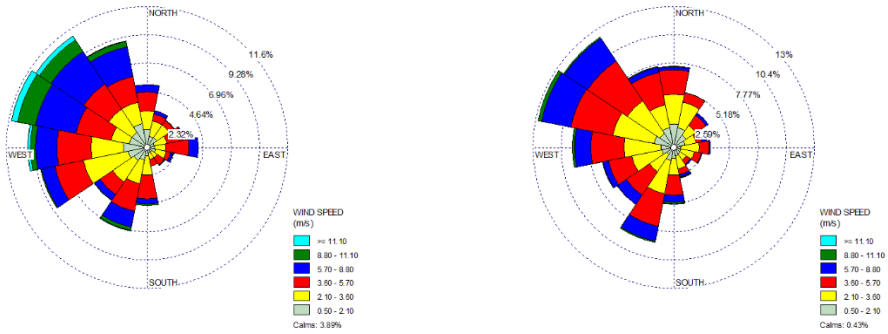
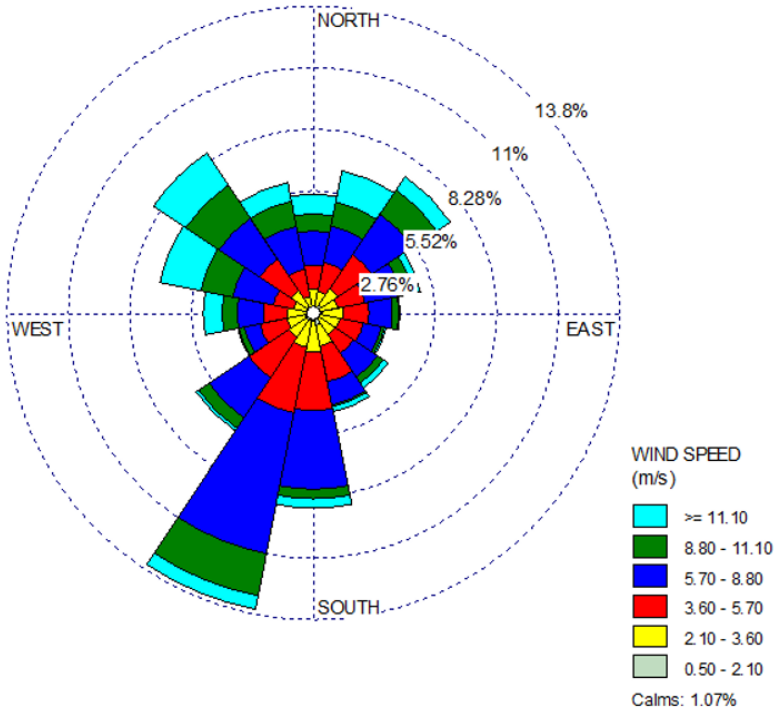


Figure 2-2. Onshore Data - Comparison of Observed and WRF Seasonal Wind Roses.

Observed Annual Wind Data



WRF Annual Wind Data – Node Point Near NW Corner of Project Development

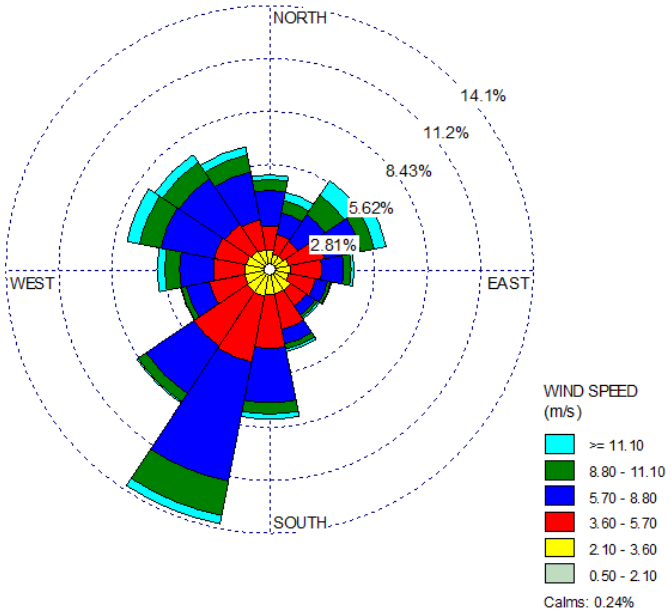
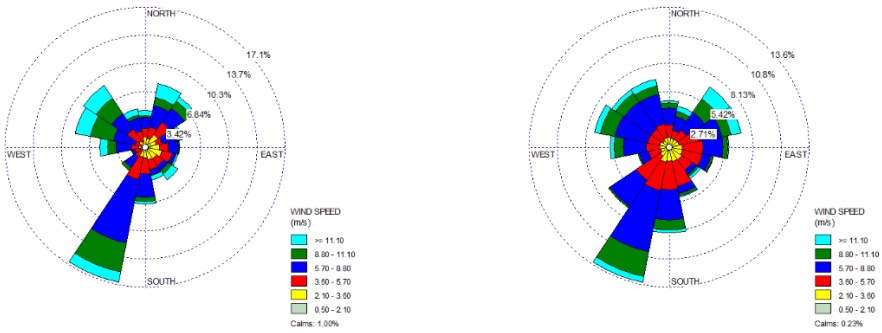
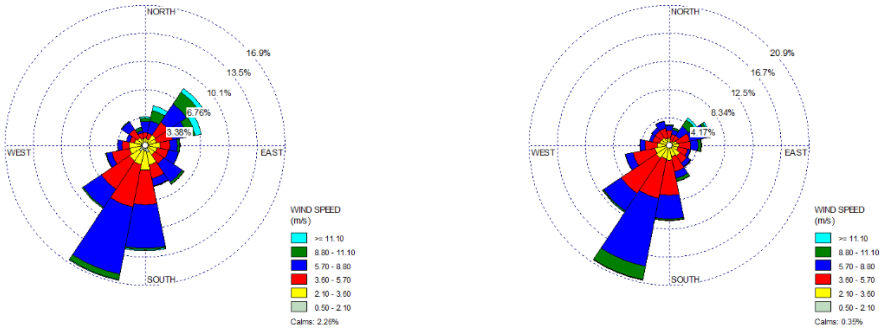


Figure 2-3. Offshore Data - Comparison of Observed and WRF Annual Wind Roses.

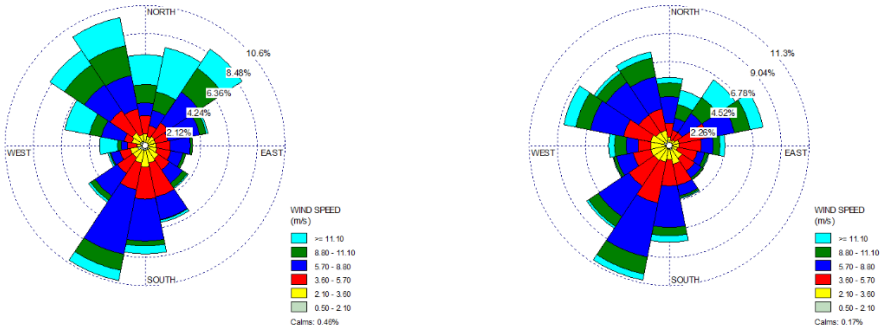
Spring: *Observed* *WRF*



Summer: *Observed* *WRF*



Autumn: *Observed* *WRF*



Winter: *Observed* *WRF*

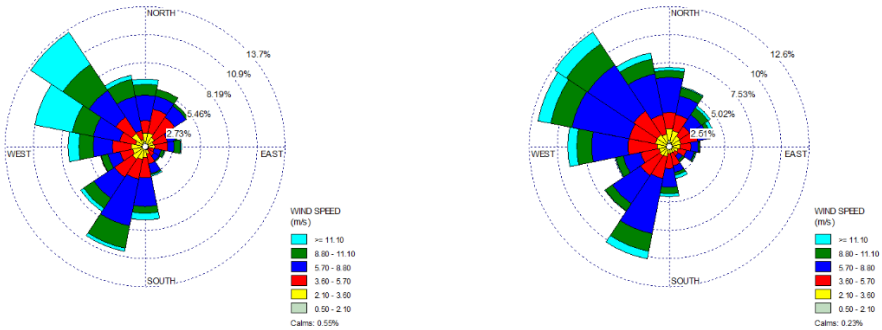


Figure 2-4. Offshore Data - Comparison of Observed and WRF Seasonal Wind Roses.

Table 2-2. Mean Bias, Fractional Bias, Root Mean Square Error, and R2 for Onshore Select Meteorological Variables (WRF-OBS) for Annual Period.

Variable	Mean Bias	Fractional Bias	RMSE	R^2
Flow Vector (degrees)	39.1938	0.7203	184.15	0.1273
Wind Speed (m/s)	-0.8503	0.4684	5.16	0.1485
Ambient Temperature (K)	-1.1589	0.7217	25.68	0.0994
Rural Mixing Height (m)	-637.0646	0.4297	942.77	0.0532

Table 2-3. Mean Bias, Fractional Bias, Root Mean Square Error, and R2 for Onshore Select Meteorological Variables (WRF-OBS) for Spring Period.

Variable	Mean Bias	Fractional Bias	RMSE	R^2
Flow Vector (degrees)	35.3192	0.5306	176.49	0.1929
Wind Speed (m/s)	-0.8266	0.5916	1.56	0.7408
Ambient Temperature (K)	-0.1702	0.8551	1.66	0.9577
Rural Mixing Height (m)	-688.9815	0.3776	1037.76	0.0747

Table 2-4. Mean Bias, Fractional Bias, Root Mean Square Error, and R2 for Onshore Select Meteorological Variables (WRF-OBS) for Summer Period.

Variable	Mean Bias	Fractional Bias	RMSE	R^2
Flow Vector (degrees)	25.0157	0.9861	177.40	0.1555
Wind Speed (m/s)	-0.5474	0.4612	3.04	0.2311
Ambient Temperature (K)	-0.2480	0.6504	1.42	0.9104
Rural Mixing Height (m)	-687.0024	0.5162	1016.54	0.0343

Table 2-5. Mean Bias, Fractional Bias, Root Mean Square Error, and R2 for Onshore Select Meteorological Variables (WRF-OBS) for Autumn Period.

Variable	Mean Bias	Fractional Bias	RMSE	R^2
Flow Vector (degrees)	27.3848	0.8679	190.36	0.1108
Wind Speed (m/s)	-0.7025	0.5254	4.31	0.2031
Ambient Temperature (K)	-0.2084	0.6789	1.67	0.9565
Rural Mixing Height (m)	-641.5000	0.5098	903.65	0.0177

Table 2-6. Mean Bias, Fractional Bias, Root Mean Square Error, and R2 for Onshore Select Meteorological Variables (WRF-OBS) for Winter Period.

Variable	Mean Bias	Fractional Bias	RMSE	R^2
Flow Vector (degrees)	69.2538	0.4697	191.96	0.0772
Wind Speed (m/s)	-1.3281	0.5336	8.75	0.0701
Ambient Temperature (K)	-4.0297	0.7078	51.43	0.0049
Rural Mixing Height (m)	-529.6553	0.3590	790.39	0.0702

Table 2-7. Mean Bias, Fractional Bias, Root Mean Square Error, and R2 for Offshore Select Meteorological Variables (WRF-OBS) for Annual Period.

Variable	Mean Bias	Fractional Bias	RMSE	R^2
Wind Direction (degrees)	6.0215	2.3350	109.59	0.1813
Wind Speed (m/s)	-0.3053	0.8779	3.18	0.2625
Mixing Height (m)	46.0955	0.9927	347.89	0.2592
Ambient Air Temperature (K)	-0.6108	0.7963	2.46	0.9128
Water Surface Temperature (K)	-1.1900	0.5397	1.87	0.9598

Table 2-8. Mean Bias, Fractional Bias, Root Mean Square Error, and R2 for Offshore Select Meteorological Variables (WRF-OBS) for Spring Period.

Variable	Mean Bias	Fractional Bias	RMSE	R^2
Wind Direction (degrees)	11.2416	1.8251	105.64	0.2269
Wind Speed (m/s)	-0.3584	0.8722	3.27	0.3031
Mixing Height (m)	-27.2954	0.6780	390.36	0.1996
Ambient Air Temperature (K)	0.4134	1.5272	2.32	0.8145
Water Surface Temperature (K)	-0.0269	1.1842	0.75	0.9711

Table 2-9. Mean Bias, Fractional Bias, Root Mean Square Error, and R2 for Offshore Select Meteorological Variables (WRF-OBS) for Summer Period.

Variable	Mean Bias	Fractional Bias	RMSE	R^2
Wind Direction (degrees)	11.6941	2.4032	96.36	0.1283
Wind Speed (m/s)	0.1457	1.1278	2.81	0.1511
Mixing Height (m)	25.3536	1.1179	219.21	0.2233
Ambient Air Temperature (K)	-0.4475	0.7060	1.74	0.7884
Water Surface Temperature (K)	-0.5455	0.6112	1.49	0.8596

Table 2-10. Mean Bias, Fractional Bias, Root Mean Square Error, and R2 for Offshore Select Meteorological Variables (WRF-OBS) for Autumn Period.

Variable	Mean Bias	Fractional Bias	RMSE	R^2
Wind Direction (degrees)	1.1561	2.9767	115.38	0.2012
Wind Speed (m/s)	-0.3810	0.6974	3.21	0.3230
Mixing Height (m)	93.0244	1.4220	370.21	0.2636
Ambient Air Temperature (K)	-1.0081	0.7237	2.67	0.8269
Water Surface Temperature (K)	-1.3643	0.2029	1.65	0.9729

Table 2-11. Mean Bias, Fractional Bias, Root Mean Square Error, and R2 for Offshore Select Meteorological Variables (WRF-OBS) for Winter Period.

Variable	Mean Bias	Fractional Bias	RMSE	R^2
Wind Direction (degrees)	-0.1255	2.3223	119.68	0.1292
Wind Speed (m/s)	-0.6319	0.8426	3.39	0.1677
Mixing Height (m)	94.3338	0.9059	383.50	0.2754
Ambient Air Temperature (K)	-1.4139	0.5602	2.95	0.4771
Water Surface Temperature (K)	-2.8431	0.0000	2.93	0.7148

Appendix B, Pre-Application Air Quality Analysis and Request for Exemption from Pre-Construction Monitoring

Ocean Wind Revised Modeling Protocol

Ocean Wind OCS Air Permit Application

1.0 Introduction

Ocean Wind LLC (Ocean Wind), a joint venture between Orsted Wind Power North America, LLC (Orsted) and Public Service Enterprise Group Renewable Generation LLC (PSEG), is submitting herein an Outer Continental Shelf (OCS) air modeling protocol to support the construction and operation of the Ocean Wind Offshore Wind Farm Project (Ocean Wind or Project).

The Ocean Wind construction and commissioning phase would trigger Prevention of Significant Deterioration of Air Quality (PSD) review and permitting under 40 CFR 55, for several pollutants: nitrogen oxides [NO_x, as a precursor to nitrogen dioxide (NO_2)], carbon monoxide (CO), volatile organic compounds (VOC, as a precursor to ozone), particles less than 10 microns in diameter (PM_{10}), and particles less than 2.5 microns in diameter ($PM_{2.5}$). Preliminary dispersion modeling indicates the project would have maximum CO impacts below significant impact levels (SILs – see 40 CFR 51.165) and below the significant monitoring concentration (SMC) of 575 µg/m3 for 8-hour average CO[1] (see Section 2.0 below). Therefore, the revised permit application to be submitted mid-July will contain a pre-application air quality analysis, meaning an analysis of existing air quality in the project area, for NO_2, PM_{10} and $PM_{2.5}$.

The pre-application air quality analysis can utilize existing air quality data, or new data collected by the project sponsor, representative of the project area. Given the offshore location of the Project, substantial infrastructure, including an offshore platform, would have been required to perform air quality monitoring within the bounds of the wind turbine array. In addition, air pollutant emissions and concentrations in the vicinity of the proposed array are expected to be quite small, due to passing marine vessels, and some downwind transport of emissions from onshore sources. Because of the lack of stationary emissions sources near the array, it is expected that the existing land-based monitors in the region will provide conservatively high estimates of pollutant concentrations in the immediate project area.

Figure 2-1 shows the proposed offshore wind turbine array, and locations of existing/pre-existing monitor sites in the region, selected for this analysis because they are not only the nearest site to the project area, but because they are expected to provide the most representative data for the project area. Note that while an air quality analysis is not required for ozone (given its nonattainment status), an ozone monitor site is shown on Figure 2-1, as ozone data from this site will be used for the NO_2 modeling analysis via application of the Ozone Limiting Method. As described above, measurements from these sites are expected to be conservatively high compared to actual concentrations in the project development area, as well as in areas where on-land receptors will be placed (i.e., in the Ocean City vicinity) for the dispersion modeling analysis of compliance with National Ambient Air Quality Standards (NAAQS) and PSD Class II allowable concentration increments. Table 2-1 provides a summary listing of the site addresses, site IDs, etc., including the period of record available at each monitoring site. Data completeness and summaries of monitored values for each site were obtained from EPA's AirData web site (Air Data: Air Quality Data Collected at Outdoor Monitors Across the US | US EPA).

[1] Obtained from Table A-1 in NJDEP Guidance on Preparing an Air Quality Modeling Protocol dated May 2021. Retrieved from: https://www.state.nj.us/dep/aqpp/downloads/techman/1002.PDF.

2.0 Pre-Construction Monitoring and Air Quality Analysis Exemption Request

OCS preliminary air dispersion modeling was performed for the worst-case 24-hour emissions activities, to determine if maximum modeled CO concentrations from project sources would be less than SILs and/or below the applicable SMC of 575 µg/m3 for 8-hour average CO. Project impacts below an applicable SMC level for a pollutant mean that a project qualifies for an exemption from the Preconstruction Air Quality Analysis otherwise required under PSD rules. Project impacts below the applicable SILs for a pollutant mean that a cumulative impact analysis, considering background concentrations, is not required for that pollutant. Table 2-2 summarizes the preliminary modeling results for CO, in comparison to the SMC and SIL thresholds.

The modeled sources for this preliminary CO analysis included the worst-case construction activity in terms of short-term CO emissions, which is the monopile installation as part of wind tower foundation installation. The OCD model was executed simulating this activity as if it were occurring full-time for the whole 3-year period of meteorology (2018-2020).

Based on the results summarized in Table 2-2, the Project qualifies for an exemption from a full Air Quality Analysis for CO, including the Pre-Application Air Quality Analysis otherwise required under paragraph (m) of 40 CFR 52.21. Therefore, the Project sponsor requests that EPA grant this exemption. In addition, the preliminary CO results in Table 2-2 show that the worst-case emissions activity (monopile installation) will have maximum impacts less than the SILs for 1-hour and 8-hour CO. Therefore, the Project will not need to undergo a cumulative air quality impact analysis for CO, which would consider background CO concentrations.

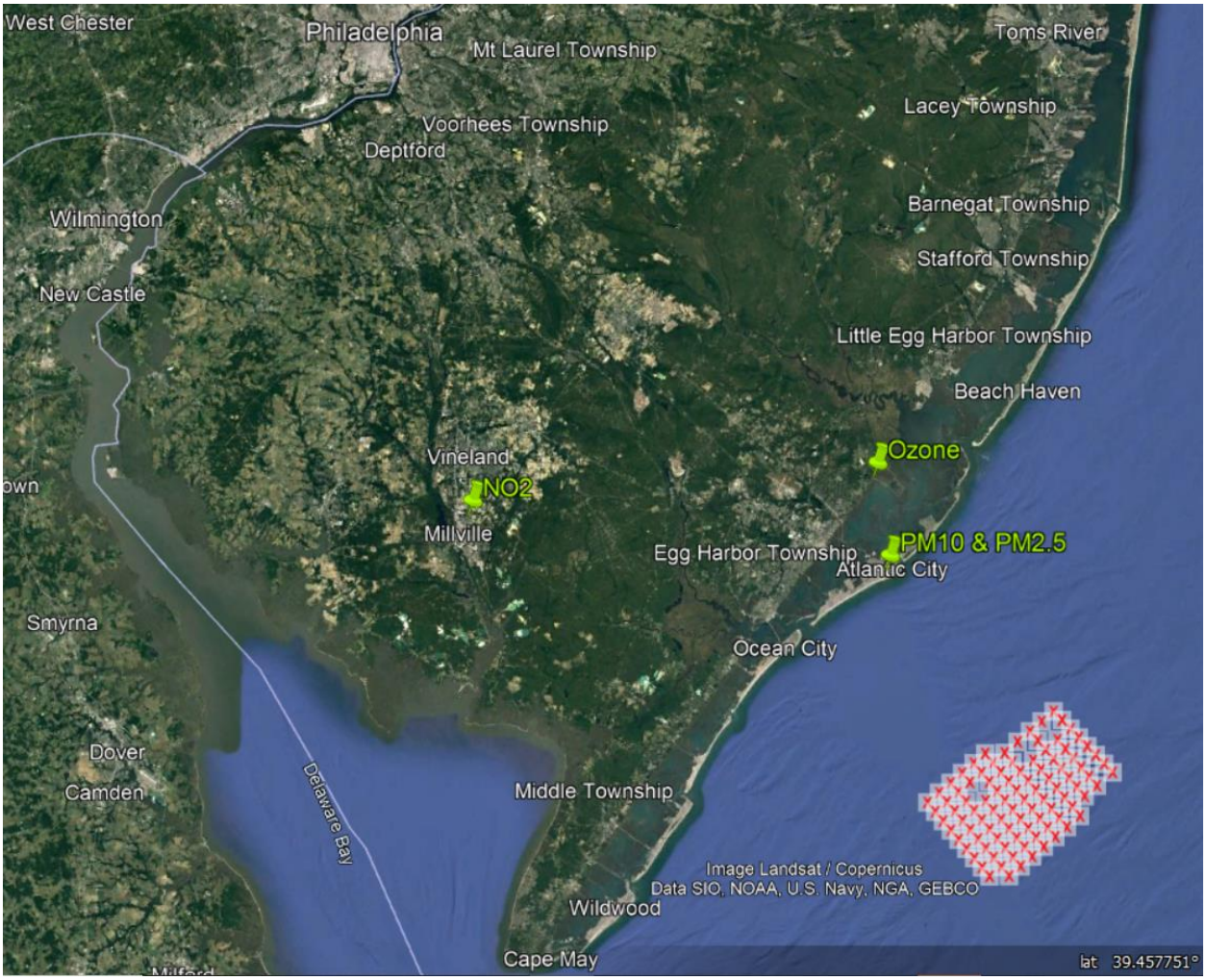


Figure 2-1. Existing Monitoring Sites for Pre-Application Air Quality Analysis.

Table 2-1. Listing of Selected Monitor Sites for Pre-Application Air Quality Analysis.

Pollutant	Monitoring Site Address	EPA Site ID	Period of Record	Distance from Nearest Array Edge (km)
NO_2	Behind 4401 S. Main Road, Millville, NJ	340110007	2016-2022	65
$PM_{2.5}$	Atlantic Cape Community College, 1535 Bacharach Boulevard, Atlantic City, NJ	340011006	2001-2021	26
PM_{10}	Atlantic Cape Community College, 1535 Bacharach Boulevard, Atlantic City, NJ	340011006	2001-2010	26

Table 2-2. Preliminary OCD Carbon Monoxide Modeled Impacts Compared to SILs and SMC.

Pollutant	Averaging Period	Maximum Predicted Impact (µg/m³)	SMC (µg/m³)	SIL (µg/m³)
CO	1-hour	401.3	NA	2,000
	8-hour	327.3	575	500

3.0 Existing Air Quality in the Project Area

The following sections provide a summary of the basis for selecting each proposed monitor site as the most representative of the Project area. The representativeness of these regional monitoring data provides the basis for not requiring new pre-application monitoring to be performed in the Project area for these pollutants.

3.1 Nitrogen Dioxide (NO_2)

As shown in Table 2-1 and Figure 2-1, there is an existing NO_2 ambient air monitor located in the city of Millville, which is approximately 65 km west-northwest of the proposed offshore wind turbine array. Among monitor site with data for recent years, this is the nearest NO_2 monitor location to the project area. The next nearest NO_2 monitors include several at sites along the urban corridor extending from Washington, D.C., to Baltimore, to Philadelphia, to Trenton, and to New York City. The nearest of these is over 100 km from the project area, and all of these sites are in much more urbanized areas, which would be less representative of the Project area in terms of emissions levels and population levels.

Based on the above, the Millville NO_2 monitor is clearly the most representative of the over water project area, which experiences only intermittent emissions from passing marine vessels, and transport of NO_2 (or precursor NO_x) emissions from distant land-based stationary and mobile emission sources. The data completeness for each of the most recent three years of data (2019, 2020, 2021) is well above the EPA minimum criteria of 90%, with hourly readings at 96.8% completeness in 2019 and 97.5% completeness in both 2020 and 2021. Therefore, these data are proposed for use in the pre-application air quality analysis for NO_2.

3.2 Particles Less than 2.5 Microns in Diameter Ozone ($PM_{2.5}$).

For $PM_{2.5}$, there are existing monitors in downtown Atlantic City (data from 2001-2021) and near the EBFNWR visitor center (data from 2016-2021). Land use is more pristine, obviously, near the EBFNWR visitor center, and in this respect, localized $PM_{2.5}$ emissions near that monitor may be perceived as more representative of the relatively pristine offshore project location. However, $PM_{2.5}$, monitoring data for collected over many years in metropolitan areas of the eastern US indicate that $PM_{2.5}$ concentrations tend to vary little at multiple monitors across an urban area or region of similar size. This is because most $PM_{2.5}$ in the eastern US is formed by photochemical processes acting on gaseous precursor pollutants (NO_x, SO_2, etc.) transported over long distances. This is not true in many local areas in the western US, where temperature inversions tend to trap the air in the valleys/basins, and people burn a lot of wood for heating or recreational fires. In such cases, $PM_{2.5}$ concentrations can vary substantially over short distances.

While the downtown Atlantic City $PM_{2.5}$ monitor may present slightly more conservative concentration data than the EBFNWR monitor, the Atlantic City monitor data are from nearer the project location. The 2017-2019 data from the Atlantic City site are proposed for use in the pre-application air quality analysis for $PM_{2.5}$, given that the more recent years (2020, 2021) has much less than complete data for the 1 in 3 day monitoring schedule.

3.3 Particles Less than 10 Microns in Diameter Ozone (PM_{10}).

The are no existing PM_{10} ambient air monitors in Atlantic County or nearby counties. The nearest currently operating monitors are along the urbanized corridor from Washington, D.C. to New York City, with the nearest two monitors located near the center of the Philadelphia urban area. However, PM_{10} concentrations had been measured in Atlantic City from 2001 until 2010. The last 3-4 years of data had significant data missing from the scheduled every-6th-day PM_{10} monitoring schedule. Therefore the 2005-2007 years, which each had over 50 sample days out of a maximum possible of 61 per year, are proposed to conservatively characterize PM_{10} concentrations in the project area.

4.0 Data Summary

The representative or conservatively representative ambient air quality monitoring data for the sites and years described above are listed in Table 4-1. The monitored concentration data for the three years of data for each pollutant, from the selected monitor data sites, are provided for the ranked values according to the form of the NAAQS. All 3-year average pollutant concentrations are less than the respective NAAQS.

Table 4-1. Pre-Application Analysis Representative Monitoring Data Summary.

Pollutant	Averaging Period	Rank	Monitored Background Concentration				Units	NAAQS
			2018	2019	2020	3-Year Average		
NO_2	1-hour	8th High Daily Max	65.8	60.2	63.9	63.3	µg/m^3	188
	Annual	N/A	11.9	11.9	11.8	11.9	µg/m^3	100
			2017	**2018**	**2019**			
$PM_{2.5}$	24-hour	98th Percentile	18	15	17	16.7	µg/m^3	35
	Annual	N/A	6.9	6.3	6.5	6.6	µg/m^3	12
			2005	**2006**	**2007**			
PM_{10}	24-hour	2nd High	50	37	47	44.7	µg/m^3	150

Appendix C, Ozone Limiting Method FORTRAN Post-processing Code

Ocean Wind Revised Modeling Protocol

Ocean Wind OCS Air Permit Application

```
      program ocdolm_bkgd
!     this program takes the binary nox data outputted from program ocd
!     and adjusts nox concentrations as a function of ozone
!     concentration using the "ozone limiting method"
!     ** it adds additional features to the original ocdolm.f software
!     HDR, Inc (May, 2022)
!     Author: Jim Hallden (james.hallden@hdrinc.com)
!     Release 1.00
      implicit none
      integer*4 ndesc,nmet,ntimes,ndays,hrperday
      parameter(ndesc=3,nmet=7,hrperday=24)
      real*4 qtr_breakday(4)
      character*255 infile,outfile,ozone_file,tstring,no2_file
      character*80 line_description(ndesc)
!     information for each record in hourly output (7 meteorological conditions)
!     1) overwater mixing eight (m)
!     2) wind direction (FROM, deg)
!     3) inferred overwater stability class
!     4) overwater wind speed, m/s
!     5) overland mixing height(m)
!     6) overland stablity class
!     7) overland wind speed
!     concentration(g/M3)
      character*12, allocatable :: date(:)  !  date from ozone conc file
      real*4, allocatable::  ow_mix(:),ow_stab(:),ow_wspeed(:) ! met 1,2,4 (above)
     &                      ,ol_mix(:),ol_stab(:),ol_wspeed(:) ! met 4,6,7 (above)
     &                      ,wind_dir(:)    ! met 2 (above)
     &                      ,hour(:),day(:) ! hour and day indices
     &                      ,sortvar(:,:)   ! variable used by sort algorithm
      real*8, allocatable:: recpt_annual_avg(:)
     &                     ,recpt_annual_avg_nobkgr(:)
      real*4, allocatable::  conc_dailymax(:) ! olm-corrected daily max
concintrations
      real*4, allocatable::  hour_dailymax(:) ! olm-corrected daily max
concintrations
      integer*4 i,j,k,nrecpt,nargs,idum,m,ncol
      integer*4 iwant_debug,debug_recpt ! save raw information for cell debug_recpt

      real*4, allocatable:: rx_coord(:),ry_coord(:),conc(:,:) !coordinates and
concs from ocd output
      real*4, allocatable:: ozone(:) ! ozone from ozone file
      real*4 no2_hravg(hrperday,4)
      real*4 no2_bgr  ! no2 background value from hourly/quarterly lookup
      real*4 conc_ori
      integer*4 jk(3),id(3),is_leapyear,iday,ihr ! leapyear flag, integer day and
hour indices
      real*4 aisr,olm_val,concppm ! stack ratio, self-explanatory temporary values
      data jk/1,0,0/ ! sort order of variables for sorting subroutine
      data id/2,0,0/ ! sort ascending (=1) or descending (=2) for sort subroutine
```

```
      ncol=3 ! number of columns to be passed to sort routine (conc,day)
      nargs=iargc() ! get number of command line arguments

!     print out a message and terminate if there aren't 5 command line
!     arguments
!     test for debug flag
      iwant_debug=0
      if(nargs.eq.6) then
        call getarg(6,tstring)
        read(tstring,fmt='(i10)') debug_recpt ! receptor number for debug
        iwant_debug=1
      endif
      if(nargs.lt.5) then
        write(6,*)
        write(6,*) 'usage: ocdolm_bkgd <binary conc file>'
     &  //' <output basename>'
     &  //' <ozone_file> <AISR> <no2_file> (optional)'
     &  //' <debug receptor_number>'
        write(6,*)
        stop
      endif

!     get command line arguments
      call getarg(1,infile)  ! conc.bin-style file name
      open(11,file=trim(infile),form='unformatted',status='old')
      call getarg(2,outfile) ! output file name
      open(98,file=trim(outfile)//'_peak.csv',status='unknown')
      call getarg(3,ozone_file) ! ozone file name
      open(12,file=trim(ozone_file),form='formatted',status='unknown')
!     important ==> ozone file must match exact hours of ocd conc file
      call getarg(4,tstring)
      read(tstring,fmt='(f16.0)') aisr  ! stack ratio
      call getarg(5,no2_file)
      open(13,file=trim(no2_file),form='formatted',status='unknown')
!     also open a dailymax .csv file for debugging purposes to save
!     all dailymax values per receptor
      open(91,file=trim(outfile)//'_annual_avg.csv',status='unknown')
      if(iwant_debug.eq.1) then
        open(89,file=trim(outfile)//'_debug_daily.csv',form='formatted'
     & ,status='unknown')
        open(88,file=trim(outfile)//'_debug_hourly.csv',form='formatted'
     & ,status='unknown')
      endif
      write(6,*)
!     get allocatable array dimensions from OCD conc.bin-style binary file
!     read the ocd run description
      read(11) line_description
      write(6,*)
      write(6,*) 'OCDOLM_BKGD (OLM Correction plus NO2 Background)'
      write(6,*)
```

```
      write(6,*) 'File Assignments'
      write(6,*) 'OCD Conc Input File: '//trim(infile)
      write(6,*) 'Ozone Conc Input File: '//trim(ozone_file)
      write(6,*) 'NO2 Conc Input File: '//trim(no2_file)
      write(6,*) 'Peak Conc Output File: '
     &  //trim(outfile)//'_peak.csv'
      write(6,*) 'Annual Avg Conc Output File: '
     &  //trim(outfile)//'_annual_avg.csv'
      if(iwant_debug.eq.1) then
        write(6,fmt='(a,i6)') 'Debugging output requested for '
     &    //'receptor,',debug_recpt
        write(6,fmt='(a)') 'Debug Output Files: '//trim(outfile)
     &   //'_debug_daily.csv and '//trim(outfile)
     &    //'_debug_hourly.csv'
      endif
      write(6,*)
      do i=1,3
        write(6,fmt='(a)') 'Description in Concentration File: '
     &   //trim(line_description(i))
      enddo
      read(11) nrecpt
      ntimes=0
!     read a dummy record until the end of file is hit
      do while (1.eq.1)
        read(11,end=10) idum
        ntimes=ntimes+1
      enddo
   10 continue
      ndays=ntimes/24
!     set leap year depending on number of days encountered in
!     output conc record from OCD
      qtr_breakday(1)=90
      qtr_breakday(2)=181
      qtr_breakday(3)=273
      qtr_breakday(4)=365
      if(ndays.eq.365) then
        is_leapyear=0
      elseif(ndays.eq.366) then
        is_leapyear=1
        qtr_breakday=qtr_breakday+1 ! array operation
      else
        write(6,*) '** error: this is not a full annual simulation '
     &  //'(exiting)'
        stop
      endif
      write(6,fmt='(a,i6,a,i6,a)') 'there are ',ntimes,
     & ' time records present and ',nrecpt,' receptors'
      write(6,fmt='(a,f8.2)') 'the all-stack, in-stack ratio is',aisr

!     allocate variables
```

```
      allocate(ow_mix(ntimes),ow_stab(ntimes),ow_wspeed(ntimes))
      allocate(ol_mix(ntimes),ol_stab(ntimes),ol_wspeed(ntimes))
      allocate(wind_dir(ntimes),sortvar(ndays,3))
      allocate(rx_coord(nrecpt),ry_coord(nrecpt))
      allocate(conc(ntimes,nrecpt),hour(ntimes))
      allocate(date(ntimes),ozone(ntimes))
      allocate(conc_dailymax(ndays),hour_dailymax(ndays))
      allocate(day(ndays))
      allocate(recpt_annual_avg(nrecpt))
      allocate(recpt_annual_avg_nobkgr(nrecpt))
!
!     read no2 hourly averaged data by annual quarter
      read(13,*)
      do i=1,hrperday
        read(13,*) idum,(no2_hravg(i,j),j=1,4)
        if(iwant_debug.eq.1) then
          if(i.eq.1) then
            write(6,*) '  NO2 Background Conc (ppb)'
            write(6,*) '  Hour    Q1conc    Q2conc   Q3conc   Q4conc'
          endif
          write(6,fmt='(i5,4f8.2)') idum,(no2_hravg(i,j),j=1,4)
        endif
      enddo
!     write file headers for output files
      if(iwant_debug.eq.1) then
        write(89,fmt='(a)')
     &  'Receptor,x_coord,y_coord,day,conc_g/m3,hour_of_max'
        write(88,fmt='(a)') 'Receptor,day,hour,model_conc_g/m3,'
     &    //'olm+bkgr_conc_g/m3,ozone_ppm,no2_bkgr_ppm'
      endif
      write(98,fmt='(a)')
     &   'Receptor,x_coord,y_coord,conc_high_g/m3,day_high,hour_high'
     & //',conc_8th_g/m3,day_eigth,hour_eigth'
!     rewind concentration input file, skip decriptions and get
!     coordinates
      rewind(11)
      read(11) ! descriptions skipped
      read(11) idum,(rx_coord(i),ry_coord(i),i=1,nrecpt)
      read(12,*) ! also skip descriptiong header for ozone file
!     read the actual data (7 meteorological conditions and conc)
!     for each receptor-time
      do m=1,ntimes
        read(11) ow_mix(m),wind_dir(m),ow_stab(m),ow_wspeed(m)
     &    ,ol_mix(m),ol_stab(m),ol_wspeed(m),(conc(m,i),i=1,nrecpt)
        read(12,fmt='(a12,es12.4)') date(m),ozone(m)
!       add in the olm correction
        do i=1,nrecpt
!         convert conc to (g/M^3) to ppm
          conc_ori=conc(m,i)
          concppm=conc(m,i)*1.E6/1880.0
```

```
          olm_val=concppm*aisr + min(ozone(m),(1.-aisr)*concppm)
!         add background no2 values hourly average file
          ihr=mod(m,24)+1
          iday=(m-1)/24+1
          no2_bgr=-999.
          do j=1,4
            if(iday.le.qtr_breakday(j)) then
              no2_bgr=no2_hravg(ihr,j)/1000.0 ! ppb to ppm in background
              exit
            endif
          enddo
          if(no2_bgr.eq.-999.) stop ' ** error in no2_bgr lookup'
!         annual average summation without bacground no2
          recpt_annual_avg_nobkgr(i)=recpt_annual_avg_nobkgr(i)+olm_val
!         add no2 background value to olm_val (both in ppm)
          olm_val=olm_val+no2_bgr
!         annual average summation including bacground no2
          recpt_annual_avg(i)=recpt_annual_avg(i)+olm_val
!         convert from ppm back to (g/M^3)
          conc(m,i)=olm_val*1880.0/1.E6
          if(iwant_debug.eq.1.and.i.eq.debug_recpt) then
            write(88,2005) i,iday,ihr,conc_ori,conc(m,i),ozone(m)
     &      ,no2_bgr
 2005       format(i6,',',2(i4,','),3(es12.4,','),es12.4)
          endif
        enddo
        hour(m)=m
      enddo

!     divide recpt_annual_avg and nobkgr sums from the above loop by ntimes to
!     get the annual average by receptor and write to file
      recpt_annual_avg=recpt_annual_avg/ntimes*1880.0/1.E6
      recpt_annual_avg_nobkgr=recpt_annual_avg_nobkgr/ntimes*1880.0/1.E6
      write(91,fmt='(a)')
     & '"Receptor","Modeled_Annual_Average","Modeled+Background"'
      do i=1,nrecpt
        write(91,2004) i,recpt_annual_avg_nobkgr(i),recpt_annual_avg(i)
 2004   format(i6,',',es12.4,',',es12.4)
      enddo

!     compute daily maximum values for each 24-hour period
!     for each receptor
      do i=1,nrecpt
!       initialize conc_dailymax to a large negative number
        conc_dailymax=-1.E37
!       initialize hour index m from the raw records
        m=0
!       for each day
        do k=1,ndays
          day(k)=k
```

```
!         for each hour in one day
          do j=1,24
!           increment the hour counter
            m=m+1
!           conc_dailymax(k)=max(conc(m,i),conc_dailymax(k))
            if(conc(m,i).gt.conc_dailymax(k)) then
              conc_dailymax(k)=conc(m,i)
              hour_dailymax(k)=mod(m,24)+1
!             write(6,*) 'hour_dailymax=',hour_dailymax(k)
            endif
          enddo
!         write all daily maximum values for each receptor to file for
!         debugging
          if(iwant_debug.eq.1.and.i.eq.debug_recpt) then
           write(89,2002)
     &     i,rx_coord(i),ry_coord(i),k,conc_dailymax(k),hour_dailymax(k)
 2002      format(i6,',',2(f9.3,','),i4,',',es13.3,',',f6.0)
          endif
        enddo
!       we now have 365 or 366 values for each receptor
!       sort daily max data
!       subroutine shelr requires a multi-dimensional array
!       to be established when sorting more than one variable
!       in this case we're sorting day and conc_dailymax to
!       maintain a record of the day in which each sorted value
!       was observed
        sortvar(:,1)=conc_dailymax
        sortvar(:,2)=day
        sortvar(:,3)=hour_dailymax

!       for debug
!       if(i.eq.3) then
!         write(6,*)
!         write(6,fmt='(a,8es9.2,/,10x,8f9.0)')
!    &    'before sort:',sortvar(1:8,1),sortvar(1:8,2)
!       endif

        call shelr(sortvar,ndays,ndays,ncol,jk,id)

!       for debug
!       write(6,*) 'at shell sort i=',i
!       if(i.eq.3) then
!         write(6,fmt='(a,8es9.2,/,10x,8f9.0)')
!    &    'after sort:',sortvar(1:8,1),sortvar(1:8,2)
!         write(6,*)
!       endif

!       write final requested outputs
        write(98,2003)
     &  i,rx_coord(i),ry_coord(i),sortvar(1,1),int(sortvar(1,2))
```

```
     & ,int(sortvar(1,3)),sortvar(8,1),int(sortvar(8,2))
     & ,int(sortvar(8,3))
 2003 format(i6,',',2(f9.3,','),es11.3,',',2(i6,','),es11.3,',',i6
     &         ,',',i6)
      enddo

  999 continue
!     close files and exit
      close(98)
      close(91)
      close(89)
      close(88)
      close(11)
      write(6,*)
      write(6,fmt='(a)') 'Program Completed Successfully'
      write(6,*)
      end

C     SHELL SORT
C     REFERENCES..
C         D.A.SHELL, CACM, VOL 2 (1959), PP 30..32
C         T.N. HIBBERD, SDC RPEORT SP-982
C         J.ROOTHROYD, CACM, ALBORITHM 201
C     THIS IS A FORTRAN VERSION OF ALGORITHM 201.
      SUBROUTINE SHELR ( A,N,NROW,NCOL,JK,ID)
C      A=INPUT ARRAY TO BE ARRANGED
C     N=NUMBER OF ELEMENTS (FILLED ROWS) IN  A (usually=nobs)
C     NROW=NUMBER OF ROWS IN  A (usually=nvec)
C     NCOL=NUMBER OF COLUMNS IN  A  (this is the no. of arguments ie. if
c      sending just x then ncol=1, if sending xy(nvec,2)=x(1) & y(1) then
c      ncol=2 etc...)
C     JK=ARRAY CONTAINING HIERARCHY OF COLUMNS TO DETERMINE
C              FINAL ARRANGEMENT OF  A (JK(LAST+1)=0)
C     ID=ARRAY IN 1 OT 1 CORRESPONDANCE WITH JK TO DETERMINE DIRECTION O
C             SORT.  ID=1...ASCENDING
C                    ID=2...DESCENDING
c---  JK - contains order of arrays in which to sort,
c---     last element must =0.  For example have two columns to sort (x&y)
c---     want to sort by y only so jk=/2,0/  if sort by x jk=/1,0/  if
c---     sort by y first then x jk=/2,1,0/ etc...
c---     ID- contains ascending or descending flag must have same
c---     number of elements as JK, one for each sort.
c     DIMENSION  A(1),ID(1),JK(1)
cjah  DIMENSION  A(NROW*NCOL),ID(NCOL),JK(NCOL+1)
cjah  jk(ncol+1)=0.
      DIMENSION  A(NROW*NCOL),ID(NCOL),JK(NCOL)
!     do i=1,ncol
!       write(6,2001) i,jk(i),id(i)
!2001   format(1x,'in shelr i,jk,id=',3i5)
!     enddo
```

```
C     FIND M=ONE LESS THAN LEAST POWER OF 2.GT.N
      M=0
   10 M=M+M+1
      IF (M-N) 10,20,20
C  20 OUTER LOOP. .HALVE M.
   20 M=M/2
C     TEST FOR END OF OUTER LOOP.
      IF (M) 70,70,30
C  30 FIND LIMIT FOR MIDDLE LOOP
   30 K=N-M
C     BEGIN MIDDLE LOOP
      DO 60 J=1,K
C     SETUP FOR INNER LOOP
      I=J
C  40 MIDDLE AND INNER LOOP . . COMPARE.
   40 L=I+M
      LJ=1
   23 IAD=NROW*(JK(LJ)-1)
      L1=L+IAD
      I1=I+IAD
      IDEC=ID(LJ)
      GO TO (21,22),IDEC
   21 IF ( A(I1)- A(L1)) 60,61,50
   22 IF ( A(I1)- A(L1)) 50,61,60
   61 LJ=LJ+1
      IF(LJ.GT.NCOL) THEN
        J_TEST=0
      ELSE
        J_TEST=JK(LJ)
      ENDIF
      IF (J_TEST) 60,60,23
C  50 NOT IN SEQUENCE, SO SWAP
   50 DO 80 IP=1,NCOL
      NROCO=NROW*(IP-1)
      NI=NROCO+I
      NL=NROCO+L
       TEMP= A(NI)
       A(NI)= A(NL)
   80  A(NL)= TEMP
C     GO DOWN INNER LOOP . . ONLY IF SWAP
      I=I-M
C     TEST FOR END OF INNER LOOP
      IF (I) 60,60,40
C  60 END OF INNER AND MIDDLE LOOP.
   60 CONTINUE
      GO TO 20
C  70 SORT COMPLETE
   70 RETURN
      END
```

```
! scraps
!     write(99,fmt='(a)')
!    &    'receptor_idx,xcoord,ycoord,hour'
!    &  //',wind_direction,ow_mix,ow_stab,ow_wspeed'
!    &  //',ol_mix,ol_stab,ol_wspeed,concentration'
```

Ocean Wind
An Ørsted & PSEG project

Ocean Wind Offshore Wind Farm

Modeling Report

OCS Air Permit Application

July 15, 2022

Table of Contents

1. Introduction 5

2. Project Description 5

2.1 Project Location 5

2.2 Project OCS Sources and Modeled Emission Units 5

2.3 Tentative Schedule 5

3. Air Quality Analysis 7

3.1 Project-Only Impact Analysis 8

3.1.1 Direct Impacts Analysis 9

3.1.2 Secondary Formation of $PM_{2.5}$ and PM_{10} 9

3.1.3 Project Impacts versus SILs 11

3.1.4 PSD Class II Increment Analysis 11

3.1.4.1 $PM_{2.5}$ 24-hour Class II PSD Increment 12

3.1.5 PSD Class I Increment Analysis 13

3.2 NAAQS Analysis 14

3.2.1 NO_2 1-hour NAAQS 14

4. Additional Impact Analysis 16

4.1 Visibility 16

4.1.1 Class I Area Visibility Assessment 16

4.1.2 Non-Class I Areas 16

4.2 Soils and Vegetation 16

4.2.1 Soils 17

4.2.2 Vegetation 17

4.3 Growth 18

4.4 Additional Impacts Summary 19

5. AQRV Analysis 19

5.1 Plume Blight Analysis Results 20

5.1.1 Level 1 Analysis Results 20

5.1.2 Level 2 Analysis Results 22

5.2 Regional Haze Analysis Results 24

5.3 Acid Deposition Results 25

List of Tables

Table 3-1. NAAQS. 8
Table 3-2. PSD Increment – Class I and Class II. 8
Table 3-3. SILs. 8
Table 3-4. Summary of Secondary Impacts Based on EPA Hypothetical Model Location at Kent County, Delaware. 11
Table 3-5. Facility Impacts Compared to SILs. 11
Table 3-6. Modeled Impacts versus PSD Class II Allowable Increments. 12
Table 3-7. Modeled Impacts versus PSD Class I Allowable Increments. 13
Table 3-8. Maximum Modeled Impacts vs NAAQS. 14
Table 4-1. Comparison of Maximum Modeled Concentrations to Vegetation Screening Thresholds. 18
Table 5-1. Emissions and Distance Data Input to VISCREEN. 20
Table 5-2. Results of VISCREEN Runs for Stability and Wind Speed Combinations. 23
Table 5-3. Worst-Case Meteorological Conditions Frequency Summary for Source-Site Wind Sector. 23
Table 5-4. CALPUFF Regional Haze Results for 8th High Day Each Year. 25
Table 5-5. Maximum Receptor Modeled Sulfur and Nitrogen Deposition Compared to FLAG Screening Thresholds. 26

List of Figures

Figure 2-1. Project Location and Layout. 6
Figure 2-2. Indicative Construction Schedule. 7
Figure 3-1. Distance from WTA to Class I Area Boundary. 10
Figure 3-2. $PM_{2.5}$ 24-hour Maximum Modeled Concentrations Exceeding 9.0 µg/m^3 in WTG Vicinity. 15

Appendices

Appendix A Emission Calculations for Modeled Emission Rates

Appendix B Modeled Emission Sources Description

Appendix C MERP Analysis Workbook

Table of Abbreviations

AQRV	Air Quality Related Values
BOEM	Bureau of Ocean Energy Management
CO	Carbon Monoxide
CO_2e	Carbon Dioxide Equivalent
COA	Corresponding Onshore Area
CTV	Crew Transfer Vessel
EAB	Environmental Appeals Board
EPA	Environmental Protection Agency
FLM	Federal Land Manager
GHG	Greenhouse Gas
GUI	Graphical User Interface
HDD	Horizontal Directional Drilling
H_2SO_4	Sulfuric Acid
NH_3	Ammonia
NO_x	Nitrogen Oxides

NAAQS	National Ambient Air Quality Standards
NSR	New Source Review
NJAAQS	New Jersey Ambient Air Quality Standards
N.J.A.C.	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NM	Nautical Mile
NNSR	Nonattainment New Source Review
NO_x	Nitrogen Oxides
NSR	New Source Review
NWS	National Weather Service
OCD	Offshore and Costal Dispersion Model
OCS	Outer Continental Shelf
O&M	Operations and Maintenance
OSS	Offshore Substations
Pb	Lead
PM	Particulate Matter
PM_{10}	Particulate Matter with Diameter 10 Micrometer or Less
$PM_{2.5}$	Particulate Matter with Diameter 2.5 Micrometer or Less
PSD	Prevention of Significant Deterioration
PTE	Potential to Emit
SCRAM	Support Center for Regulatory Atmospheric Modeling
SO_2	Sulfur Dioxide
TPY	Tons per Year
VOC	Volatile Organic Compounds
WRF	Weather Research and Forecasting Model
WTA	Wind Turbine Array
WTG	Wind Turbine Generator

1. Introduction

Ocean Wind, LLC is proposing to install wind turbine generators (WTGs) and offshore infrastructure required to transmit power generated by the WTGs to onshore interconnection point(s). The offshore components of Ocean Wind (Project) include WTGs, three offshore substations installed on platforms (OSSs), array cabling connecting WTGs, substation interconnector cable linking two OSSs to each other, offshore export cabling connecting OSSs to land, and emergency generators installed on a portion of the WTGs. The Project will install up to 98 WTGs which will be constructed on monopile support structures anchored to the ocean floor. The Project will be located approximately 13 nautical miles (nm) southeast of the Atlantic City, New Jersey shoreline.

This modeling report has been prepared in support of the Project's OCS air permit application, revised July 15, 2022, and pursuant to the U.S. Environmental Protection Agency's (EPA's) OCS Air Regulations promulgated in 40 CFR Part 55. This report follows the methodology presented in the Project's revised modeling protocol dated July 15, 2022 included in Appendix D of the revised OCS air permit application package. The modeling protocol dated July 15, 2022 is the same as the modeling protocol submitted to the EPA on June 20, 2022 with the addition of a discussion on fumigation and downwash, as well as a revised Appendix A Meteorological Data and Air Dispersion Modeling Comparisons.

2. Project Description

2.1 Project Location

The Project will be located on the OCS with the nearest edge of the wind farm area approximately 13 nm southeast of the Atlantic City, New Jersey shoreline. The Bureau of Ocean Energy Management (BOEM) lease area is approximately 75,525 acres and is depicted in **Figure 2-1** as Ocean Wind Lease Area (OCS-A0498). The WTGs will occupy the portion labeled Wind Farm Area on the figure; this area is referred to as the Wind Turbine Array (WTA) in this modeling report. All offshore components of the Project will be located within the WTA, except for the offshore export cabling, which will run from the OSSs to two onshore interconnection points, also shown on **Figure 2-1**.

2.2 Project OCS Sources and Modeled Emission Units

All emission units considered OCS sources and all potential emissions associated with the OCS source(s) were included in the modeling. See Section 2.3, 2.4, and 2.5 of the OCS Air Permit Application dated July 15, 2022, for a detailed explanation of the Project OCS source(s) and potential emissions.

Additionally, as requested by EPA, the Project will also model emissions from horizontal directional drilling (HDD) activities occurring within the 25-nm radius OCS air permit circle as well as other miscellaneous vessels including fisheries monitoring vessels and a marine mammal mitigation vessel.

The vessel list and associated information for each vessel is presented in Appendix C of the revised OCS air permit application package.

2.3 Tentative Schedule

For the dispersion modeling air quality analysis, the most aggressive (shortest) construction schedule is assumed as a conservative assumption. It is conservative because the Project is modeling against 24-hour and annual air quality standards and assuming that the Project will complete all offshore construction within a one-

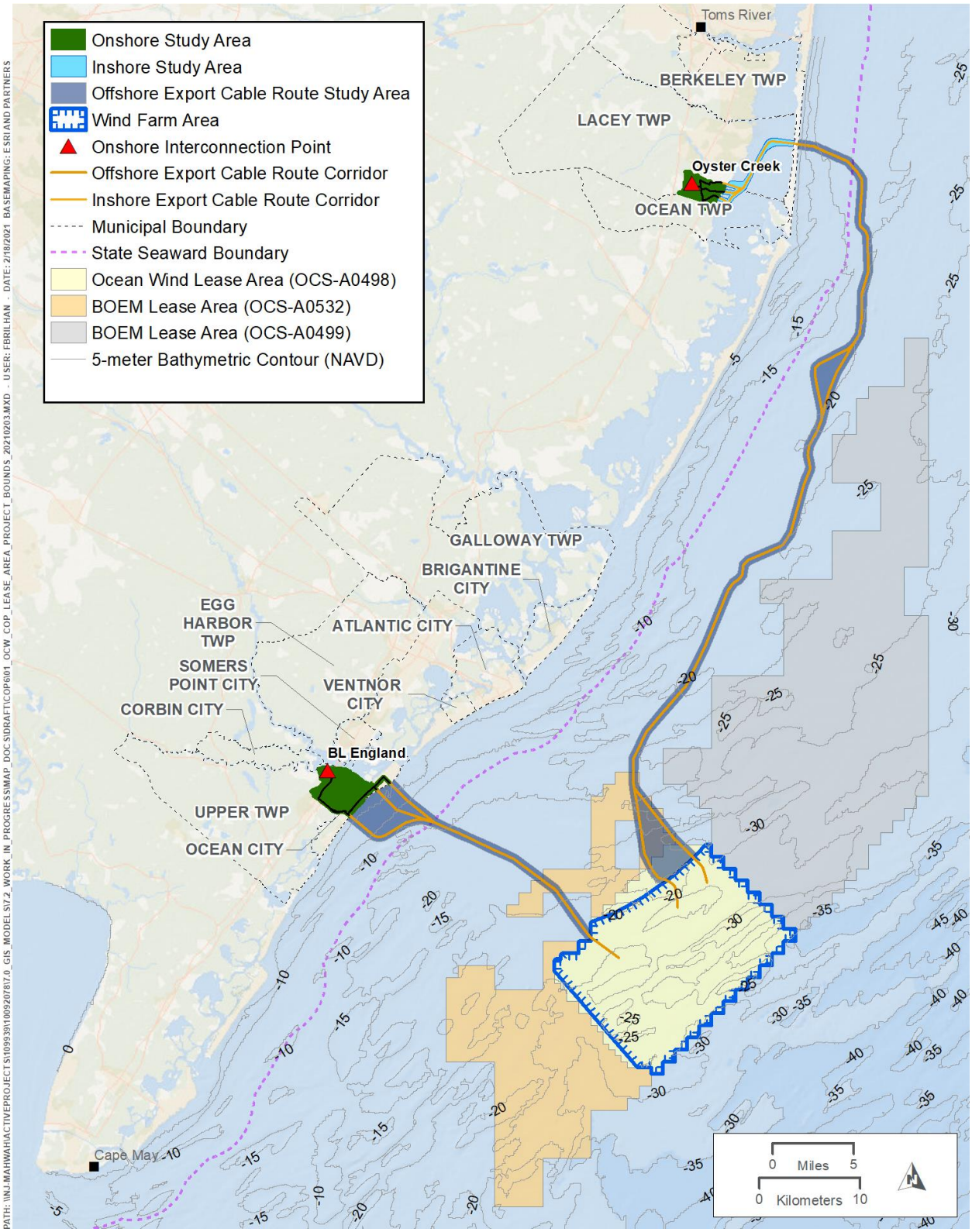


Figure 2-1. Project Location and Layout.

year timeframe maximizes the potential 24-hour and annual emission rates. The construction schedule is displayed in **Figure 2-2**.

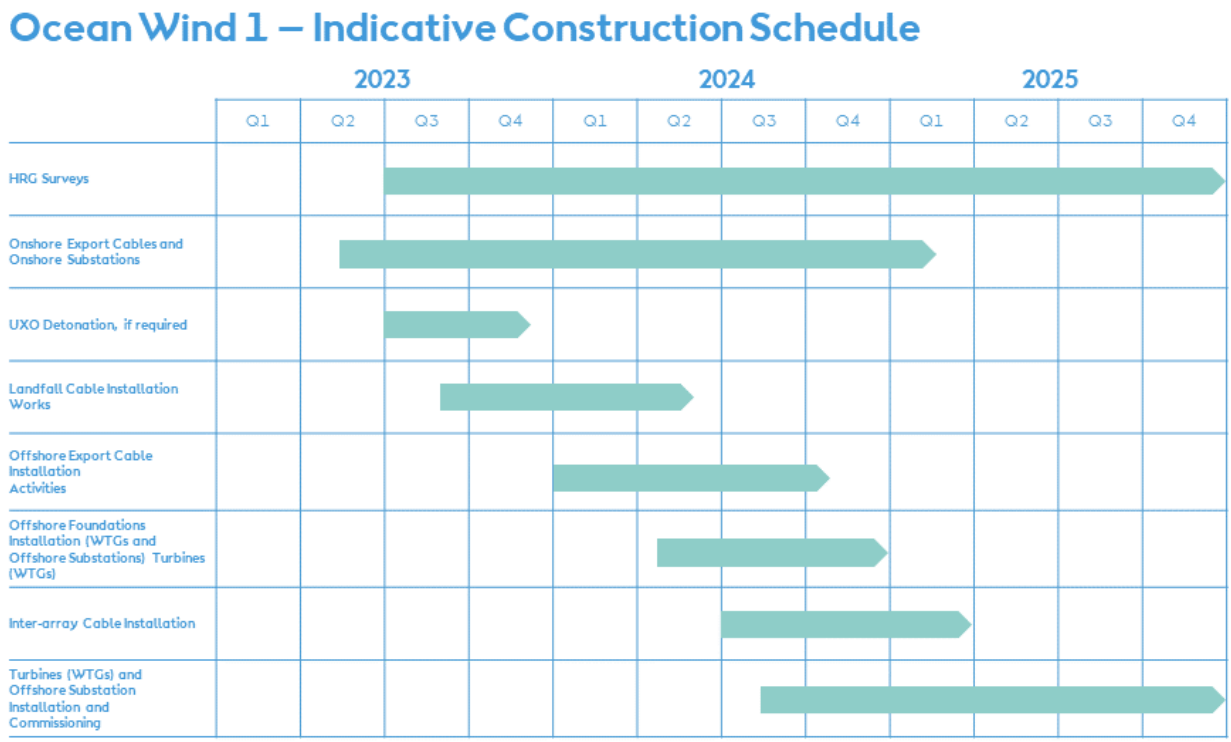


Figure 2-2. Indicative Construction Schedule.

3. Air Quality Analysis

The Project has made a good-faith effort to estimate emissions and model Project impacts using conservative assumptions where aspects of the construction activities are uncertain. For example, the Project assumes the most aggressive construction schedule when determining annual and short-term emission rates to be modeled. Additionally, where multiple port options exist for a construction activity, the longest route was selected. Specific vessels are dependent upon global availability of the unique vessels required to construct large offshore wind farms. Therefore, the specific vessel type cannot be known until construction is underway. The Project has assumed worst-case vessel characteristics (e.g., engine size, duration of use) in an effort to model a conservative emissions scenario. Final construction vessels and activity schedules may differ as the Project construction effort is continually refined and optimized.

This section presents the results of the air quality analyses conducted in support of the OCS air permit application. The Project is required to submit an air dispersion modeling analysis for several PSD-regulated pollutants. As described in the Ocean Wind Modeling Protocol, a PSD air quality analysis is required for PM_{10}, $PM_{2.5}$, NO_2 and CO. Although PM and CO_2e also trigger PSD review, there is no applicable NAAQS or PSD increment for these pollutants, so they don't require analysis through air quality modeling. The NAAQS for which the Project must demonstrate compliance are presented in **Table 3-1**.

Table 3-1. NAAQS.

Pollutant	Primary	Secondary
CO		
1-Hour Average [a]	35 parts per million (ppm) [b]	NA
8-Hour Average [a]	9 ppm [b]	NA
NO_2		
1-Hour Average [c]	100 ppb (188 µg/m^3)	NA
Annual Average	0.053 ppm (100 µg/m^3)	0.053 ppm (100 µg/m^3)
PM_{10}		
24-Hour Average [a]	150 µg/m^3	150 µg/m^3
$PM_{2.5}$		
24-Hour Average [d]	35 µg/m^3	35 µg/m^3
Annual Average	12 µg/m^3	15 µg/m^3

[a] Not to be exceeded more than once per year.
[b] Equivalent to 40 and 10 milligrams/m^3 for the 1-hour and 8-hour averages, respectively.
[c] Attained when the 98th percentile value of daily maximum 1-hour concentrations, averaged over a 3-year period is less than or equal to the standard.
[d] Attained when the 98th percentile value, averaged over a 3-year period, is less than or equal to the standard.

The Class I and Class II impact analysis will be conducted for pollutants subject to PSD review for which there are Class I and Class II increment limits. The pollutants for which modeling will be conducted are NO_2, PM_{10}, and $PM_{2.5}$. **Table 3-2** presents the applicable Class I and Class II PSD increments as established in 40 CFR 51.166(c)(1).

Table 3-2. PSD Increment – Class I and Class II.

Pollutant	Class I	Class II
NO_2		
Annual Average [a]	2.5 µg/m^3	25 µg/m^3
PM_{10}		
24-Hour Average [b]	8 µg/m^3	30 µg/m^3
Annual Average [a]	4 µg/m^3	17 µg/m^3
$PM_{2.5}$		
24-Hour Average [b]	2 µg/m^3	9 µg/m^3
Annual Average [a]	1 µg/m^3	4 µg/m^3

[a] The form of the standard is the annual arithmetic mean.
[b] The 24-hour increment may be exceeded during one 24-hour period per year at any one location. In other words, the highest second highest (H2H) 24-hour concentration is compared to the increment.

3.1 Project-Only Impact Analysis

EPA has established significant impact levels (SILs) as a compliance demonstration tool to show whether a proposed PSD source will cause or contribute to a violation of the NAAQS or PSD increments. This section provides a summary of Project-only modeling for the significant impact level (SIL) analysis. The SILS for pollutants which require analysis for the Project are presented in **Table 3-3**.

Table 3-3. SILs.

Pollutant	Class I	NAAQS/Class II
CO		
1-Hour Average	NA	2000 µg/m^3

Pollutant	Class I	NAAQS/Class II
8-Hour Average	NA	500 µg/m^3
NO_2		
1-Hour Average	NA	7.5 µg/m^3
Annual Average	0.1[a] µg/m^3	1 µg/m^3
PM_{10}		
24-Hour Average	0.3[a] µg/m^3	5 µg/m^3
Annual Average	0.2[a] µg/m^3	1 µg/m^3
$PM_{2.5}$		
24-Hour Average	0.27 µg/m^3	1.2 µg/m^3
Annual Average	0.05 µg/m^3	0.2 µg/m^3

[a] These SILs were not officially promulgated but have been "used in practice" (Technical Support Document for AMS/EPA Regulatory Model (AERMOD)-Based Assessments of Long-Range Transport Impacts for Primary Pollutants, Publication EPA-454/B-15-003 (page 9), July 2015).

This section also provides the basis for the precursor impacts analysis, which analyses secondary pollutant formation (O_3, $PM_{2.5}$, and PM_{10}) due to atmospheric chemical transformations. The secondary impacts, for applicable pollutants, are added to the direct impact to estimate total Project impacts, for both NAAQS and PSD increment, for comparison to the SILs.

3.1.1 Direct Impacts Analysis

The OCD model was used to provide estimates of Project direct impacts. The methodology for this modeling analysis was provided in the Ocean Wind Modeling Protocol, including a discussion of meteorological data, facility layout, vessel stack parameters, and receptor grid. The annual emission rates modeled are the emission rates presented for each vessel in Appendix C of the revised OCS air permit application dated July 2022. The maximum short-term emission rates modeled for all of the short-term standards (24-hour, 8-hour, 3-hour, and 1-hour) for each vessel are presented in **Appendix A**. Additionally, a description of the modeled emission source names is provided in **Appendix B**.

3.1.2 Secondary Formation of $PM_{2.5}$ and PM_{10}

In addition to estimating direct impacts with an EPA-approved model, current EPA guidance requires permit applicants assess the impacts of precursor air pollutants on indirect or secondary pollutant impacts with respect to ozone (Class II areas) and $PM_{2.5}$ (Class I and Class II areas). NJDEP modeling guidance also requires that secondary pollutant impacts be evaluated for PM_{10}.

The impacts of the secondary formation of PM_{10} and $PM_{2.5}$ were estimated using EPA's final *Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program*, dated April 30, 2019. In addition, information obtained from EPA's spreadsheet of illustrative site modeling results (MERPs View Qlik | Support Center for Regulatory Atmospheric Modeling (SCRAM) | US EPA), and MERPS View Qlik website (accessed at https://www.epa.gov/scram/merps-view-qlik) were used in the analysis. Because the COA is designated nonattainment for ozone, the PSD program does not apply to ozone. However, in order to assess potential impacts on soils and vegetation, the secondary formation of ozone is estimated using EPA MERP guidance.

As described in the Ocean Wind Modeling Protocol, Ocean Wind determined that the Kent County, DE site is the most representative of the Project, Kent County is also the most conservative among the four options as it results in the highest predicted secondary formation of PM_{10} and $PM_{2.5}$. To estimate the impact at the nearest Class I area boundary, the shortest distance between the Project WTA and the Class I area boundary was conservatively utilized, as depicted in **Figure 3-1**. A summary of the maximum secondary impacts based on the

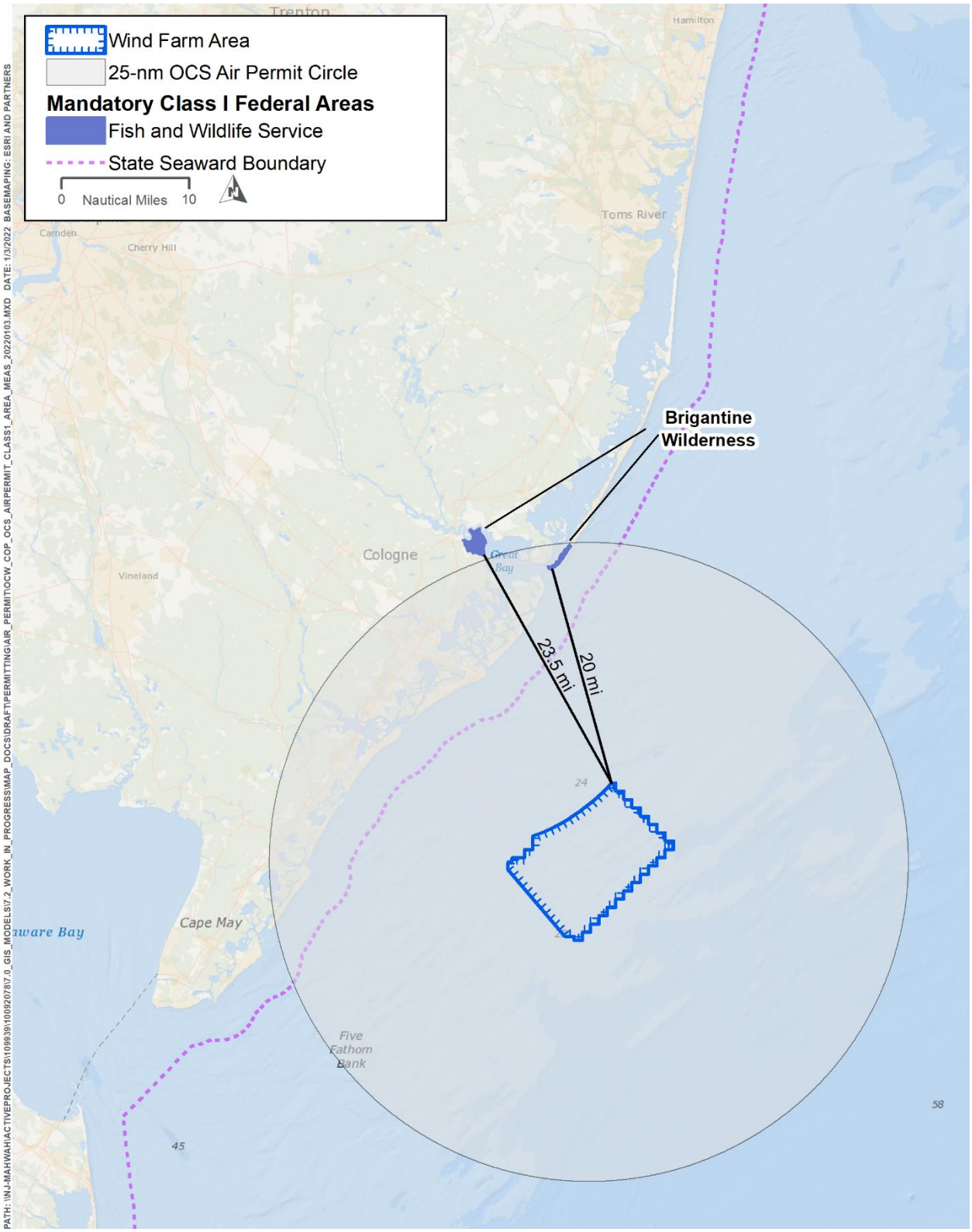


Figure 3-1. Distance from WTA to Class I Area Boundary.

Kent County site is provided in **Table 3-4**. A complete tabulation of all the MERP-calculated impacts is provided in Appendix C. Project emissions used to estimate the MERP-calculated impacts reflect the annual emission rate from all on-site activity (vessel transit, vessel on-site maneuvering, auxiliary equipment, generators) used during construction and commissioning. The worst-case Project impacts from the MERP procedure at any distance or stack height were used for each pollutant and averaging period as a conservative approach.

Table 3-4. Summary of Secondary Impacts Based on EPA Hypothetical Model Location at Kent County, Delaware.

Pollutant/Area	Averaging Period	Maximum Impact	Units
Class II O_3	8-hour	4.56	ppb
Class II $PM_{2.5}$	24-hour	0.52	µg/m^3
	Annual	0.04	µg/m^3
Class I $PM_{2.5}$	24-hour	0.39	µg/m^3
	Annual	0.02	µg/m^3

3.1.3 Project Impacts versus SILs

The maximum OCD-predicted (Modeled) plus MERP impacts of the Project compared to the respective SILs are provided in **Table 3-5**. For 1-hour CO, 8-hour CO, and annual PM_{10}, maximum impacts are below the applicable SILs for PSD Class II increment and NAAQS, and therefore no refined modeling analysis considering background concentrations is required for these pollutants.

Table 3-5. Facility Impacts Compared to SILs.

Pollutant	Modeled Rank	Concentration (µg/m^3)				
		Modeled	MERP	Modeled + MERP	Class I SIL	NAAQS/ Class IISIL
CO						
1-Hour	High	401.33	NA	401.33	NA	2,000
8-Hour	High	327.05	NA	327.05	NA	500
NO_2						
1-Hour	H1H 3-Yr Avg	223.43 [a]	NA	223.43 [a]	NA	7.5
Annual	Maximum	15.31	NA	15.31	0.1	1
PM_{10}						
24-Hour	H1H	12.06	0.52	12.58	0.3	5
Annual	Max. Any Year	0.9	0.04	0.94	0.2	1
$PM_{2.5}$						
24-Hour	H1H 3-Yr Avg	10.14	0.52	10.66	0.27	1.2
Annual	Max. Any Year	0.89	0.04	0.93	0.05	0.2

[a] Note that this value includes the background, so the modeled value is lower than what is displayed in this table. The modeled value is assumed to be well over the SIL.

3.1.4 PSD Class II Increment Analysis

The maximum OCD-predicted (Modeled) plus MERP impacts of the Project compared to the respective allowable increment are provided in Table 3-6. The modeled PSD Class II increment consumption, combined with the estimated secondary impacts for PM_{10} and $PM_{2.5}$, is below maximum allowable increment levels for all applicable pollutants. Thus, the Project's emissions would not cause or contribute to a PSD Class I increment violation. Additional discussion for some pollutants is provided in this section.

Table 3-6. Modeled Impacts versus PSD Class II Allowable Increments.

Pollutant	Rank [a]	Latitude N.	Longitude W.	Increment Consumption (µg/m³)			Allowable Increment Consumption (µg/m³)
				Modeled	MERP	Modeled + MERP	
NO_2							
Annual	Max. Year	39.21278	74.19117	15.31	NA	15.31	25
$PM_{2.5}$							
24-hour	H2H	39.21364	74.19352	7.61	0.52	8.13	9
Annual	Max. Year	39.21288	74.19143	0.89	0.04	0.93	4
PM_{10}							
24-hour	H2H	39.21364	74.19352	10.24	0.52	10.76	30

[a] Rank of "Max. Year" refers to selecting the maximum value in any year of meteorology, according to PSD rules. Likewise, the highest second highest (H2H) concentration (i.e., the highest of the second highest concentrations among all receptors) is selected, among all years of meteorology, for the 24-hour average, given that the short-term increments may be exceeded once per year under PSD rules.

3.1.4.1 $PM_{2.5}$ 24-hour Class II PSD Increment

Modeling of the worst-case 24-hour emissions from all construction activities resulted in a few receptors for which the overall highest concentrations, and the second highest 24-hour concentrations, were above the PSD Class II allowable increment of 9.0 µg/m3, which is allowed to be exceeded no more than one day per year at any receptor.

A few receptors marginally over the allowable increment were at the 500-meter setback ring of receptors around the northern (Oyster Creek) export cable installation vessel group. That vessel group was placed at a point along that route that is closest to the Brigantine Class I area for both the nearfield and Class I impact modeling. The export cable vessel group will move along at approximately 100 meters/hour, or 2.4 km per day, when installing the cable. Therefore, it will not be possible for the same receptors to be impacted significantly on more than one day, and no further analysis of Class II 24-hour $PM_{2.5}$ increment was performed with respect to receptors near this vessel group.

For the worst-case 24-hour emissions scenario (for all construction activity source groups), the only additional receptors potentially exceeding the $PM_{2.5}$ allowable increment based on 2nd highest concentrations in any calendar year, was for the 2018 meteorological data, at receptors near the WTG foundation installation. Source contribution analysis confirmed that virtually all of the modeled impacts was due to vessels in the foundation installation group, which were nearest the receptors.

A foundation installation would take 3-4 days total, but only 1.7 days is needed for the monopile installation phase, and the first day of that phase would have the maximum instantaneous emissions. The initial model run with OCD for 24-hour $PM_{2.5}$ increment simulated emissions for the monopile installation activity, which includes two barge tugs maintaining a barge at a static location using engine power for approximately 6 hours. After the barge is unloaded, the tugs move the barge out of the area and monopile/foundation installation continues. Thus, the maximum day 24-hour emission rates included the barge tugs in maneuvering mode with emissions of 6/24 times their full maneuvering emission rate, plus all other vessels in the foundation installation group operating at their expected loads for the foundation monopile installation process.

Because the Class II short-term (including 24-hour $PM_{2.5}$) increments allow one exceedance per year, per receptor, a second emission scenario was modeled for 24-hour $PM_{2.5}$, which represented the second highest day of emissions from the foundation installation phases. This second maximum day for the foundation install group removed the two barge tugs and represented the remaining sources at 70% of their full-day emissions.

The results from this second emissions scenario showed compliance with the 24-hour $PM_{2.5}$ increment by a significant margin.

However, there was one additional step needed for a compliance demonstration for 24-hour $PM_{2.5}$. It is theoretically possible that the worst-case monopile installation at one WTG tower/foundation location creates an exceedance on one day, and then when that same worst-case activity takes place at an adjacent tower/foundation location, the same receptors that received one exceedance from the nearest foundation install activity could receive a second or additional exceedances from the adjacent tower/foundation installation when the worst-case monopile install emissions occur there.

To determine if multiple exceedances are possible at the same receptors from adjacent tower/foundation installation activities, a contour plot was created to show where receptors exceeded a concentration of 9.0 µg/m3, for the overall highest impact day of the 3-year period of meteorology (which occurred in 2018). **Figure 3-2** shows the contour plot, with receptors inside the contours identified as the only ones exceeding the 9.0 $\mu g/m^3$ increment threshold for each receptor's highest impact episode (day). Note that the maximum secondary $PM_{2.5}$ concentration (0.52 $\mu g/m^3$), calculated using EPA's MERP procedure, was added to the OCD modeled values for the primary or direct emissions, to create this contour plot.

Because the meteorological data set is the same regardless of source location, it follows that the same pattern of receptor exceedances shown on **Figure 3-2** would occur if the modeled tower/foundation location was moved to an adjacent tower location, the two nearest of which are shown in the bottom left and right corners of the figure. It is obvious from inspection of this figure that if the same exceedance contours are placed in the same positions relative to either of these adjacent tower/foundation locations, the exceedance contours from these adjacent monopile installations would not overlap any of the receptors exceeding the increment from the worst-case (overall maximum) emissions case. Thus, this demonstrates that the project would meet the $PM_{2.5}$ Class II 24-hour increment.

3.1.5 PSD Class I Increment Analysis

The maximum OCD-predicted (Modeled) plus MERP impacts of the Project compared to the respective allowable increment are provided in **Table 3-7**. The modeled PSD Class I increment consumption, combined with the estimated secondary impacts for PM_{10} and $PM_{2.5}$, is below maximum allowable increment levels for all applicable pollutants. Thus, the Project's emissions would not cause or contribute to a PSD Class I increment violation. Additional discussion for some pollutants is provided in this section.

Table 3-7. Modeled Impacts versus PSD Class I Allowable Increments.

Pollutant	Rank [a]	Latitude N.	Longitude W.	Increment Consumption ($\mu g/m^3$)			Allowable Increment Consumption ($\mu g/m^3$)
				Modeled	MERP	Modeled + MERP	
NO_2							
Annual	Max. Year	39.45417	74.32917	0.68	NA	NA	2.5
$PM_{2.5}$							
24-hour	H2H	39.45417	74.32917	0.69	0.52	1.21	2
Annual	Max. Year	39.44583	74.34583	0.02	0.04	0.06	1
PM_{10}							
24-hour	H2H	39.45417	74.32917	0.71	0.52	1.23	8
Annual	Max. Year	39.44583	74.34583	0.02	0.04	0.06	4

[a] Rank of "Max. Year" refers to selecting the maximum value in any year of meteorology, according to PSD rules. Likewise, the highest second highest (H2H) concentration (i.e., the highest of the second highest concentrations among all receptors) is selected,

among all years of meteorology, for the 24-hour average, given that the short-term increments may be exceeded once per year under PSD rules.

3.2 NAAQS Analysis

For those pollutants with maximum impacts over the SIL, this analysis adds conservative background concentrations from on-land ambient air monitoring sites. Table 4-1 in Appendix B of the revised Ocean Wind Modeling Protocol presents a summary of the ambient monitoring data used in this analysis. The revised Ocean Wind Modeling Protocol is included in Appendix D of the revised OCS Air Permit Application dated July 15, 2022. Given that the monitor sites selected for this analysis have greater concentrations of existing emissions sources in close proximity than do the receptors of maximum concentration for each NAAQS-modeled pollutant, it was not necessary to add in any "nearby" emissions sources into the analysis. Review of New Jersey permitting records indicates that there are no new large emissions sources in the Atlantic City area that could potentially add to the modeled concentrations of project sources, and thus, impacts of existing emission sources should be adequately captured by the conservative background monitors used for this analysis.

Table 3-8 provides a summary of maximum modeled impacts and background for comparison against the NAAQS for pollutants with facility modeled impacts were over the corresponding SILs (see **Table 3-5**).

Table 3-8. Maximum Modeled Impacts vs NAAQS.

Pollutant	Modeled Rank	Concentration (µg/m^3)					
		Modeled	MERP	Background	Modeled + MERP + Background	NAAQS	SIL
NO_2							
1-Hour	H8H 3-Yr Avg	See Protocol [a]	NA	See Protocol [a]	174.07	188	7.5
Annual	Max. Any Year	See Protocol [a]	NA	See Protocol [a]	27.21	100	1
PM_{10}							
24-Hour	H2H	10.24	0.52	44.7	55.46	150	5
$PM_{2.5}$							
24-Hour	H8H 3-Yr Avg	5.57 [b]	0.52	16.7	22.79	35	1.2
Annual	Max. Any Year	0.89	0.04	6.6	7.53	12	0.2

[a] Per the modeling protocol, background values were varied by hour of the day and season of the year and added to the modeled values hour-by-hour of each year at each receptor to generate the estimates of total NO_2 impact for the 1-hour and annual averaging periods (based on 3-yr averages).
[b] Note this value is the H5H, not the H8H, due to limitations of the OCD model.

3.2.1 NO_2 1-hour NAAQS

While all modeled receptors showed 1-hour NO_2 concentrations less than the NAAQS of 188 µg/m3 (with background added), the overall 98th percentile value (highest, 8th highest daily maximum 1-hour concentration) was not far below the NAAQS. Review of the location found that the receptor was part of the coarse 1.0 km spacing receptor grid. That receptor happened to be 269 meters from the location of a safety vessel that was placed into the model at a location some distance away from any concentrated activity group. Because the safety vessel was not in an area of concentrated activity, a ring of 500-meter setback receptors was not placed around that vessel. Given the nearby receptor fell within the 500-meter setback or buffer zone assumed for vessels, that receptor is disregarded in the tabular summary of model results, and the next highest 8th high daily maximum receptor concentration is reported in **Table 3-8**.

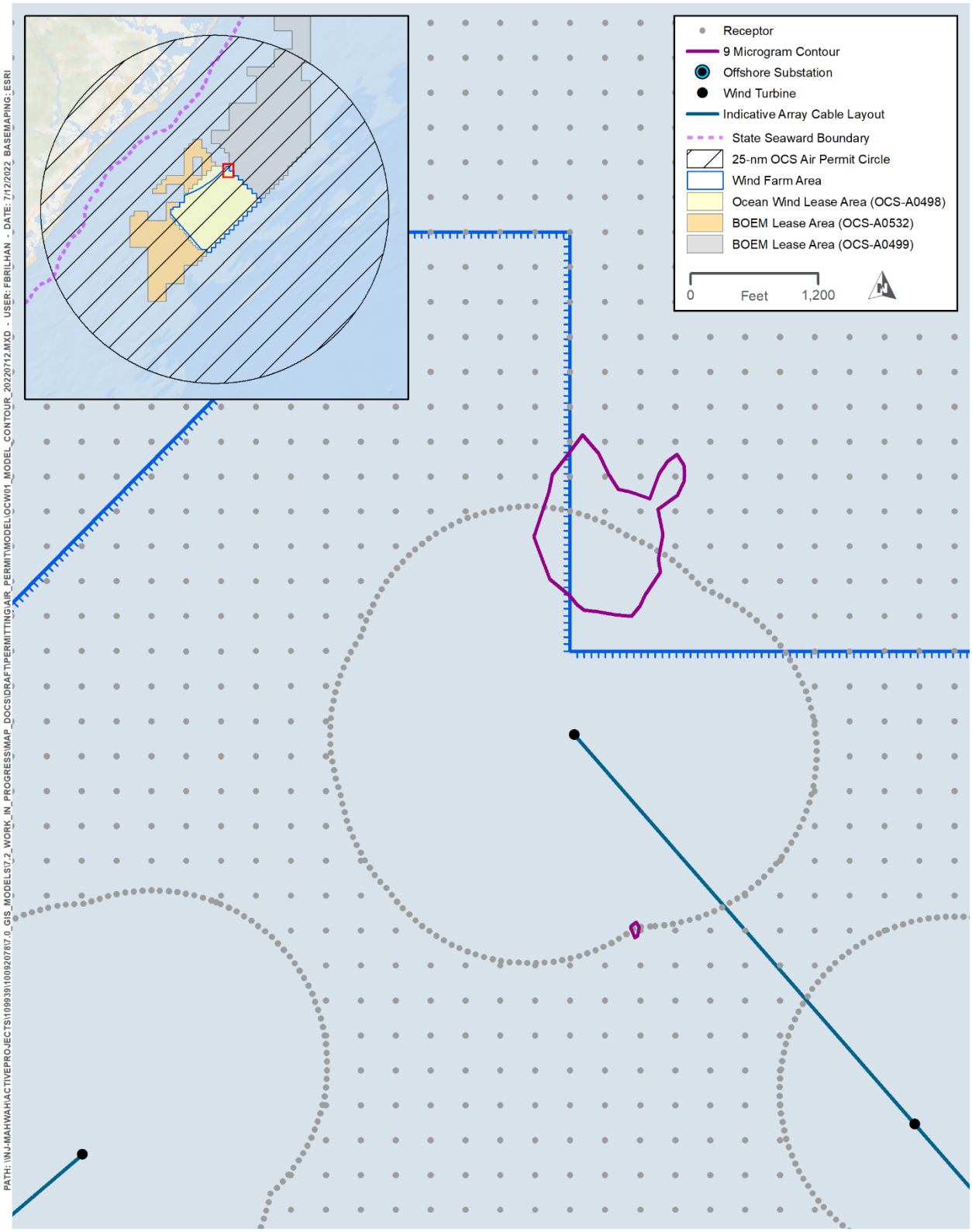


Figure 3-2. $PM_{2.5}$ 24-hour Maximum Modeled Concentrations Exceeding 9.0 µg/m³ in WTG Vicinity.

4. Additional Impact Analysis

Per 40 CFR § 52.21(o), the Project owner or operator must assess potential impacts of the Project's emissions on visibility, soil, and vegetation, and the air quality impacts from growth associated with the Project. Specifically, 40 CFR § 52.21(o) requires:

1. An analysis of the impairment to visibility, soils, and vegetation that would occur as a result of the new source… and general commercial, residential, industrial, and other growth associated with the new source… The applicant need not provide an analysis of the impact on vegetation having no significant commercial or recreational value.
2. 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….

The discussions in the following subsections indicate the Project is not expected to produce any adverse impacts with respect to the above criteria. The Project will apply stringent LAER and/or BACT requirements to all OCS sources. Additionally, the Project is located out in coastal waters, approximately 13 nm from the New Jersey coastline, so emissions from the Project are separated from onshore areas by a significant distance. Finally, the Project has conducted modeling demonstrating the Project will not cause or contribute to an exceedance of an applicable NAAQS or PSD increment. See Section 3.

The Project has the potential to emit CO, NO_x, PM, PM_{10}, $PM_{2.5}$, and GHG at greater than the PSD significant net emissions increase thresholds. These pollutants, with the exception of GHG, are considered in this section of the application. EPA guidance[1] indicates that the Additional Impact Analysis requirements do not apply to emissions of GHG.

4.1 Visibility

4.1.1 Class I Area Visibility Assessment

A visibility assessment of the nearest Class I area, Brigantine Wilderness, was conducted to demonstrate that the Project will not have an adverse impact on visibility. The results of this analysis are included in Section 5 of this report.

4.1.2 Non-Class I Areas

Considerations for non-Class I areas include evaluating potentially adverse visibility impacts on safe transportation, such as interference with airport approaches and departures or with roadways and evaluating potential effects in sensitive areas such as national scenic areas or scenic vistas. The greatest potential for visibility impairment is typically very near a facility. Given the Project's location in coastal waters, it is unlikely the Project will result in adverse visibility impacts on safe transportation. Additionally, the nearest sensitive area is Brigantine Wilderness, a Class I area. Since the Project is demonstrating that it will not have an adverse impact in Brigantine Wilderness, it is unlikely the Project will have an adverse impact on non-Class I areas.

4.2 Soils and Vegetation

Pollutants directly emitted from the facility that exceed PSD significant emission rate thresholds and are documented to have potential effects on soils and vegetation include NO_x and VOC. NO_x is typically emitted from combusted sources as NO, with a lesser amount of NO_2 and very small amounts of N_2O. NO_x can impact soils and vegetation through nitrate deposition. Ozone, which can result from the photochemical reaction of NO_x and VOC in the atmosphere, can adversely impact vegetation. Finally, the NJDEP modeling guidance

[1] US Environmental Protection Agency (EPA). 2011. *PSD and Title V Permitting Guidance for Greenhouse Gases*. EPA-457/B-11-001.

states that the NAAQS or NJAAQS may not provide sufficient protection against damage to sensitive vegetation in New Jersey and therefore requires additional screening for SO_2 at 3-hour and 12-month intervals.

4.2.1 Soils

The area surrounding the Project is ocean. The dispersion modeling results for annual average NO_2 show that the maximum facility impacts are estimated to be approximately 15% of the annual average NO_2 NAAQS. Since NAAQS are intended to protect against effects on human health and welfare (including adverse effects on crops, animals, etc.), nitrogen deposition from the Project will not be significant. Additionally, the receptors with the highest facility impacts are those immediately surrounding the northeast corner of the WTA where the modeled construction activity is concentrated. The facility impacts of receptors overland are all less than 2% of the NAAQS. Therefore, since the highest facility impacts occur over water at a significant distance from land, it is anticipated that the impact on land will be insignificant. Finally, only the construction and commissioning phase is subject to PSD permitting and the construction phase is anticipated to last less than two years. Therefore, any potential impact the Project would have on soils would be temporary and would not cause any significant changes to soil chemistry.

4.2.2 Vegetation

According to EPA's Integrated Science Assessment[2] presenting effects of NO_x on plants, most research on direct phytotoxic effects (decreasing photosynthesis, foliar injury) dates from 1993 with little research having been conducted more recently. The 1993 Air Quality Criteria Document (ACQD) for NO_x concluded that atmospheric NO_x concentrations are rarely high enough to cause phytotoxic effects.[2] The current 1-hour average NO_2 NAAQS is much more stringent than the annual NO_2 NAAQS; the annual NO_2 NAAQS was the only NO_2 NAAQS at the time EPA's research was conducted. Since 1993, NOx emission controls have dramatically reduced emissions from a wide range of stationary and mobile source of NO_x. Concentrations of NO_2, as indicated by EPA monitoring data, have dropped substantially across the United States since 1993. Therefore, it is even more unlikely present levels of NO_2 would cause phytotoxic effects. The Project's maximum NO_2 impact is predicted to occur nearest to the Project and the maximum facility impact is approximately 15% of the longstanding annual average NO_2 NAAQS of 100 ug/m3. Furthermore, the Project's maximum NO_2 impact is predicted to occur overwater, a significant distance from the nearest vegetation.

According to EPA's latest ozone Integrated Science Assessment,[3] studies indicate slight foliar injury and slight biomass reduction for ozone levels at and significantly below the current NAAQS of 70 ppb. However, effects on vegetation observed at levels below 70 ppb have generally been slight with typically single digit percentage decreases in biomass production. The amount of vegetative damage observed increases at levels well above the NAAQS. For example, 8-hour concentrations of ozone in the 60 to 120 ppb range have been shown to cause increasing foliar injury as ozone levels increase within that range.

Based on the MERP analysis presented in Section 3.1.2, the Project could increase ozone by up to 4.56 ppb. Given the relatively small potential increase in ozone relative to the 70 ppb NAAQS, the facility's potential effects on vegetation due to the predicted potential ozone production from Project emissions would be too small to discern.

An evaluation was conducted in accordance with EPA guidance[4] to determine the potential air quality impacts on sensitive vegetation types that may be present in onshore areas near the Project. The evaluation compares

---

[2] US Environmental Protection Agency (EPA). 2018. *Integrated Science Assessment for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter – Ecological Criteria (Second External Review Draft)*. EPA/600/R-18/097.
[3] US Environmental Protection Agency (EPA). 2020. *Integrated Science Assessment for Ozone and Related Photochemical Oxidants.* EPA/600/R-20/012.
[4] US Environmental Protection Agency (EPA). 1980. *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals.* EPA 450/2-81-078.

the combination of predicted air quality concentrations of recommended pollutants as a result of the Project with ambient background concentrations and compares the total to screening thresholds. The NJDEP Modeling Guidance states that screening for SO_2 at the 3-hour and 12-month intervals is required and the screening thresholds are adopted from the same EPA guidance.[4] Therefore, the sensitive vegetation screening exercise satisfies this NJDEP requirement.

As shown in **Table 4-1**, all predicted over-water concentrations are below the thresholds used to evaluate impacts to vegetation. Over-land impacts of the project will be much lower than over-water impacts. Therefore, the Project is not anticipated to cause impacts to vegetation.

Table 4-1. Comparison of Maximum Modeled Concentrations to Vegetation Screening Thresholds.

Pollutant	Concentration (µg/m³)			
	Modeled	Background [a]	Modeled + Background	Sensitive Vegetation Screening Value [b]
SO_2				
3-Hour	270.5	3.6	274.1	786
Annual	0.08	0.14	0.22	18

[a] The background SO_2 values are based on 3-year (2018-2020) averages of the 1-hour 2nd highest concentrations (as conservative for 3-hour concentrations) and annual average concentrations for the SO_2 monitor located at the Edwin B. Forsythe Visitor Center in the Brigantine Wildlife Refuge. Source: Monitor Values Report | US EPA (https://www.epa.gov/outdoor-air-quality-data/monitor-values-report), accessed 7/15/2022.

[b] The screening value is found in Table A-2 of the NJDEP Modeling Guidance dated May 2021. The screening value is based on the sensitive vegetation screening value in the USEPA document 450/2-81-078. This value should be compared to the maximum average ambient air concentration plus background for the specified averaging period.

4.3 Growth

Elements of the growth analysis include: 1) a projection of the associated industrial, commercial, and residential growth that would occur due to the construction and operation of the source, and 2) an estimate of the air emissions generated by the associated growth. As discussed below, for PSD air permit application purposes, the Project is anticipated to cause limited associated growth.

Project-related activities and infrastructure that could potentially result in direct or indirect impacts to population, economy, and employment resources were discussed in Section 2.3.1.1.3 of Volume II of the Project's Construction and Operations Plan (COP). The analysis found that the Project will support an estimated 6,598 job-years during the construction and commissioning phase and an estimated additional 6,114 job-years in the operations and maintenance phase. During the construction and commissioning phase, approximately 3,103 job-years are direct. During the operations and maintenance phase, approximately 2,780 job-years are direct.

Ocean Wind opened an office in Atlantic City in May 2018 and will hire local workers to the extent practical. Ocean Wind will also hire non-local workers with specialized skills. The construction workforce will include civil and electrical construction workers for onshore facilities. Installation of offshore facilities (e.g., wind turbine generators, foundations, cables, and substations) will require specialized marine equipment and workers. Offshore cables will be installed by jet plow, mechanical plow, mechanical trenching, and/or dredging. Installation of offshore foundations, WTGs, and substations will require jack-up vessels and accompanying barges.

Population impacts to the communities could result from the short-term influx of construction personnel. The total population change would equal the total number of non-local construction workers plus any family members that may accompany them. However, because of the relatively short duration of construction, it is anticipated that most non-local workers would not travel with their families to the study area. Based on populations within the study area, the temporary addition of the non-local workforce for the duration of

construction would not result in a sizeable population change. The temporary increase in population would be distributed throughout the study area and would have no permanent impact on the population. Additionally, given the population in the study area, the relatively small number of workers needed for operation of the Ocean Wind onshore and offshore facilities would not result in a sizeable population change.

During construction and commissioning, the non-local workforce would require temporary housing accommodations. Temporary housing is readily available in the study area, as indicated by the large number of housing units for seasonal, occupational, or occasional use, and numerous hotels, motels, campgrounds, and RV parks. For the operations and maintenance phase, permanent employees would be likely to live in the vicinity of the Project facilities. Relatively high vacancy rates in the study area indicate that sufficient housing for the operations and maintenance workforce would be readily available.

Due to the small number of new individuals expected to move into the area to support the Project and the significant level of existing commercial activity in the area, new commercial construction is not foreseen to be needed to support the Project's work force.

For reasons described above, no significant emissions from secondary growth are anticipated to occur during either the construction and commissioning phase or the operations and maintenance phase. Therefore, the air quality impacts of the modest residential, commercial, or industrial growth associated with the Project will be insignificant.

Finally, the use of wind to generate electricity results in a net reduction of regional air pollution over the life of the Project through displacement of electricity generated by power plants fueled with fossil fuels.

4.4 Additional Impacts Summary

In conclusion, the associated growth from the Project's construction, commissioning, operations, and maintenance would not cause a significant increase of emissions in the Project area. Therefore, the air quality impacts of the modest residential, commercial, or industrial growth associated with the Project will be insignificant. The Additional Impacts Analysis supports the following conclusions:

- Deposition of nitrogen compounds from Project emissions would be too small to affect soil acidity or to measurably affect soil nitrogen profiles on land, given the construction-related emissions would occur mostly well off the coast, and would be temporary, whereas acid deposition is generally a longer-term (multi-year) concern.
- Concentrations of nitrogen oxides due to Project emissions would be too low to cause observable or measurable effects on vegetation on land.
- Incremental concentrations of ozone due to Project emission would be too small to cause an observable change in vegetative biomass production or an observable increase in foliar injury on-land.
- Growth associated with the Project would be small in relation to the current level of residential, commercial, and industrial development in the Project area and is not expected to cause significant air pollutant emissions. Therefore, additional growth attributed to the Project would have minimal air quality and associated impacts.

5. AQRV Analysis

This section addresses visibility (both plume blight and regional haze) and acid deposition, as requested by the Federal Land Manager of the Edwin B. Forsythe National Wildlife Refuge in a meeting on February 23, 2022. The modeling protocol submitted to the USFWS and EPA on July 6, 2022 is included in Appendix I of the revised OCS air permit application package.

5.1 Plume Blight Analysis Results

The plume blight analysis, using VISCREEN screening tool, provides a conservative assessment of the potential for visible plumes due to emissions of groups of closely located project sources to be seen by observers within the Class I area. The construction emissions from project vessels will be emitted across a wide area covering the wind turbine generator (WTG) array, transits by vessels installing power export cables, and transits by both crew and equipment transport vessels. Thus, the project construction emissions will be spread across tens of kilometers.

To perform a bounding analysis of potential plume blight impacts at the Class I area, collections of vessels and their propulsion and/or auxiliary engines were modeled as single sources in three locations with concentrated vessel activity:

1. the WTG foundation location at the NW corner of the wind turbine array, which is closest WTG location to the Class I area (and conservatively represents impact from foundation monopile installation at any of the WTG locations),
2. the horizontal directional drilling (HDD) location near Ocean City, just south of Atlantic City, and
3. a point along the northern export cable installation route closest to the Brigantine Class I area.

These activity locations, as analyzed in VISCREEN, are shown below in **Figure 5-1**.

Other activities, such as vessel transits, array cable installation, offshore platform installation, etc. would occur in areas too far away from the other modeled activity groups to be able to form a single plume. While the more widely dispersed collection of construction-related emission sources over the broader area could contribute to regional haze impacts, such impacts were explicitly modeled as described in Section 5.2 below. Note that there will be a second HDD location along the coast north of the WTG array, near Oyster Creek. However, the southern HDD location is analyzed here because it is significantly nearer to the Class I area.

Emissions from all the vessels within each of the above three installation activity groups were aggregated and input to VISCREEN using a stack with height and other stack parameters in the midrange of the parameter values for the activity group. This very conservatively concentrates the emissions from each of these activities into a single plume, which should overestimate the potential for visible plumes at the Class I area.

The emissions and distance ranges (to the Class I boundaries) input to VISCREEN for each of the three above activities are shown in **Table 5-1**. Note that the emission rates in tons per year (TPY) are the equivalent emissions if the activity was continuous for a whole year. The emissions input to VISCREEN are the TPY equivalents of the estimated maximum 24-hour emission rates for each activity.

Table 5-1. Emissions and Distance Data Input to VISCREEN.

Activity Description	PM	NOx	Min. Class I Distance	Max. Class I Distance
	(TPY)	(TPY)	(km)	(km)
WTG and OSS Foundation Installation	13.95	422.60	29.3	43.0
HDD Installation – BL England Route	11.97	356.27	29.6	42.9
Offshore Export Cable Installation – Oyster Creek Route	20.64	611.82	12.5	25.9

5.1.1 Level 1 Analysis Results

The VISCREEN model was executed for each of the above three cases, using the default settings. For all three cases, the VISCREEN results show that at least one screening criterion was exceeded using the worst-case

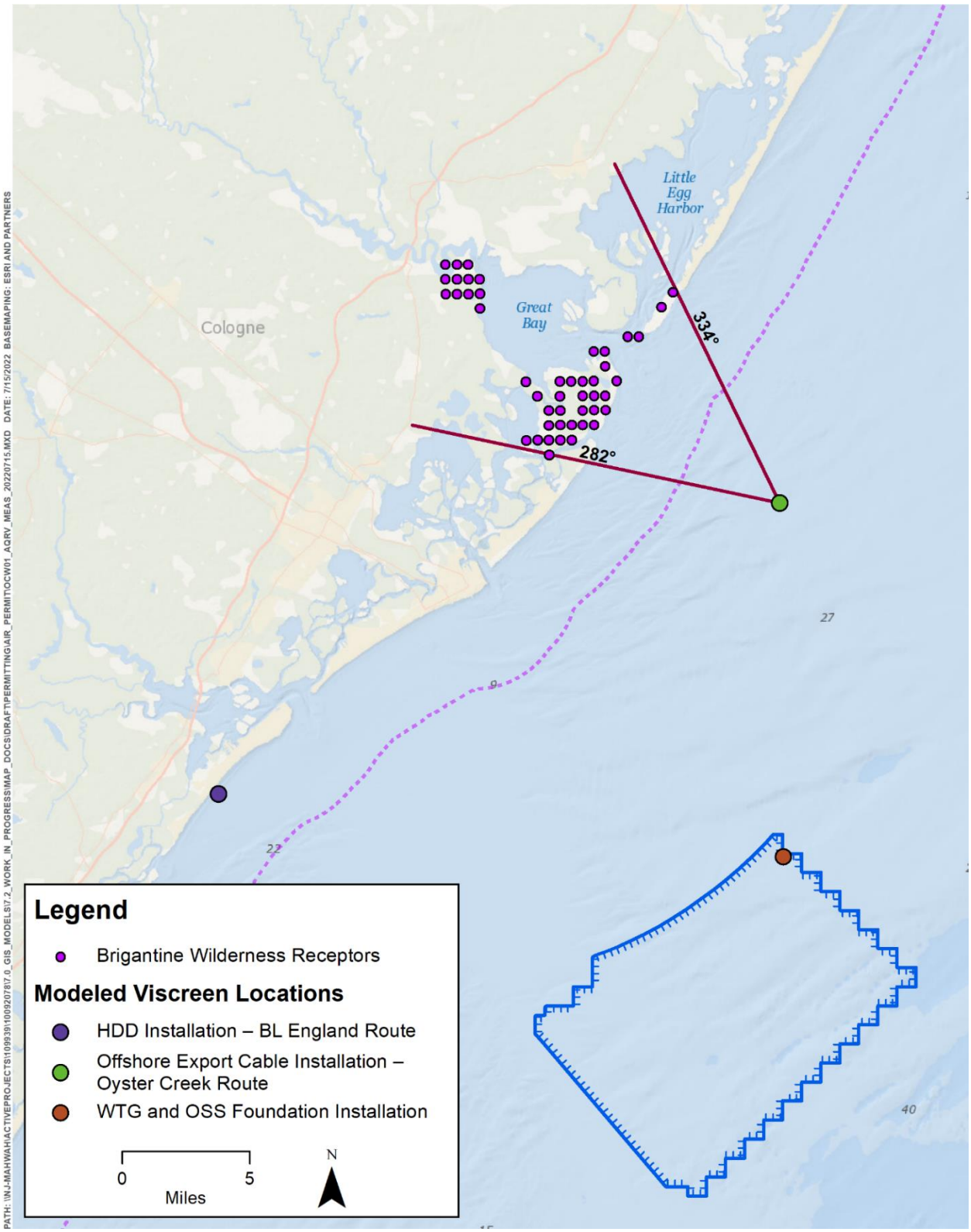


Figure 5-1. Wind Sector for Level 2 VISCREEN Analysis of Offshore Cable Installation Emissions

Class F stability category and a 1.0 meter/second (m/s) wind speed. For the WTG and OSS foundation installation case and the HDD installation case, only the modeled plume delta E (change in light extinction) value exceeded the screening level, whereas for the offshore export cable installation – Oyster Creek case, the impact result exceeded all four of the VISCREEN screening criteria (Plume Delta E against sky and terrain background, and plume contrast for sky and terrain background). Because at least one screening criterion was exceeded for each emission activity, all three cases were taken to the Level 2 VISCREEN analysis.

5.1.2 Level 2 Analysis Results

The Level 2 analysis follows the example provided in the document “Tutorial Package for the VISCREEN Model” prepared by Pacific Environmental Services, Inc. for USEPA in July 1992, and which is based on the document "Workbook for Plume Visual Impact Screening and Analysis" (EPA-450/4-88-015).

The first step in the Level 2 analysis was to run VISCREEN (separately for each of the three emission activities) for each combination of stability and wind speed that could potentially cause impacts at the Class I area exceeding the screening criteria. This initial step identified that for the WTG foundation monopile installation case and the HDD case, only the stability F and 1.0 m/s combination exceeded the one “plume delta E” criterion. For these two emission activities, all other stability and wind speed combinations had impacts below all screening criteria. Furthermore, for these two emissions activities, the transport time calculated in accordance with the above guidance indicates that transport time would exceed 12 hours for the F and 1 m/s combination, so this combination of stability and wind speed drops out of the analysis. Therefore, only the export cable installation for the northern route (to Oyster Creek) emissions are carried into a full Level 2 analysis.

For the northern export cable route, as discussed earlier, the emissions for this analysis were placed at a point along the route that is nearest the Brigantine Class I area boundary. With respect to this point, the wind flow vectors (opposite of wind directions) of interest for Brigantine receptors range from 282 to 334 degrees of the compass with respect to the source, as shown in **Figure 5-1**.

Applying VISCREEN to the export cable vessels total emissions at one location for the northern (Oyster Creek) export cable installation is a very conservative procedure for a couple of reasons:

1. the maximum 24-hour emissions (equivalent tpy values) from all vessels in this group were assumed to form a single plume, and
2. the emissions are analyzed at this point nearest Brigantine for a full year.

The second point is most critical, because the vessel group is expected to move along the route at a speed of approximately 100 meters per hour, or 2.4 km per day. Thus, this whole export cable installation from the WTG array to Oyster Creek would take about 30 days to complete at this speed. Not only would the emissions occur for less than 10% of the year, but the emissions would mostly occur at significantly greater distances from Brigantine than assumed in this conservative “stationary source” analysis.

The next step in the Level 2 analysis, for the export cable activity, is to run VISCREEN for all the stability and wind speed combinations that potentially could cause an exceedance of one or more of the screening criteria. **Table 5-2** shows the results of this step, which indicates that there are 7 combinations of stability and wind speed where one or more screening criteria are exceeded.

The final step in the Level 2 analysis is to determine the frequency of the critical stability and wind speed conditions for the wind directions or wind flow vectors of interest. In this case, with respect to the Brigantine Class I area, the wind flow vectors of interest are in the range of 282 to 324 degrees of the compass, with respect to the assumed export vessel group centroid location.

For this analysis, the surface meteorological data use to determine the frequency of critical meteorological

Table 5-2. Results of VISCREEN Runs for Stability and Wind Speed Combinations.

Stability Class	Wind Speed	Plume Delta E Exceeds Screening Criterion for Sky Background	Plume Delta E Exceeds Screening Criterion for Terrain Background	Plume Contrast Exceeds Screening Criterion for Sky Background	Plume Contrast Exceeds Screening Criterion for Terrain Background
F	1.0	**Yes**	**Yes**	**Yes**	**Yes**
F	2.0	**Yes**	**Yes**	No	No
F	3.0	**Yes**	**Yes**	No	No
E	1.0	**Yes**	**Yes**	No	No
E	2.0	**Yes**	**Yes**	No	No
E	3.0	**Yes**	No	No	No
E	4.0	No	No	No	No
E	5.0	No	No	No	No
D	1.0	**Yes**	**Yes**	No	No
D	2.0	No	No	No	No
D	3.0	No	No	No	No
D	4.0	No	No	No	No

conditions are the Atlantic City airport meteorological data for 2018 to 2020 (matching the OCD modeled years). The observed parameters were taken from the Integrated Surface Hourly Dataset (ISHD) downloaded from the NOAA National Centers for Environmental Information. The Atlantic City ISHD data was formatted for input to the PCRAMMET meteorological data processor, along with Brookhaven, NY upper air data (which was not important to this analysis) to generate the PCRAMMET output files. The PCRAMMET output files contain the Pasquill-Gifford Stability Classes (as well as wind speed and wind direction) used in the Level 2 meteorology frequency analysis. As PCRAMMET generates Pasquill-Gifford Stability Classes from 1 to 7, the stability class 7 (G – extremely stable) quantities were added to the class 6 (F Stability) quantities for calculating the frequencies for the Level 2 analysis. The PCRAMMET output files were placed into an excel file to calculate stability class, wind speed and wind flow direction frequencies.

Table 5-3 presents the results of the final step of the Level 2 analysis for the export cable installation emission activity. This table shows that for the categories of stability, wind speed and wind direction that could impact Brigantine with plume visual impacts exceeding one or more screening criteria, the cumulative frequency based on the 3-year period of meteorology is 3.44 % (as shown in the bolded line in the table). This equates to approximately 12.6 days/year.

Table 5-3. Worst-Case Meteorological Conditions Frequency Summary for Source-Site Wind Sector.

Dispersion Condition (Stability, Wind Speed)	SigmaZ * u (m^2/s)	Transport Time (hours)	Frequency of Occurrence of Given Dispersion Condition Associated with Worst-Case Wind Direction for Given Time of Day (%)				Frequency (f) and Cumulative Frequency (cf) (%)	
			1-6	7-12	13-18	19-24	F	cf
F,1	50.83	6.9	0.40	0.08	0.02	0.29	0.40	0.40
E,1	87.66	6.9	0.02	0.03	0.00	0.00	0.03	0.43
F,2	101.67	2.3	0.85	0.02	0.06	1.03	1.03	1.46
F,3	152.50	1.4	0.27	0.02	0.03	0.88	0.88	2.34
D,1	152.83	6.9	0.02	0.03	0.02	0.02	0.03	2.37

Dispersion Condition (Stability, Wind Speed)	SigmaZ * u (m^2/s)	Transport Time (hours)	Frequency of Occurrence of Given Dispersion Condition Associated with Worst-Case Wind Direction for Given Time of Day (%)				Frequency (f) and Cumulative Frequency (cf) (%)	
			1-6	7-12	13-18	19-24	F	cf
E,2	175.32	2.3	0.23	0.03	0.06	0.33	0.33	2.71
E,3	**262.97**	**1.4**	**0.40**	**0.03**	**0.15**	**0.73**	**0.73**	**3.44**
D,2	305.66	2.3	0.52	0.47	0.11	0.17	0.52	3.95
E,4	350.63	1.0	0.20	0.02	0.05	0.52	0.52	4.47
E,5	438.29	0.8	0.12	0.00	0.02	0.23	0.23	4.70
D,3	458.50	1.4	0.87	0.71	1.05	0.81	1.05	5.75
D,4	611.33	1.0	0.47	0.62	1.81	0.71	1.81	7.56
D,5	764.16	0.8	0.38	0.70	1.51	0.71	1.51	9.06
D,6	916.99	0.6	0.53	0.47	1.19	0.65	1.19	10.25
D,7	1069.82	0.5	0.20	0.53	0.50	0.26	0.53	10.78
D,8	1222.65	0.5	0.05	0.29	0.33	0.06	0.33	11.12

Considering that the cable laying vessel group would take only about 30 days out of the year to install the offshore export cable route to Oyster Creek, the random probability of the emissions occurring along with the critical meteorological conditions is less than 10%. If one multiplies the yearly impact days by 30/365 to adjust for the estimated 30 days of emissions, the days per year of impacts exceeding one or more criteria would be approximately 1 day in a year. If an impact does not exceed a threshold of impact at least 1% of the time (3-4 days per year), it is considered to have passed the Level 2 screening and no further analysis is required. Given the statistical probability of exceeding thresholds is less than <1%, this emissions activity passes the Level 2 screening.

Even the above probability analysis is very conservative, because as stated earlier, for most of the export cable route, the vessel group would much farther from Brigantine than analyzed here. In any case, no further analysis is needed based on these results.

5.2 Regional Haze Analysis Results

The regional haze analysis with CALPUFF utilized of all the project emission sources and emission rates input to OCD for the near-field short-term standards (24 hours and shorter) worst-case analyses. Emissions of SO_2, NO_x, and PM_{10} were input to CALPUFF for all sources. The methodology for this analysis was as described in Appendix D of this permit application.

The metric used to assess the potential for discernible visibility reduction is the deciview (dV). A change in visibility of approximately 1.0 dV is assumed to be detectable to a human observer looking at a distant scene or object. As with the initial implementation period for Regional Haze rules under 40 CFR 51, Appendix Y, a screening level of 0.5 dV is used here as a screening benchmark for whether the proposed project would potentially cause or contribute to visibility impairment at the Class I area. The 0.5 dV threshold is based on the 8th high daily modeled dV change in each calendar year of meteorology (2018, 2019, 2020), representing approximately the 98th percentile value among all receptors (collectively) in the Brigantine Class I area.

Table 5-4 summarizes the CALPUFF regional haze modeling results for each year of meteorology. Note that the background dV values are based on recommended monthly values for the Brigantine region. Also, the last three columns of data present the modeled contributions to light extinction due to only project emissions of the chemical species or their precursors.

Table 5-4. CALPUFF Regional Haze Results for 8th High Day Each Year.

Year	Julian Day of Year	Total	Background	Delta	% of Modeled Light Extinction		
		(dV)	(dV)	(dV)	Sulfate PM	Nitrate PM	NO_2 (gas)
2018	129	10.292	8.704	1.588	0.66	88.96	10.38
2019	126	10.141	8.704	1.437	1.47	78.57	19.95
2020	147	10.351	8.704	1.647	1.69	79.02	19.29

These CALPUFF regional haze modeling results are quite conservative for the following reasons:

1. All construction activities would not operate (as modeled) at their worst-case 24-hour emission rates continuously for an entire year. For example, the worst-case 24-hour period for WTG foundation monopile installation would happen on only one day for each of the 98 tower foundations, thus happening on 98 out of 365 days, assuming that construction can be accomplished in a 1-year period (it will likely be longer). Similar conservatism applies to other construction activities (offshore substations, array cable install, WTG tower/turbine install) taking place in the WTG lease area.
2. The HDD emissions modeled just offshore of the BL England substation ("southern") connection point for the export cable would happen for only about a month during the construction period, whereas these emissions are modeled as if occurring full time.
3. The northern export cable installation vessel group would cover approximately 2.4 km of route every day, taking about a month to complete that approximately 70 km long route. These emission sources were modeled as if stationary at a point along that route that is closest to Brigantine. The southern export cable route is much shorter and should take about 2 weeks. So together, these export cable installation emissions would happen for less than 6 weeks, as opposed to being modeled with OCD at their closest approach to Brigantine along the northern export cable route as if emitting there for a full year.
4. The model results are expected to be quite conservative based on a validation study[5] performed elsewhere (i.e., western Wyoming) using a constant NH3 background level of 1.0 ppb. The Wyoming study showed that CALPUFF results for nitrate concentrations with the 1.0 ppb background NH3 were approximately a factor of 3 too high compared to observations. Even using a 0.5 ppb background NH3 level, the modeled nitrate concentrations were about a factor of 2 too high compared to observations for the Wyoming study. Given that nitrate concentrations are the primary driver of modeled visibility impact for the proposed project, the actual impacts are expected to be much smaller than modeled for this reason alone.

Given the above conservative factors, it is not expected that the project would cause visibility impacts at a discernible level (> 1.0 dV) and is likely to have 98th percentile impacts below the 0.5 dV screening level used in the Regional Haze rules (40 CFR 51, Appendix Y).

5.3 Acid Deposition Results

For the long-term (annual) deposition modeling, CALPUFF was executed using the same long-term emission rates used for the annual average NAAQS and PSD increment modeling with the OCD model. In other words, these emission rates were "annualized" to account for the duration of a particular construction activity. For example, if an activity is estimated to be needed for 30 days to complete that portion of construction, the associated short-term (24-hour) emission rate was multiplied by 30/365 to obtain an emission rate for the annual impact assessments.

[5] Protocol for the Application of the CALPUFF Model for Analyses of Best Available Retrofit Technology (BART), December 22, 2005 (Revision 3.2 - 8/31/06), Visibility Improvement State and Tribal Association of the Southeast (VISTAS). See Figure 3-3b.

The CALPUFF deposition results for total sulfur (as elemental sulfur) and total nitrogen (as elemental nitrogen) are summarized in **Table 5-5**. The 3-year averages of the modeled total sulfur and nitrogen annual deposition values are less than the screening levels provided in the 2010 FLAG guidance document.[6] Based on these results, the project is not expected to have a significant or adverse effect on soils, vegetation, or biota in the Brigantine Class I area due to deposition of sulfur and nitrogen compounds.

Table 5-5. Maximum Receptor Modeled Sulfur and Nitrogen Deposition Compared to FLAG Screening Thresholds.

Species	2018	2019	2020	Modeled 3-yr Avg. Dep.	Modeled 3-yr Avg. Dep.	FLAG Screening Threshold
	(µg/m²/s)	(µg/m²/s)	(µg/m²/s)	(µg/m²/s)	(kg/ha/yr)	(kg/ha/yr)
Total S	1.22E-06	1.02E-06	1.60E-07	7.99E-07	0.00025	0.005
Total N	3.27E-05	2.54E-05	7.91E-06	2.20E-05	0.00694	0.010

[6] Federal Land Managers' Air Quality Related Values Work Group (FLAG), *Phase I Report—Revised (2010)*

Vessel Transit Distances (nautical miles): Construction Phase [1] [2]	Distance Within OCS	Distance Outside OCS	Total Trip Distance (One-Way)
Atlantic City, NJ	21.2	0	21.2
Charleston, SC	25	513.6	538.6
Europe	25	168.1	193.1
Hope Creek, NJ	25	67.9	92.9
Norfolk, VA	25	166.0	191.0
Paulsboro, NJ	25	101.8	126.8
Port Elizabeth, NJ	25	57.2	82.2
Repauno, NJ	25	118.3	124.5

[1] The ports listed are the expected list of ports Ocean Wind may use; this table displays distances to each port and breaks it down into distances occuring within the 25 nautical mile radius from the centroid of the array area and those outside that circle. When calculating time spent in transit for the purpose of estimating emissions, the longest route was selected among the list of expected possible ports for each vessel as a conservative assumption.

[2] It is assumed all crew transfer vessels utilize Atlantic City port.

Project Information - Bureau of Ocean Energy Management (BOEM) Default Vessel Parameters

Vessel Type [1]	Vessel Speed [1] Knots			Main Engine Power Rating [1] kW			Auxiliary Engine Power Rating [1] kW		
	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
Anchor Handling Tugs	12.37	12.37	12.37	5,732.71	5,732.71	5,732.71	1,237.10	1,237.10	1,237.10
Barge	19.99	19.99	19.99	22,424.22	22,424.22	22,424.22	3,020.00	3,020.00	3,020.00
Cable Laying	12.24	12.24	12.24	6,657.62	6,657.62	6,657.62	3,025.77	3,025.77	3,025.77
Crew	22.13	22.13	22.13	3,013.01	3,013.01	3,013.01	201.05	201.05	201.05
Dredging	10.92	10.92	10.92	3,233.66	3,233.66	3,233.66	963.82	963.82	963.82
Jackup	7.00	7.00	7.00	3,214.91	3,214.91	3,214.91	895.08	895.08	895.08
Research/Survey	12.46	12.46	12.46	2,996.75	2,996.75	2,996.75	1,362.92	1,362.92	1,362.92
Shuttle Tanker	14.76	14.76	14.76	17,484.02	17,484.02	17,484.02	30,769.22	30,769.22	30,769.22
Supply Ship	12.12	12.12	12.12	3,842.65	3,842.65	3,842.65	873.99	873.99	873.99
Tug	11.53	11.53	11.53	2,053.16	2,053.16	2,053.16	238.13	238.13	238.13

[1] Chang, R., B. Do, and R. Billings. 2017. Technical Summary for the Offshore Wind Energy Facilities Emission Estimating Tool. US Dept. of the Interior, Bureau of Ocean Energy Management, Sterling, VA. OCS Study BOEM 2017. 9 pp.

Project Information - BOEM Default Emission Factors

Category	Engine	Type [1]	Units	Emission Factors [1]									
				CO2	CH4	N2O	CO	NOX	PM10	PM2.5	SO2	Lead	VOC
FACILITY	Main	Anchor Handling Tugs	g/kW-hr	636.09	4.00E-03	3.10E-02	2.16	9.26	0.34	0.33	7.87E-02	4.03E-05	0.24
FACILITY	Main	Barge	g/kW-hr	588.90	4.00E-03	3.10E-02	1.40	13.61	0.45	0.42	0.36	1.18E-05	0.63
FACILITY	Main	Cable Laying	g/kW-hr	635.02	4.00E-03	3.10E-02	2.20	9.49	0.34	0.33	8.51E-02	3.88E-05	0.25
FACILITY	Main	Crew	g/kW-hr	648.16	4.00E-03	3.10E-02	2.30	5.51	0.15	0.15	6.24E-03	4.65E-05	0.14
FACILITY	Main	Dredging	g/kW-hr	630.62	4.00E-03	3.10E-02	2.13	9.60	0.36	0.34	0.11	3.70E-05	0.28
FACILITY	Main	Jackup	g/kW-hr	647.08	4.00E-03	3.10E-02	2.30	10.03	0.31	0.30	1.27E-02	4.51E-05	0.14
FACILITY	Main	Research/Survey	g/kW-hr	638.26	4.00E-03	3.10E-02	2.25	9.86	0.34	0.33	6.57E-02	4.15E-05	0.22
FACILITY	Main	Shuttle Tanker	g/kW-hr	588.90	4.00E-03	3.10E-02	1.40	9.05	0.45	0.42	0.36	1.18E-05	0.63
FACILITY	Main	Supply Ship	g/kW-hr	644.58	4.00E-03	3.10E-02	2.29	9.44	0.32	0.31	2.77E-02	4.45E-05	0.17
FACILITY	Main	Tug	g/kW-hr	643.66	4.00E-03	3.10E-02	2.29	9.52	0.33	0.32	3.33E-02	4.48E-05	0.18
FACILITY	Main	Feeder Barge Tug	g/kW-hr	643.66	4.00E-03	3.10E-02	2.29	9.52	0.33	0.32	3.33E-02	4.48E-05	0.18
FACILITY	Main	Multi-Purpose Service Vessel	g/kW-hr	630.62	4.00E-03	3.10E-02	2.13	9.60	0.36	0.34	1.12E-01	3.70E-05	0.28
FACILITY	Main	Noise Monitoring Vessel	g/kW-hr	643.66	4.00E-03	3.10E-02	2.29	9.52	0.33	0.32	3.33E-02	4.48E-05	0.18
FACILITY	Main	Guard Vessel	g/kW-hr	638.26	4.00E-03	3.10E-02	2.25	9.86	0.34	0.33	6.57E-02	4.15E-05	0.22
FACILITY	Main	Heavy Lift Installation Vessel	g/kW-hr	647.08	4.00E-03	3.10E-02	2.30	10.03	0.31	0.30	1.27E-02	4.51E-05	0.14
FACILITY	Main	Platform Support Vessel	g/kW-hr	644.58	4.00E-03	3.10E-02	2.29	9.44	0.32	0.31	2.77E-02	4.45E-05	0.17
FACILITY	Main	Compressor	g/kW-hr	647.08	4.00E-03	3.10E-02	2.30	10.03	0.31	0.30	1.27E-02	4.51E-05	0.14
FACILITY	Main	Heavy Transport Vessel	g/kW-hr	647.08	4.00E-03	3.10E-02	2.30	10.03	0.31	0.30	1.27E-02	4.51E-05	0.14
FACILITY	Main	Support Vessel - Small	g/kW-hr	644.58	0.00	0.03	2.29	9.44	0.32	0.31	0.03	0.00	0.17
FACILITY	Main	Support Vessel - Large	g/kW-hr	638.26	0.00	0.03	2.25	9.86	0.34	0.33	0.07	0.00	0.22
FACILITY	Main	Dive Vessel	g/kW-hr	630.62	0.00	0.03	2.13	9.60	0.36	0.34	0.11	0.00	0.28
FACILITY	Auxiliary	Anchor Handling Tugs	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	9.88	0.32	0.31	6.00E-03	4.80E-05	0.14
FACILITY	Auxiliary	Barge	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	12.57	0.32	0.31	6.00E-03	4.80E-05	0.14
FACILITY	Auxiliary	Cable Laying	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	9.89	0.32	0.31	6.00E-03	4.80E-05	0.14
FACILITY	Auxiliary	Crew	g/kW-hr	648.20	0.00	0.03	2.48	5.51	0.15	0.15	0.01	0.00	0.14
FACILITY	Auxiliary	Dredging	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	9.85	0.32	0.31	6.00E-03	4.80E-05	0.14
FACILITY	Auxiliary	Jackup	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	11.55	0.32	0.31	6.00E-03	4.80E-05	0.14
FACILITY	Auxiliary	Research/Survey	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.21	0.32	0.31	6.00E-03	4.80E-05	0.14
FACILITY	Auxiliary	Shuttle Tanker	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	9.80	0.32	0.31	6.00E-03	4.80E-05	0.14
FACILITY	Auxiliary	Supply Ship	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.43	0.32	0.31	6.00E-03	4.80E-05	0.14
FACILITY	Auxiliary	Tug	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.10	0.32	0.31	6.00E-03	4.80E-05	0.14
FACILITY	Auxiliary	Feeder Barge Tug	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.10	0.32	0.31	6.00E-03	4.80E-05	0.14
FACILITY	Auxiliary	Multi-Purpose Service Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	9.85	0.32	0.31	6.00E-03	4.80E-05	0.14
FACILITY	Auxiliary	Noise Monitoring Vessel	g/kW-hr	648.20	0.00	0.03	2.48	10.10	0.32	0.31	0.01	0.00	0.14
FACILITY	Auxiliary	Guard Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.21	0.32	0.31	6.00E-03	4.80E-05	0.14
FACILITY	Auxiliary	Heavy Lift Installation Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	11.55	0.32	0.31	6.00E-03	4.80E-05	0.14
FACILITY	Auxiliary	Platform Support Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	10.43	0.32	0.31	6.00E-03	4.80E-05	0.14
FACILITY	Auxiliary	Compressor	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	11.55	0.32	0.31	6.00E-03	4.80E-05	0.14
FACILITY	Auxiliary	Heavy Transport Vessel	g/kW-hr	648.20	4.00E-03	3.10E-02	2.48	11.55	0.32	0.31	6.00E-03	4.80E-05	0.14
FACILITY	Auxiliary	Support Vessel - Small	g/kW-hr	648.20	0.00	0.03	2.48	10.43	0.32	0.31	0.01	0.00	0.14
FACILITY	Auxiliary	Support Vessel - Large	g/kW-hr	648.20	0.00	0.03	2.48	10.21	0.32	0.31	0.01	0.00	0.14
FACILITY	Auxiliary	Dive Vessel	g/kW-hr	648.20	0.00	0.03	2.48	9.85	0.32	0.31	0.01	0.00	0.14

[1] Emission factors for project-specific vessels are assumed to be equivalent to BOEM Wind Tool emission factors for the vessel that is closest in engine rating, except for crew vessels. The NO_x, PM_{10}, and $PM_{2.5}$ emission facors correspond to the lowest (resulting in highest emissions) Tier emission standard in 40 CFR § 1042 that this vessel type may be certified by the manufacturer as meeting.

Vessel Type	Equivalent Vessel Type in BOEM WindTool	Maneuvering Time per Roundtrip [1] [2] (hours)
Misc.	All others	1
Tanker	Shuttle Tanker	1
Tug	Tug	1.7
Vehicle Carrier	Barge	1

[1] U.S.EPA. (2018). 2014 National Emissions Inventory, Version 2 Technical Support Document.

[2] Manuevering time at port and vessel type obtained from Table 4-111 of 2014 NEI Technical Support Document. The types of vessels the Project will use was aligned with the vessel types given in the NEI table as shown in column 'Equivalent Vessel Type in BOEM WindTool'. The time Project vessels spend maneuvering at port is subtracted, along with other activities, from the total time the vessel is used to obtain time spent in on-site maneuvering.

Propulsion Engines Load Factor [1]				
Vessel Type	Transit	On-site Maneuvering	Port Maneuvering	Hoteling [2]
All	0.82	0.2	0.2	0
Jackup [3]	0.82	0	0.2	0

[1] Load factors for the propulsion engines are the default BOEM WindTool load factors, as a worst case assumption. The default BOEM load factors for propulsion engines are consistent with other available sources of marine vessel load factors, including USEPA (2000), 2009 USEPA, and 2014 NEI (EPA, 2018). Note that the terms propulsion engine and main engine are used interchangeably throughout workbook.

[2] It is assumed only auxiliary engines are used for hoteling for all vessel types, based on 2014 NEI (EPA, 2018).

[3] Jack-up vessels plant their legs on the seafloor to remain in place, so it is assumed the propulsion engines of jack-up vessels will not engage in on-site maneuvering.

Auxiliary Engines Load Factor				
Table 4-120 of 2014 NEI				Table 2-7 of 2009 USEPA [2]
Vessel Type	Type in BOEM WindTool	Maneuvering	Hotel [1]	Transit
Drilling	Dredging	0.45	0.22	0.32
Jackup [3]	Jackup	0	0.22	0.32
Pipelaying	Cable Laying	0.45	0.22	0.32
Research	Research/Survey	0.45	0.22	0.32
Supply	Supply Ship	0.45	0.22	0.32
Support	Crew	0.45	0.22	0.32
Tanker	Shuttle Tanker	0.33	0.26	0.32
Tug	Tug	0.45	0.22	0.32
Vehicle Carrier	Barge	0.45	0.22	0.32

[1] Load factors for auxiliary engines in transit are from 2009 USEPA, which based load factors on a study conducted for the 2005 emissions inventory for the Port of Los Angeles. Excluding cruise ships, the highest load factor among cruise load factors and Reduced Speed Zone (RSZ) load factors is assumed to represent transit load factors for all vessels used for Ocean Wind, as a conservative assumption.

[2] It is assumed vessels equipped with Category 1 or 2 propulsion engines do not engage propulsion or auxiliary engines while hoteling based on 2014 NEI (EPA, 2018) and assume to engage in cold ironing. Category 1, 2 and 3 marine vessel engines are defined in 40 CFR 1042.901 based on engine displacement. Because engine displacement information is unknown, it was assumed that Category 1 and 2 engines are typically smaller than 3,000 kW (Browning and Bailey). If the propulsion engine is greater than 3,000 kW then the load factor displayed is utilized in emissions calculations for hoteling for auxiliary engines.

[3] Jack-up vessels plant their legs on the seafloor to remain in place, so it is assumed the auxiliary engines of jack-up vessels will not engage in on-site maneuvering.

Sources:

2014 NEI: U.S.EPA. (2018). 2014 National Emissions Inventory, Version 2 Technical Support Document.

Browning and Bailey: Browning, ICF Consulting and Bailey, USEPA. Current Methodologies and Best Practice for Preparing Port Emission Inventories. https://www3.epa.gov/ttnchie1/conference/ei15/session1/browning.pdf

U.S.EPA. (2000). Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data. https://nepis.epa.gov/Exe/ZyPDF.cgi/P1009Z2K.PDF?Dockey=P1009Z2K.PDF

2009 USEPA: U.S.EPA. (2009). Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories. https://www.epa.gov/sites/production/files/2016-06/documents/2009-port-inventory-guidance.pdf

Phase	Activity	Vessel Description	Project-Specific Vessel Type	BOEM Wind Tool Vessel Type	Vessel Type [1]	Number of Vessels	Port	Longest Overall Route Distance	Main Engine Rating (kW)	Auxiliary Engine Rating (kW)	Average Speed of Vessel (nm/hr) 1 knot = 1 nm/hr	Number of One Way Trips Per Vessel Between Array and Port	Time to Travel One-way (Hours)	Installation Duration Not Including Transit (Days)	Transit & Installation Duration (Days)	Average Days Between Roundtrips	Propulsion Engines Load Factor: Transit	Propulsion Engine Load Factor: Maneuvering	Propulsion Engine Load Factor: Hoteling	Auxiliary Engine Load Factor: Transit	Auxiliary Engine Load Factor: Maneuvering	Auxiliary Engine Load Factor: Hoteling
Construction	Array Cable Installation	Pre-lay Survey Vessel	Not Given	Crew	Crew	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,060	201	10.00	3	8	60	67	44	0.82	0.2	0	0.32	0.45	0
Construction		Pre-lay Grapnel Run (PLGR) Vessel	Not Given	Dredging	Dredging	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,234	964	10.00	3	8	35	42	28	0.82	0.2	0	0.32	0.45	0.22
Construction		Boulder Clearance Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,132	1,007	10.00	3	8	50	57	38	0.82	0.2	0	0.32	0.45	0.22
Construction		Sandwave Clearance Vessel	Not Given	Dredging	Dredging	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,234	964	10.00	3	8	35	42	28	0.82	0.2	0	0.32	0.45	0.22
Construction		Cable Laying Vessel	Not Given	Cable Laying	Cable Laying	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	6,658	3,026	10.00	14	8	100	131	19	0.82	0.2	0	0.32	0.45	0.22
Construction		Cable Burial Vessel	Not Given	Cable Laying	Cable Laying	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	6,658	3,026	10.00	14	8	150	181	26	0.82	0.2	0	0.32	0.45	0.22
Construction		Crew Transport Vessel	Not Given	Crew	Crew	2	Atlantic City, NJ	Atlantic City, NJ	2,060	201	22.13	99	1	75	79	2	0.82	0.2	0	0.32	0.45	0
Construction		Walk to Work Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,132	1,007	10.00	99	8	120	342	7	0.82	0.2	0	0.32	0.45	0.22
Construction		Post-Lay Inspection Survey Vessel	Not Given	Crew	Crew	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,060	201	10.00	50	8	110	222	9	0.82	0.2	0	0.32	0.45	0
Construction		DP2 Construction Vessel - Jack of All Trades	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,132	1,007	10.00	51	8	71	186	7	0.82	0.2	0	0.32	0.45	0.22
Construction	Offshore Export Cable & Interconnection Cable Installation	Cable Lay and Burial Vessel	Not Given	Cable Laying	Cable Laying	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	6,658	3,026	10.00	20	8	200	245	24	0.82	0.2	0	0.32	0.45	0.22
Construction		Cable Burial Vessel	Not Given	Cable Laying	Cable Laying	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	6,658	3,026	10.00	21	8	15	62	6	0.82	0.2	0	0.32	0.45	0.22
Construction		Anchor Handling Tug	Not Given	Tug	Tug	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,053	238	10.00	30	8	60	127	8	0.82	0.2	0	0.32	0.45	0
Construction		Pull tug to move barges	Not Given	Tug	Tug	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,053	238	10.00	100	8	200	424	8	0.82	0.2	0	0.32	0.45	0
Construction		Pull ahead export cable tug for assist CLV	Anchor Tug	NA	Anchor Tug	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	1,230	357	10.00	70	8	135	292	8	0.82	0.2	0	0.32	0.45	0
Construction		Pre-lay Grapnel Run (PLGR) Vessel	Not Given	Dredging	Dredging	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,234	964	10.00	11	8	60	85	15	0.82	0.2	0	0.32	0.45	0.22
Construction		Boulder Clearance Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,132	1,007	10.00	5	8	30	41	16	0.82	0.2	0	0.32	0.45	0.22
Construction		Crew Transport Vessel	Not Given	Crew	Crew	2	Atlantic City, NJ	Atlantic City, NJ	2,060	201	22.13	11	1	68	68	12	0.82	0.2	0	0.32	0.45	0
Construction		Guard Vessel	Guard Vessel	NA	Guard Vessel	5	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,460	357	10.00	30	8	200	267	18	0.82	0.2	0	0.32	0.45	0
Construction		Post-Lay Inspection Survey Vessel	Not Given	Crew	Crew	2	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	2,060	201	10.00	11	8	18	43	8	0.82	0.2	0	0.32	0.45	0
Construction		General Work Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Port Elizabeth, NJ, Charleston, SC, or Europe	Charleston, SC	3,132	1,007	10.00	15	8	67	101	13	0.82	0.2	0	0.32	0.45	0.22
Construction	OSS Topside	Heavy Transport Vessel	Heavy Transport Vessel	NA	Heavy Transport Vessel	2	Atlantic City, NJ	Atlantic City, NJ	10,022	0	10.00	12	2	3	4	1	0.82	0.2	0	0.32	0.45	0.22
Construction	WTG & OSS Platform Foundation Installation	Heavy Lift Installation Vessel	Heavy Transport Vessel	NA	Heavy Transport Vessel	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	10,022	0	10.00	99	13	210	290	6	0.82	0.2	0	0.32	0.45	0.22
Construction		Secondary Steel Installation	Not Given	Jackup	Jackup	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	3,215	895	10.00	99	13	210	290	6	0.82	0	0	0.32	0	0.22
Construction		Feeder Barge Tug	Feeder Barge Tug	Tug	Feeder Barge Tug	2	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	8,113	340	10.00	99	13	90	170	3	0.82	0.2	0	0.32	0.45	0.22
Construction		Rock Dumping Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	3,132	1,007	10.00	99	13	105	185	4	0.82	0.2	0	0.32	0.45	0.22
Construction		Bubble Curtain Vessel	Platform Support Vessel	NA	Platform Support Vessel	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	4,516	1,618	10.00	99	13	150	230	5	0.82	0.2	0	0.32	0.45	0.22
Construction		Heavy Transport Vessel	Heavy Transport Vessel	NA	Heavy Transport Vessel	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	10,022	0	10.00	99	13	180	260	5	0.82	0.2	0	0.32	0.45	0.22
Construction		Crew Transport Vessel	Not Given	Crew	Crew	1	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	2,060	201	22.13	99	6	210	246	5	0.82	0.2	0	0.32	0.45	0
Construction		Noise Monitoring Vessel	Noise Monitoring Vessel	NA	Noise Monitoring Vessel	2	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	970	0	10.00	99	13	105	185	4	0.82	0.2	0	0.32	0.45	0
Construction		Platform Support Vessel	Platform Support Vessel	NA	Platform Support Vessel	2	Paulsboro, NJ, Repauno, NJ, or Europe	Europe	4,516	1,618	10.00	99	13	105	185	4	0.82	0.2	0	0.32	0.45	0.22
Construction	WTG Construction	Installation Vessel	Not Given	Jackup	Jackup	1	Norfolk, VA or Hope Creek, NJ	Norfolk, VA	3,215	895	10.00	17	9	100	114	13	0.82	0	0	0.32	0	0.22
Construction		Towing Tug	Not Given	Tug	Tug	2	Norfolk, VA or Hope Creek, NJ	Norfolk, VA	2,053	238	10.00	17	9	50	63	8	0.82	0.2	0	0.32	0.45	0
Construction	Construction Package	Safety Vessel	Not Given	Supply Ship	Supply Ship	1	Atlantic City, NJ	Atlantic City, NJ	3,843	874	10.00	140	2	650	662	9	0.82	0.2	0	0.32	0.45	0.22
Construction		Crew Transport Vessel	Not Given	Crew	Crew	6	Atlantic City, NJ	Atlantic City, NJ	2,060	201	22.13	2300	1	539	631	1	0.82	0.2	0	0.32	0.45	0
Construction		Service Operation Vessel	Multi-Purpose Service Vessel	NA	Multi-Purpose Service Vessel	1	Atlantic City, NJ	Atlantic City, NJ	3,132	1,007	10.00	70	2	491	497	14	0.82	0.2	0	0.32	0.45	0.22
Construction	HDD	Crew Transport Vessel	Not Given	Crew	Crew	1	Atlantic City, NJ	Atlantic City, NJ	2,060	201	22.13	200	1	50	58	1	0.82	0.2	0	0.32	0.45	0
Construction		Supply Vessel	Not Given	Supply Ship	Supply Ship	1	Paulsboro, NJ	Paulsboro, NJ	1,300	651	10.00	14	13	15	22	3	0.82	0.2	0	0.32	0.45	0
Construction		Guard Vessel	Guard Vessel	NA	Guard Vessel	1	Atlantic City, NJ	Atlantic City, NJ	800	200	10.00	200	2	50	68	1	0.82	0.2	0	0.32	0.45	0
Construction		Towing Tug	Not Given	Tug	Tug	1	Paulsboro, NJ	Paulsboro, NJ	2,053	238	10.00	2	13	1	2	2	0.82	0.2	0	0.32	0.45	0
Construction		Support Vessel - Small	Support Vessel - Small	NA	Support Vessel - Small	3	Atlantic City, NJ	Atlantic City, NJ	600	300	10.00	10	2	5	6	1	0.82	0.2	0	0.32	0.45	0
Construction		Support Vessel - Large	Support Vessel - Large	NA	Support Vessel - Large	3	Atlantic City, NJ	Atlantic City, NJ	3,000	600	10.00	100	2	50	59	1	0.82	0.2	0	0.32	0.45	0
Construction		Dive Vessel	Dive Vessel	NA	Dive Vessel	1	Paulsboro, NJ	Paulsboro, NJ	1,300	700	10.00	30	13	15	31	2	0.82	0.2	0	0.32	0.45	0
Construction		Jack-up Vessel	Not Given	Jackup	Jackup	1	Paulsboro, NJ	Paulsboro, NJ	3,215	895	10.00	2	13	50	51	51	0.82	0	0	0.32	0	0.22
Construction	Fisheries Monitoring	Research Vessel	Not Given	Research/Survey	Research/Survey	3	Paulsboro, NJ	Paulsboro, NJ	2,997	1,363	10.00	2	13	12	13	13	0.82	0.2	0	0.32	0.45	0
Construction		Fishing Vessel	Not Given	Research/Survey	Research/Survey	1	Paulsboro, NJ	Paulsboro, NJ	2,997	1,363	10.00	2	13	12	13	13	0.82	0.2	0	0.32	0.45	0
Construction	Marine Mammal Mitigation	Research Vessel	Not Given	Research/Survey	Research/Survey	1	Paulsboro, NJ	Paulsboro, NJ	2,997	1,363	10.00	4	13	2	4	2	0.82	0.2	0	0.32	0.45	0

[1] Vessel specifications are from vessel specificiation sheets, where possible; otherwise, vessel specifications are BOEM defaults.

Project-Specific Information - Activity Hours for Each Marine Vessel

Phase	Activity	Vessel Description	Vessel Type	Number of Vessels	Average Speed of Vessel (nm/hr) 1 knot = 1 nm/hr	Number of One Way Trips Per Vessel Between Array and Port	Duration (Total Days)	Year 1 Hours of Transit within OCS	Year 1 Rate Main Engine Used hp-hr/year	Year 1 Rate Auxiliary Engine Used hp-hr/year	Year 1 Hours of Transit Outside OCS	Year 1 Hours of Maneuvering at Port	Year 1 Hours of Hoteling [1]	Year 1 Total Hours of Onsite Maneuvering [2]	Hours of Transit within OCS During 24-Hour Period [3]
Construction	Array Cable Installation	Pre-lay Survey Vessel	Crew	1	10.00	3.0	67	8	20,703	2,021	154	1.50	0	1,422	2.5
Construction		Pre-lay Grapnel Run (PLGR) Vessel	Dredging	1	10.00	3.0	42	8	32,498	9,686	154	1.50	10	828	2.5
Construction		Boulder Clearance Vessel	Multi-Purpose Service Vessel	1	10.00	3.0	57	8	31,476	10,117	154	1.50	14	1,185	2.5
Construction		Sandwave Clearance Vessel	Dredging	1	10.00	3.0	42	8	32,498	9,686	154	1.50	10	828	2.5
Construction		Cable Laying Vessel	Cable Laying	1	10.00	14.0	131	35	312,242	141,909	719	7.00	32	2,361	2.5
Construction		Cable Burial Vessel	Cable Laying	1	10.00	14.0	181	35	312,242	141,909	719	7.00	44	3,549	2.5
Construction		Crew Transport Vessel	Crew	2	22.13	99.0	79	95	261,860	25,556	0	49.50	0	1,732	1.0
Construction		Walk to Work Vessel	Multi-Purpose Service Vessel	1	10.00	99.0	342	248	1,038,701	333,865	5,085	49.50	82	2,748	2.5
Construction		Post-Lay Inspection Survey Vessel	Crew	1	10.00	50.0	222	125	345,050	33,675	2,568	25.00	0	2,562	2.5
Construction		DP2 Construction Vessel - Jack of All Trades	Multi-Purpose Service Vessel	1	10.00	51.0	186	128	535,089	171,991	2,619	25.50	45	1,641	2.5
Construction	Offshore Export Cable & Interconnection Cable Installation	Cable Lay and Burial Vessel	Cable Laying	1	10.00	20.0	245	50	446,060	202,727	1,027	10.00	59	4,731	2.5
Construction		Cable Burial Vessel	Cable Laying	1	10.00	21.0	62	53	468,363	212,863	1,079	10.50	15	335	2.5
Construction		Anchor Handling Tug	Tug	1	10.00	30.0	127	75	206,343	23,932	1,541	15.00	0	1,394	2.5
Construction		Pull tug to move barges	Tug	1	10.00	100.0	424	215	591,524	68,606	4,417	43.00	0	3,997	2.5
Construction		Pull ahead export cable tug for assist CLV	Anchor Tug	1	10.00	70.0	292	175	288,435	83,717	3,595	35.00	0	3,135	2.5
Construction		Pre-lay Grapnel Run (PLGR) Vessel	Dredging	1	10.00	11.0	85	28	119,160	35,517	565	5.50	20	1,414	2.5
Construction		Boulder Clearance Vessel	Multi-Purpose Service Vessel	1	10.00	5.0	41	13	52,460	16,862	257	2.50	10	708	2.5
Construction		Crew Transport Vessel	Crew	2	22.13	11.0	68	11	29,096	2,840	0	5.50	0	1,598	1.0
Construction		Guard Vessel	Guard Vessel	5	10.00	30.0	267	75	247,230	35,879	1,541	15.00	0	4,721	2.5
Construction		Post-Lay Inspection Survey Vessel	Crew	2	10.00	11.2	43	28	77,291	7,543	575	5.60	0	404	2.5
Construction		General Work Vessel	Multi-Purpose Service Vessel	1	10.00	15.0	101	38	157,379	50,586	770	7.50	24	1,576	2.5
Construction	OSS Topside	Heavy Transport Vessel	Heavy Transport Vessel	2	10.00	12.0	4	25	341,695	0	0	6.00	1	65	2.1
Construction	WTG & OSS Platform Foundation Installation	Heavy Lift Installation Vessel	Heavy Transport Vessel	1	10.00	99.0	290	248	3,323,796	0	1,664	49.50	70	4,921	2.5
Construction		Secondary Steel Installation	Jackup	1	10.00	99.0	290	248	1,066,224	296,852	1,664	49.50	70	4,921	2.5
Construction		Feeder Barge Tug	Feeder Barge Tug	2	10.00	99.0	170	248	2,690,676	112,761	1,664	49.50	41	2,070	2.5
Construction		Rock Dumping Vessel	Multi-Purpose Service Vessel	1	10.00	99.0	185	248	1,038,701	333,865	1,664	49.50	44	2,426	2.5
Construction		Bubble Curtain Vessel	Platform Support Vessel	1	10.00	99.0	230	248	1,497,731	536,610	1,664	49.50	55	3,495	2.5
Construction		Heavy Transport Vessel	Heavy Transport Vessel	1	10.00	99.0	260	248	3,323,796	0	1,664	49.50	62	0	2.5
Construction		Crew Transport Vessel	Crew	1	22.13	99.0	246	112	308,754	30,133	752	49.50	0	4,931	1.1
Construction		Noise Monitoring Vessel	Noise Monitoring Vessel	2	10.00	99.0	185	248	321,701	0	1,664	49.50	0	2,426	2.5
Construction		Platform Support Vessel	Platform Support Vessel	2	10.00	99.0	185	248	1,497,731	536,610	1,664	49.50	44	2,426	2.5
Construction	WTG Construction	Installation Vessel	Jackup	1	10.00	17.0	114	43	183,089	50,975	282	8.50	27	2,364	2.5
Construction		Towing Tug	Tug	2	10.00	16.5	63	41	113,489	13,163	274	8.25	0	1,177	2.5
Construction	Construction Package	Safety Vessel	Supply Ship	1	10.00	140.0	662	297	1,528,487	347,647	0	70.00	159	15,371	2.1
Construction		Crew Transport Vessel	Crew	6	22.13	2300.0	631	2,204	6,083,623	593,734	0	1,150.00	0	11,639	1.0
Construction		Service Operation Vessel	Multi-Purpose Service Vessel	1	10.00	70.0	497	148	622,890	200,213	0	35.00	119	11,630	2.1
Construction	HDD	Crew Transport Vessel	Crew	1	22.13	200.0	58	192	529,011	51,629	0	100.00	0	1,086	1.0
Construction		Supply Vessel	Supply Ship	1	10.00	14.0	22	35	60,970	30,532	142	7.00	0	348	2.5
Construction		Guard Vessel	Guard Vessel	1	10.00	200.0	68	424	454,593	113,648	0	100.00	0	1,084	2.1
Construction		Towing Tug	Tug	1	10.00	2.0	2	5	13,756	1,595	20	1.00	0	23	2.5
Construction		Support Vessel - Small	Support Vessel - Small	3	10.00	10.0	6	21	17,047	8,524	0	5.00	0	114	2.1
Construction		Support Vessel - Large	Support Vessel - Large	3	10.00	100.0	59	212	852,361	170,472	0	50.00	14	1,136	2.1
Construction		Dive Vessel	Dive Vessel	1	10.00	30.0	31	75	130,650	70,350	305	15.00	0	338	2.5
Construction		Jack-up Vessel	Jackup	1	10.00	2.0	51	5	21,540	5,997	20	1.00	12	1,187	2.5
Construction	Fisheries Monitoring	Research Vessel	Research/Survey	3	10.00	2.0	13	5	20,078	9,132	20	1.00	0	284	2.5
Construction		Fishing Vessel	Research/Survey	1	10.00	2.0	13	5	20,078	9,132	20	1.00	0	284	2.5
Construction	Marine Mammal	Research Vessel	Research/Survey	1	10.00	4.0	4	10	40,156	18,263	41	2.00	0	45	2.5

[1] Hoteling is the amount of time vessels spend at port. To estimate hours vessels spend hoteling, Ocean Wind assumes that vessels spend 1% of time hoteling, based on time the ratio of time spent at port vs. underway for Deepwater Vessel Type from Table 3 of USEPA. (2015) Category 1 / Category 2 Vessel Port Underway Split for 2011 National Emission Inventory. https://www3.epa.gov/ttn/chief/conference/ei21/session7/billings.pdf. It is also assumed vessels equipped with Category 1 or 2 propulsion engines do not engage propulsion or auxiliary engines while hoteling based on 2014 NEI (2017) because it is assumed vessels engage in cold ironing. Category 1 and 2 engines are typically smaller than 3,000 kW (Browning and Bailey).

[2] As a worst-case assumption, it is assumed that marine vessel engines are being utilized 24 hours per day for the expected duration of the construction activity. It is assumed that vessel engines are engaged in on-site maneuvering every hour the vessel is not at port and not in transit. Based on the definition of potential emissions in 40 CFR Part 55.2, emissions from vessel engines while they are at port are not included in the *potential emissions* of the OCS source even if the port is within 25 miles of the OCS source because vessels at port are not 'enroute to or from the source'.

[3] It is conservatively assumed that each vessel will travel to the Project site within the same 24-hour period, for modeling the 24-hour standards, even though it is unlikely all vessels will travel to the Project site on the same day. Hours spent in transit is estimated based on a one-way trip because vessels will engage in construction activities after traveling to the Project site and vessels are not anticipated to make a round trip in a single 24-hour period.

Construction Emissions from Vessel Engines - Transit within OCS Area

Main Engine:										
tons/year=	hrs/year x kW, main engine x load factor, propulsion engine x EF x 1.1X10^-6 g/ton x # of Vessels									
	CO2	CH4	N2O	CO	NOX	PM10	PM2.5	SO2	Lead	VOC
Construction (Year 1)	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	9.03	5.57E-05	0.00	0.03	0.08	0.00	0.00	0.00	6.47E-07	0.00
Dredging	13.80	8.75E-05	0.00	0.05	0.21	0.01	0.01	0.00	8.10E-07	0.01
Multi-Purpose Service Vessel	13.36	8.47E-05	0.00	0.05	0.20	0.01	0.01	0.00	7.85E-07	0.01
Dredging	13.80	8.75E-05	0.00	0.05	0.21	0.01	0.01	0.00	8.10E-07	0.01
Cable Laying	133.47	8.41E-04	0.01	0.46	2.00	0.07	0.07	0.02	8.15E-06	0.05
Cable Laying	133.47	8.41E-04	0.01	0.46	2.00	0.07	0.07	0.02	8.15E-06	0.05
Crew	228.50	1.41E-03	0.01	0.81	1.94	0.05	0.05	0.00	1.64E-05	0.05
Multi-Purpose Service Vessel	440.92	2.80E-03	0.02	1.49	6.71	0.25	0.24	0.08	2.59E-05	0.20
Crew	150.54	9.29E-04	0.01	0.53	1.28	0.04	0.04	0.00	1.08E-05	0.03
Multi-Purpose Service Vessel	227.14	1.44E-03	0.01	0.77	3.46	0.13	0.12	0.04	1.33E-05	0.10
Cable Laying	190.67	1.20E-03	0.01	0.66	2.85	0.10	0.10	0.03	1.16E-05	0.07
Cable Laying	200.20	1.26E-03	0.01	0.69	2.99	0.11	0.10	0.03	1.22E-05	0.08
Tug	89.40	5.56E-04	0.00	0.32	1.32	0.05	0.04	0.00	6.22E-06	0.02
Tug	256.29	1.59E-03	0.01	0.91	3.79	0.13	0.13	0.01	1.78E-05	0.07
Anchor Tug	124.97	7.77E-04	0.01	0.44	1.85	0.06	0.06	0.01	8.70E-06	0.03
Dredging	50.58	3.21E-04	0.00	0.17	0.77	0.03	0.03	0.01	2.97E-06	0.02
Multi-Purpose Service Vessel	22.27	1.41E-04	0.00	0.08	0.34	0.01	0.01	0.00	1.31E-06	0.01
Crew	25.39	1.57E-04	0.00	0.09	0.22	0.01	0.01	0.00	1.82E-06	0.01
Guard Vessel	531.09	3.33E-03	0.03	1.87	8.21	0.28	0.27	0.05	3.46E-05	0.18
Crew	67.44	4.16E-04	0.00	0.24	0.57	0.02	0.02	0.00	4.83E-06	0.01
Multi-Purpose Service Vessel	66.81	4.24E-04	0.00	0.23	1.02	0.04	0.04	0.01	3.92E-06	0.03
Heavy Transport Vessel	297.67	1.84E-03	0.01	1.06	4.61	0.14	0.14	0.01	2.07E-05	0.07
Heavy Transport Vessel	1,447.75	8.95E-03	0.07	5.14	22.43	0.69	0.67	0.03	1.01E-04	0.32
Jackup	464.42	2.87E-03	0.02	1.65	7.20	0.22	0.21	0.01	3.24E-05	0.10
Feeder Barge Tug	2,331.57	1.45E-02	0.11	8.29	34.49	1.19	1.14	0.12	1.62E-04	0.64
Multi-Purpose Service Vessel	440.92	2.80E-03	0.02	1.49	6.71	0.25	0.24	0.08	2.59E-05	0.20
Platform Support Vessel	649.85	4.03E-03	0.03	2.31	9.52	0.32	0.31	0.03	4.49E-05	0.17
Heavy Transport Vessel	1,447.75	8.95E-03	0.07	5.14	22.43	0.69	0.67	0.03	1.01E-04	0.32
Crew	134.71	8.31E-04	0.01	0.48	1.15	0.03	0.03	0.00	9.66E-06	0.03
Noise Monitoring Vessel	278.76	1.73E-03	0.01	0.99	4.12	0.14	0.14	0.01	1.94E-05	0.08
Platform Support Vessel	1,299.71	8.07E-03	0.06	4.61	19.04	0.64	0.62	0.06	8.98E-05	0.34
Jackup	79.75	4.93E-04	0.00	0.28	1.24	0.04	0.04	0.00	5.56E-06	0.02
Tug	98.34	6.11E-04	0.00	0.35	1.45	0.05	0.05	0.01	6.85E-06	0.03
Supply Ship	663.20	4.12E-03	0.03	2.35	9.72	0.33	0.32	0.03	4.58E-05	0.17
Crew	15,925.67	9.83E-02	0.76	56.46	135.38	3.76	3.76	0.15	1.14E-03	3.37
Multi-Purpose Service Vessel	264.41	1.68E-03	0.01	0.89	4.02	0.15	0.14	0.05	1.55E-05	0.12
Crew	230.81	1.42E-03	0.01	0.82	1.96	0.05	0.05	0.00	1.65E-05	0.05
Supply Ship	26.45	1.64E-04	0.00	0.09	0.39	0.01	0.01	0.00	1.83E-06	0.01
Guard Vessel	195.31	1.22E-03	0.01	0.69	3.02	0.10	0.10	0.02	1.27E-05	0.07
Tug	5.96	3.70E-05	0.00	0.02	0.09	0.00	0.00	0.00	4.15E-07	0.00
Support Vessel - Small	22.19	1.38E-04	0.00	0.08	0.33	0.01	0.01	0.00	1.53E-06	0.01
Support Vessel - Large	1,098.61	6.89E-03	0.05	3.87	16.98	0.58	0.56	0.11	7.15E-05	0.38
Dive Vessel	55.46	3.52E-04	0.00	0.19	0.84	0.03	0.03	0.01	3.26E-06	0.03

Jackup	9.38	5.80E-05	0.00	0.03	0.15	0.00	0.00	0.00	6.54E-07	0.00
Research/Survey	25.88	1.62E-04	0.00	0.09	0.40	0.01	0.01	0.00	1.68E-06	0.01
Research/Survey	8.63	5.41E-05	0.00	0.03	0.13	0.00	0.00	0.00	5.61E-07	0.00
Research/Survey	17.25	1.08E-04	0.00	0.06	0.27	0.01	0.01	0.00	1.12E-06	0.01

Auxiliary Engine:										
tons/year=	hrs/year x kW, aux engine x load factor, aux engine x EF x 1.1X10^-6 g/ton x # of Vessels									
	CO2	**CH4**	**N2O**	**CO**	**NOX**	**PM10**	**PM2.5**	**SO2**	**Lead**	**VOC**
Construction (Year 1)	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**
Crew	0.34	2.12E-06	1.65E-05	0.00	0.00	0.00	0.00	3.18E-06	2.55E-08	0.00
Dredging	1.65	1.02E-05	7.89E-05	0.01	0.03	0.00	0.00	1.53E-05	1.22E-07	0.00
Multi-Purpose Service Vessel	1.72	1.06E-05	8.24E-05	0.01	0.03	0.00	0.00	1.59E-05	1.28E-07	0.00
Dredging	1.65	1.02E-05	7.89E-05	0.01	0.03	0.00	0.00	1.53E-05	1.22E-07	0.00
Cable Laying	24.16	1.49E-04	1.16E-03	0.09	0.37	0.01	0.01	2.24E-04	1.79E-06	0.01
Cable Laying	24.16	1.49E-04	1.16E-03	0.09	0.37	0.01	0.01	2.24E-04	1.79E-06	0.01
Crew	8.70	5.37E-05	4.16E-04	0.03	0.07	0.00	0.00	8.06E-05	6.44E-07	0.00
Multi-Purpose Service Vessel	56.85	3.51E-04	2.72E-03	0.22	0.86	0.03	0.03	5.26E-04	4.21E-06	0.01
Crew	5.73	3.54E-05	2.74E-04	0.02	0.05	0.00	0.00	5.31E-05	4.25E-07	0.00
Multi-Purpose Service Vessel	29.29	1.81E-04	1.40E-03	0.11	0.45	0.01	0.01	2.71E-04	2.17E-06	0.01
Cable Laying	34.52	2.13E-04	1.65E-03	0.13	0.53	0.02	0.02	3.20E-04	2.56E-06	0.01
Cable Laying	36.24	2.24E-04	1.73E-03	0.14	0.55	0.02	0.02	3.35E-04	2.68E-06	0.01
Tug	4.08	2.51E-05	1.95E-04	0.02	0.06	0.00	0.00	3.77E-05	3.02E-07	0.00
Tug	11.68	7.21E-05	5.59E-04	0.04	0.18	0.01	0.01	1.08E-04	8.65E-07	0.00
Anchor Tug	14.25	8.80E-05	6.82E-04	0.05	0.22	0.01	0.01	1.32E-04	1.06E-06	0.00
Dredging	6.05	3.73E-05	2.89E-04	0.02	0.09	0.00	0.00	5.60E-05	4.48E-07	0.00
Multi-Purpose Service Vessel	2.87	1.77E-05	1.37E-04	0.01	0.04	0.00	0.00	2.66E-05	2.13E-07	0.00
Crew	0.97	5.97E-06	4.62E-05	0.00	0.01	0.00	0.00	8.95E-06	7.16E-08	0.00
Guard Vessel	30.55	1.88E-04	1.46E-03	0.12	0.48	0.02	0.01	2.83E-04	2.26E-06	0.01
Crew	2.57	1.59E-05	1.23E-04	0.01	0.02	0.00	0.00	2.38E-05	1.90E-07	0.00
Multi-Purpose Service Vessel	8.61	5.32E-05	4.12E-04	0.03	0.13	0.00	0.00	7.97E-05	6.38E-07	0.00
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Jackup	50.55	3.12E-04	2.42E-03	0.19	0.90	0.02	0.02	4.68E-04	3.74E-06	0.01
Feeder Barge Tug	38.40	2.37E-04	1.84E-03	0.15	0.60	0.02	0.02	3.55E-04	2.84E-06	0.01
Multi-Purpose Service Vessel	56.85	3.51E-04	2.72E-03	0.22	0.86	0.03	0.03	5.26E-04	4.21E-06	0.01
Platform Support Vessel	91.37	5.64E-04	4.37E-03	0.35	1.47	0.05	0.04	8.46E-04	6.77E-06	0.02
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Crew	5.13	3.17E-05	2.45E-04	0.02	0.04	0.00	0.00	4.75E-05	3.80E-07	0.00
Noise Monitoring Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Platform Support Vessel	182.74	1.13E-03	8.74E-03	0.70	2.94	0.09	0.09	1.69E-03	1.35E-05	0.04
Jackup	8.68	5.36E-05	4.15E-04	0.03	0.15	0.00	0.00	8.03E-05	6.43E-07	0.00
Tug	4.48	2.77E-05	2.14E-04	0.02	0.07	0.00	0.00	4.15E-05	3.32E-07	0.00
Supply Ship	59.20	3.65E-04	2.83E-03	0.23	0.95	0.03	0.03	5.48E-04	4.38E-06	0.01
Crew	606.58	3.74E-03	2.90E-02	2.32	5.16	0.14	0.14	5.61E-03	4.49E-05	0.13
Multi-Purpose Service Vessel	34.09	2.10E-04	1.63E-03	0.13	0.52	0.02	0.02	3.16E-04	2.52E-06	0.01
Crew	8.79	5.42E-05	4.20E-04	0.03	0.07	0.00	0.00	8.14E-05	6.51E-07	0.00

Construction Emissions from Vessel Engines - Transit within OCS Area

Supply Ship	5.20	3.21E-05	2.49E-04	0.02	0.08	0.00	0.00	4.81E-05	3.85E-07	0.00
Guard Vessel	19.35	1.19E-04	9.25E-04	0.07	0.30	0.01	0.01	1.79E-04	1.43E-06	0.00
Tug	0.27	1.68E-06	1.30E-05	0.00	0.00	0.00	0.00	2.51E-06	2.01E-08	0.00
Support Vessel - Small	4.35	2.69E-05	2.08E-04	0.02	0.07	0.00	0.00	4.03E-05	3.22E-07	0.00
Support Vessel - Large	87.08	5.37E-04	4.16E-03	0.33	1.37	0.04	0.04	8.06E-04	6.45E-06	0.02
Dive Vessel	11.98	7.39E-05	5.73E-04	0.05	0.18	0.01	0.01	1.11E-04	8.87E-07	0.00
Jackup	1.02	6.30E-06	4.88E-05	0.00	0.02	0.00	0.00	9.45E-06	7.56E-08	0.00
Research/Survey	4.66	2.88E-05	2.23E-04	0.02	0.07	0.00	0.00	4.32E-05	3.45E-07	0.00
Research/Survey	1.55	9.59E-06	7.44E-05	0.01	0.02	0.00	0.00	1.44E-05	1.15E-07	0.00
Research/Survey	3.11	1.92E-05	1.49E-04	0.01	0.05	0.00	0.00	2.88E-05	2.30E-07	0.00

	CO2	CH4	N2O	CO	NOX	PM10	PM2.5	SO2	Lead	VOC
	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Total OCS Construction Emissions from Transit	32,101.65	0.20	1.54	113.95	370.58	11.56	11.30	1.09	0.00	7.92

Array Cable Installation	1,518.29	0.01	0.07	5.28	20.33	0.71	0.68	0.17	0.00	0.54
Export and Interconnection Cable Installation	1,777.51	0.01	0.09	6.28	26.25	0.91	0.87	0.16	0.00	0.58
Offshore Substations	297.67	0.00	0.01	1.06	4.61	0.14	0.14	0.01	0.00	0.07
WTG and Platform Foundation Installation	7,438.04	0.05	0.36	26.41	111.93	3.65	3.52	0.31	0.00	1.91
WTG Construction	1,673.70	0.01	0.08	6.00	24.90	0.83	0.80	0.06	0.00	0.42
Construction Package	17,553.15	0.11	0.84	62.38	155.75	4.43	4.41	0.24	0.00	3.81
HDD	1,782.22	0.01	0.09	6.32	25.86	0.87	0.84	0.15	0.00	0.57
Fisheries Monitoring	40.72	0.00	0.00	0.15	0.63	0.02	0.02	0.00	0.00	0.01
Marine Mammal Mitigation	20.36	0.00	0.00	0.07	0.32	0.01	0.01	0.00	0.00	0.01

Construction Emissions from Vessel Engines - On-site Manuevering

Main Engine:										
tons/year=	hrs/year x kW, main engine x load factor, propulsion engine x EF x 1.1X10^-6 g/ton x # of Vessels									
	CO2	CH4	N2O	CO	NOX	PM10	PM2.5	SO2	Lead	VOC
Construction (Year 1)	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Crew	417.85	2.58E-03	0.02	1.48	3.55	0.10	0.10	0.00	3.00E-05	0.09
Dredging	371.68	2.36E-03	0.02	1.25	5.66	0.21	0.20	0.07	2.18E-05	0.17
Multi-Purpose Service Vessel	514.85	3.27E-03	0.03	1.74	7.84	0.29	0.28	0.09	3.02E-05	0.23
Dredging	371.68	2.36E-03	0.02	1.25	5.66	0.21	0.20	0.07	2.18E-05	0.17
Cable Laying	2,196.40	1.38E-02	0.11	7.60	32.84	1.18	1.13	0.29	1.34E-04	0.85
Cable Laying	3,301.36	2.08E-02	0.16	11.43	49.36	1.77	1.70	0.44	2.02E-04	1.28
Crew	1,017.27	6.28E-03	0.05	3.61	8.65	0.24	0.24	0.01	7.29E-05	0.21
Multi-Purpose Service Vessel	1,194.20	7.57E-03	0.06	4.03	18.18	0.68	0.65	0.21	7.01E-05	0.54
Crew	752.48	4.64E-03	0.04	2.67	6.40	0.18	0.18	0.01	5.39E-05	0.16
Multi-Purpose Service Vessel	713.08	4.52E-03	0.04	2.41	10.85	0.40	0.39	0.13	4.19E-05	0.32
Cable Laying	4,400.52	2.77E-02	0.21	15.24	65.79	2.36	2.27	0.59	2.69E-04	1.71
Cable Laying	311.20	1.96E-03	0.02	1.08	4.65	0.17	0.16	0.04	1.90E-05	0.12
Tug	405.42	2.52E-03	0.02	1.44	6.00	0.21	0.20	0.02	2.82E-05	0.11
Tug	1,162.21	7.22E-03	0.06	4.13	17.19	0.59	0.57	0.06	8.09E-05	0.32
Anchor Tug	546.02	3.39E-03	0.03	1.94	8.08	0.28	0.27	0.03	3.80E-05	0.15
Dredging	634.44	4.02E-03	0.03	2.14	9.66	0.36	0.34	0.11	3.73E-05	0.29
Multi-Purpose Service Vessel	307.46	1.95E-03	0.02	1.04	4.68	0.17	0.17	0.05	1.81E-05	0.14
Crew	938.93	5.79E-03	0.04	3.33	7.98	0.22	0.22	0.01	6.73E-05	0.20
Guard Vessel	8,153.49	5.11E-02	0.40	28.72	126.00	4.33	4.16	0.84	5.30E-04	2.83
Crew	237.45	1.47E-03	0.01	0.84	2.02	0.06	0.06	0.00	1.70E-05	0.05
Multi-Purpose Service Vessel	684.94	4.34E-03	0.03	2.31	10.43	0.39	0.37	0.12	4.02E-05	0.31
Heavy Transport Vessel	185.55	1.15E-03	0.01	0.66	2.88	0.09	0.09	0.00	1.29E-05	0.04
Heavy Transport Vessel	7,020.82	4.34E-02	0.34	24.92	108.79	3.34	3.23	0.14	4.89E-04	1.57
Jackup	0.00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00
Feeder Barge Tug	4,755.69	2.96E-02	0.23	16.91	70.35	2.42	2.33	0.25	3.31E-04	1.30
Multi-Purpose Service Vessel	1,054.20	6.69E-03	0.05	3.56	16.05	0.60	0.57	0.19	6.19E-05	0.48
Platform Support Vessel	2,238.47	1.39E-02	0.11	7.95	32.79	1.11	1.07	0.10	1.55E-04	0.58
Crew	1,448.60	8.94E-03	0.07	5.14	12.31	0.34	0.34	0.01	1.04E-04	0.31
Noise Monitoring Vessel	666.50	4.14E-03	0.03	2.37	9.86	0.34	0.33	0.03	4.64E-05	0.18
Platform Support Vessel	3,107.49	1.93E-02	0.15	11.03	45.53	1.54	1.49	0.13	2.15E-04	0.81
Jackup	0.00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00
Tug	684.16	4.25E-03	0.03	2.43	10.12	0.35	0.34	0.04	4.76E-05	0.19
Supply Ship	8,375.99	5.20E-02	0.40	29.74	122.71	4.15	4.01	0.36	5.79E-04	2.17
Crew	20,512.70	1.27E-01	0.98	72.72	174.38	4.84	4.84	0.20	1.47E-03	4.33
Multi-Purpose Service Vessel	5,053.22	3.21E-02	0.25	17.06	76.91	2.86	2.73	0.89	2.97E-04	2.28
Crew	319.03	1.97E-03	0.02	1.13	2.71	0.08	0.08	0.00	2.29E-05	0.07
Supply Ship	64.08	3.98E-04	0.00	0.23	0.94	0.03	0.03	0.00	4.43E-06	0.02
Guard Vessel	121.74	7.63E-04	0.01	0.43	1.88	0.06	0.06	0.01	7.92E-06	0.04
Tug	6.54	4.07E-05	0.00	0.02	0.10	0.00	0.00	0.00	4.56E-07	0.00
Support Vessel - Small	28.99	1.80E-04	0.00	0.10	0.42	0.01	0.01	0.00	2.00E-06	0.01
Support Vessel - Large	1,435.47	9.00E-03	0.07	5.06	22.18	0.76	0.73	0.15	9.34E-05	0.50
Dive Vessel	60.89	3.86E-04	0.00	0.21	0.93	0.03	0.03	0.01	3.58E-06	0.03
Jackup	0.00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00

Research/Survey	358.35	2.25E-03	0.02	1.26	5.54	0.19	0.18	0.04	2.33E-05	0.12
Research/Survey	119.45	7.49E-04	0.01	0.42	1.85	0.06	0.06	0.01	7.77E-06	0.04
Research/Survey	18.94	1.19E-04	0.00	0.07	0.29	0.01	0.01	0.00	1.23E-06	0.01

Auxiliary Engine:										
tons/year=	hrs/year x kW, aux engine x load factor, aux engine x EF x 1.1X10^-6 g/ton x # of Vessels									
	CO2	**CH4**	**N2O**	**CO**	**NOX**	**PM10**	**PM2.5**	**SO2**	**Lead**	**VOC**
Construction (Year 1)	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**
Crew	40.78	2.52E-04	1.95E-03	0.16	0.35	0.01	0.01	3.78E-04	3.02E-06	0.01
Dredging	113.87	7.03E-04	5.45E-03	0.44	1.73	0.06	0.05	1.05E-03	8.43E-06	0.02
Multi-Purpose Service Vessel	170.10	1.05E-03	8.13E-03	0.65	2.59	0.08	0.08	1.57E-03	1.26E-05	0.04
Dredging	113.87	7.03E-04	5.45E-03	0.44	1.73	0.06	0.05	1.05E-03	8.43E-06	0.02
Cable Laying	1,018.94	6.29E-03	4.87E-02	3.90	15.54	0.50	0.49	9.43E-03	7.55E-05	0.22
Cable Laying	1,531.55	9.45E-03	7.32E-02	5.86	23.36	0.76	0.73	1.42E-02	1.13E-04	0.33
Crew	99.29	6.13E-04	4.75E-03	0.38	0.84	0.02	0.02	9.19E-04	7.35E-06	0.02
Multi-Purpose Service Vessel	394.55	2.43E-03	1.89E-02	1.51	6.00	0.19	0.19	3.65E-03	2.92E-05	0.09
Crew	73.44	4.53E-04	3.51E-03	0.28	0.62	0.02	0.02	6.80E-04	5.44E-06	0.02
Multi-Purpose Service Vessel	235.59	1.45E-03	1.13E-02	0.90	3.58	0.12	0.11	2.18E-03	1.74E-05	0.05
Cable Laying	2,041.46	1.26E-02	9.76E-02	7.81	31.14	1.01	0.98	1.89E-02	1.51E-04	0.44
Cable Laying	144.37	8.91E-04	6.90E-03	0.55	2.20	0.07	0.07	1.34E-03	1.07E-05	0.03
Tug	47.35	2.92E-04	2.26E-03	0.18	0.74	0.02	0.02	4.38E-04	3.51E-06	0.01
Tug	135.75	8.38E-04	6.49E-03	0.52	2.12	0.07	0.06	1.26E-03	1.01E-05	0.03
Anchor Tug	159.60	9.85E-04	7.63E-03	0.61	2.49	0.08	0.08	1.48E-03	1.18E-05	0.03
Dredging	194.37	1.20E-03	9.30E-03	0.74	2.96	0.10	0.09	1.80E-03	1.44E-05	0.04
Multi-Purpose Service Vessel	101.58	6.27E-04	4.86E-03	0.39	1.54	0.05	0.05	9.40E-04	7.52E-06	0.02
Crew	91.64	5.66E-04	4.38E-03	0.35	0.78	0.02	0.02	8.48E-04	6.79E-06	0.02
Guard Vessel	1,201.68	7.42E-03	5.75E-02	4.60	18.92	0.59	0.57	1.11E-02	8.90E-05	0.26
Crew	23.18	1.43E-04	1.11E-03	0.09	0.20	0.01	0.01	2.15E-04	1.72E-06	0.01
Multi-Purpose Service Vessel	226.29	1.40E-03	1.08E-02	0.87	3.44	0.11	0.11	2.09E-03	1.68E-05	0.05
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Jackup	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Feeder Barge Tug	200.71	1.24E-03	9.60E-03	0.77	3.13	0.10	0.10	1.86E-03	1.49E-05	0.04
Multi-Purpose Service Vessel	348.29	2.15E-03	1.67E-02	1.33	5.30	0.17	0.17	3.22E-03	2.58E-05	0.08
Platform Support Vessel	806.50	4.98E-03	3.86E-02	3.09	12.98	0.40	0.39	7.47E-03	5.97E-05	0.17
Crew	141.39	8.72E-04	6.76E-03	0.54	1.20	0.03	0.03	1.31E-03	1.05E-05	0.03
Noise Monitoring Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Platform Support Vessel	1,119.60	6.91E-03	5.35E-02	4.28	18.02	0.55	0.54	1.04E-02	8.29E-05	0.24
Jackup	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Tug	79.91	4.93E-04	3.82E-03	0.31	1.25	0.04	0.04	7.40E-04	5.92E-06	0.02
Supply Ship	1,915.77	1.18E-02	9.16E-02	7.33	30.83	0.95	0.92	1.77E-02	1.42E-04	0.41
Crew	2,002.07	1.24E-02	9.57E-02	7.66	17.02	0.47	0.47	1.85E-02	1.48E-04	0.43
Multi-Purpose Service Vessel	1,669.52	1.03E-02	7.98E-02	6.39	25.38	0.82	0.80	1.55E-02	1.24E-04	0.36
Crew	31.14	1.92E-04	1.49E-03	0.12	0.26	0.01	0.01	2.88E-04	2.31E-06	0.01
Supply Ship	32.27	1.99E-04	1.54E-03	0.12	0.52	0.02	0.02	2.99E-04	2.39E-06	0.01
Guard Vessel	30.91	1.91E-04	1.48E-03	0.12	0.49	0.02	0.01	2.86E-04	2.29E-06	0.01

Construction Emissions from Vessel Engines - On-site Manuevering

Tug	0.76	4.72E-06	3.66E-05	0.00	0.01	0.00	0.00	7.07E-06	5.66E-08	0.00
Support Vessel - Small	14.58	9.00E-05	6.97E-04	0.06	0.23	0.01	0.01	1.35E-04	1.08E-06	0.00
Support Vessel - Large	291.57	1.80E-03	1.39E-02	1.12	4.59	0.14	0.14	2.70E-03	2.16E-05	0.06
Dive Vessel	33.70	2.08E-04	1.61E-03	0.13	0.51	0.02	0.02	3.12E-04	2.50E-06	0.01
Jackup	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Research/Survey	165.51	1.02E-03	7.92E-03	0.63	2.61	0.08	0.08	1.53E-03	1.23E-05	0.04
Research/Survey	55.17	3.40E-04	2.64E-03	0.21	0.87	0.03	0.03	5.11E-04	4.09E-06	0.01
Research/Survey	8.75	5.40E-05	4.18E-04	0.03	0.14	0.00	0.00	8.10E-05	6.48E-07	0.00

	CO2	CH4	N2O	CO	NOX	PM10	PM2.5	SO2	Lead	VOC
Total OCS Construction Emissions from Onsite Maneuvering	103,377.19	0.64	4.98	368.54	1,379.16	45.42	44.00	5.92	0.01	29.01

Array Cable Installation	14,642.83	0.08	0.62	45.72	183.86	6.36	6.13	1.22	0.00	4.30
Export and Interconnection Cable Installation	22,149.34	0.01	0.06	4.78	18.94	0.65	0.63	0.11	0.00	0.42
Offshore Substations	185.55	0.06	0.45	33.31	144.92	4.92	4.74	0.85	0.00	3.09
WTG and Platform Foundation Installation	18,681.18	0.12	0.93	68.97	281.85	9.16	8.86	0.82	0.00	5.01
WTG Construction	4,991.17	0.03	0.24	17.69	73.40	2.43	2.35	0.18	0.00	1.23
Construction Package	39,529.28	0.21	1.61	120.19	356.30	10.80	10.62	0.63	0.00	7.56
HDD	2,471.68	0.02	0.12	8.84	35.78	1.19	1.15	0.18	0.00	0.75
Fisheries Monitoring	698.48	0.00	0.03	2.53	10.86	0.36	0.35	0.05	0.00	0.21
Marine Mammal Mitigation	27.69	0.00	0.00	0.10	0.43	0.01	0.01	0.00	0.00	0.01

Construction Emissions from Vessel Engines - Transit within OCS Area - Short-term

Main Engine:										
g/sec=	hrs in transit per day x kW, main engine x load factor, propulsion engine x EF * # of Vessels / 60 min/hr / 60 sec/min									
	CO2	CH4	N2O	CO	NOX	PM10	PM2.5	SO2	Lead	VOC
Construction (Year 1)	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec
Cable Laying	100.31	6.32E-04	4.90E-03	0.35	1.50	5.39E-02	5.17E-02	1.34E-02	6.13E-06	3.89E-02
Cable Laying	100.31	6.32E-04	4.90E-03	0.35	1.50	5.39E-02	5.17E-02	1.34E-02	6.13E-06	3.89E-02
Multi-Purpose Service Vessel	46.86	2.97E-04	2.30E-03	0.16	0.71	2.65E-02	2.54E-02	8.29E-03	2.75E-06	2.12E-02
Cable Laying	100.31	6.32E-04	4.90E-03	0.35	1.50	5.39E-02	5.17E-02	1.34E-02	6.13E-06	3.89E-02
Tug	31.36	1.95E-04	1.51E-03	0.11	0.46	1.59E-02	1.54E-02	1.62E-03	2.18E-06	8.60E-03
Tug	31.36	1.95E-04	1.51E-03	0.11	0.46	1.59E-02	1.54E-02	1.62E-03	2.18E-06	8.60E-03
Anchor Tug	18.78	1.17E-04	9.05E-04	0.07	0.28	9.55E-03	9.22E-03	9.71E-04	1.31E-06	5.15E-03
Crew	24.29	1.50E-04	1.16E-03	0.09	0.21	5.73E-03	5.73E-03	2.34E-04	1.74E-06	5.13E-03
Guard Vessel	186.27	1.17E-03	9.05E-03	0.66	2.88	9.90E-02	9.51E-02	1.92E-02	1.21E-05	6.46E-02
Heavy Transport Vessel	261.00	1.61E-03	1.25E-02	0.93	4.04	1.24E-01	1.20E-01	5.13E-03	1.82E-05	5.82E-02
Heavy Transport Vessel	153.87	9.51E-04	7.37E-03	0.55	2.38	7.31E-02	7.08E-02	3.02E-03	1.07E-05	3.43E-02
Feeder Barge Tug	247.80	1.54E-03	1.19E-02	0.88	3.67	1.26E-01	1.22E-01	1.28E-02	1.73E-05	6.80E-02
Platform Support Vessel	69.07	4.29E-04	3.32E-03	0.25	1.01	3.42E-02	3.31E-02	2.97E-03	4.77E-06	1.79E-02
Heavy Transport Vessel	153.87	9.51E-04	7.37E-03	0.55	2.38	7.31E-02	7.08E-02	3.02E-03	1.07E-05	3.43E-02
Noise Monitoring Vessel	29.63	1.84E-04	1.43E-03	0.11	0.44	1.51E-02	1.45E-02	1.53E-03	2.06E-06	8.13E-03
Jackup	49.36	3.05E-04	2.36E-03	0.18	0.76	2.35E-02	2.27E-02	9.70E-04	3.44E-06	1.10E-02
Tug	62.71	3.90E-04	3.02E-03	0.22	0.93	3.19E-02	3.08E-02	3.24E-03	4.37E-06	1.72E-02
Supply Ship	49.84	3.09E-04	2.40E-03	0.18	0.73	2.47E-02	2.39E-02	2.14E-03	3.44E-06	1.29E-02
Crew	72.86	4.50E-04	3.48E-03	0.26	0.62	1.72E-02	1.72E-02	7.01E-04	5.22E-06	1.54E-02
Multi-Purpose Service Vessel	39.74	2.52E-04	1.95E-03	0.13	0.60	2.25E-02	2.15E-02	7.03E-03	2.33E-06	1.79E-02
Supply Ship	19.88	1.23E-04	9.56E-04	0.07	0.29	9.86E-03	9.52E-03	8.55E-04	1.37E-06	5.15E-03
Guard Vessel	10.28	6.44E-05	4.99E-04	0.04	0.16	5.46E-03	5.25E-03	1.06E-03	6.68E-07	3.56E-03
Tug	31.36	1.95E-04	1.51E-03	0.11	0.46	1.59E-02	1.54E-02	1.62E-03	2.18E-06	8.60E-03
Support Vessel - Small	23.35	1.45E-04	1.12E-03	0.08	0.34	1.16E-02	1.12E-02	1.00E-03	1.61E-06	6.05E-03
Support Vessel - Large	115.59	7.24E-04	5.61E-03	0.41	1.79	6.14E-02	5.90E-02	1.19E-02	7.52E-06	4.01E-02
Research/Survey	136.15	8.53E-04	6.61E-03	0.48	2.10	7.23E-02	6.95E-02	1.40E-02	8.86E-06	4.72E-02
Research/Survey	45.38	2.84E-04	2.20E-03	0.16	0.70	2.41E-02	2.32E-02	4.67E-03	2.95E-06	1.57E-02
Research/Survey	45.38	2.84E-04	2.20E-03	0.16	0.70	2.41E-02	2.32E-02	4.67E-03	2.95E-06	1.57E-02

Auxiliary Engine:										
g/sec=	hrs in transit per day x kW, main engine x load factor, propulsion engine x EF * # of Vessels / 60 min/hr / 60 sec/min									
	CO2	CH4	N2O	CO	NOX	PM10	PM2.5	SO2	Lead	VOC
Construction (Year 1)	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec
Cable Laying	18.16	1.12E-04	8.69E-04	6.95E-02	2.77E-01	8.97E-03	8.69E-03	1.68E-04	1.34E-06	3.92E-03
Cable Laying	18.16	1.12E-04	8.69E-04	6.95E-02	2.77E-01	8.97E-03	8.69E-03	1.68E-04	1.34E-06	3.92E-03
Multi-Purpose Service Vessel	6.04	3.73E-05	2.89E-04	2.31E-02	9.19E-02	2.98E-03	2.89E-03	5.59E-05	4.47E-07	1.30E-03
Cable Laying	18.16	1.12E-04	8.69E-04	6.95E-02	2.77E-01	8.97E-03	8.69E-03	1.68E-04	1.34E-06	3.92E-03
Tug	1.43	8.82E-06	6.84E-05	5.47E-03	2.23E-02	7.06E-04	6.84E-04	1.32E-05	1.06E-07	3.09E-04
Tug	1.43	8.82E-06	6.84E-05	5.47E-03	2.23E-02	7.06E-04	6.84E-04	1.32E-05	1.06E-07	3.09E-04
Anchor Tug	2.14	1.32E-05	1.02E-04	8.20E-03	3.34E-02	1.06E-03	1.02E-03	1.98E-05	1.59E-07	4.63E-04
Crew	0.92	5.71E-06	4.42E-05	3.54E-03	7.86E-03	2.18E-04	2.18E-04	8.56E-06	6.85E-08	2.00E-04
Guard Vessel	10.71	6.61E-05	5.12E-04	4.10E-02	1.69E-01	5.29E-03	5.12E-03	9.92E-05	7.93E-07	2.31E-03
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Construction Emissions from Vessel Engines - Transit within OCS Area - Short-term

Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Feeder Barge Tug	4.08	2.52E-05	1.95E-04	1.56E-02	6.36E-02	2.01E-03	1.95E-03	3.78E-05	3.02E-07	8.81E-04
Platform Support Vessel	9.71	5.99E-05	4.64E-04	3.72E-02	1.56E-01	4.79E-03	4.64E-03	8.99E-05	7.19E-07	2.10E-03
Noise Monitoring Vessel	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Jackup	5.37	3.32E-05	2.57E-04	2.06E-02	9.57E-02	2.65E-03	2.57E-03	4.97E-05	3.98E-07	1.16E-03
Tug	2.86	1.76E-05	1.37E-04	1.09E-02	4.45E-02	1.41E-03	1.37E-03	2.65E-05	2.12E-07	6.17E-04
Supply Ship	4.45	2.75E-05	2.13E-04	1.70E-02	7.16E-02	2.20E-03	2.13E-03	4.12E-05	3.29E-07	9.61E-04
Crew	2.77	1.71E-05	1.33E-04	1.06E-02	2.36E-02	6.55E-04	6.55E-04	2.57E-05	2.05E-07	5.99E-04
Multi-Purpose Service Vessel	5.12	3.16E-05	2.45E-04	1.96E-02	7.79E-02	2.53E-03	2.45E-03	4.74E-05	3.79E-07	1.11E-03
Supply Ship	3.91	2.41E-05	1.87E-04	1.49E-02	6.29E-02	1.93E-03	1.87E-03	3.62E-05	2.89E-07	8.44E-04
Guard Vessel	1.02	6.28E-06	4.87E-05	3.90E-03	1.60E-02	5.03E-04	4.87E-04	9.42E-06	7.54E-08	2.20E-04
Tug	1.43	8.82E-06	6.84E-05	5.47E-03	2.23E-02	7.06E-04	6.84E-04	1.32E-05	1.06E-07	3.09E-04
Support Vessel - Small	4.58	2.83E-05	2.19E-04	1.75E-02	7.37E-02	2.26E-03	2.19E-03	4.24E-05	3.39E-07	9.89E-04
Support Vessel - Large	9.16	5.65E-05	4.38E-04	3.51E-02	1.44E-01	4.52E-03	4.38E-03	8.48E-05	6.78E-07	1.98E-03
Research/Survey	24.54	1.51E-04	1.17E-03	9.39E-02	3.86E-01	1.21E-02	1.17E-02	2.27E-04	1.82E-06	5.30E-03
Research/Survey	8.18	5.05E-05	3.91E-04	3.13E-02	1.29E-01	4.04E-03	3.91E-03	7.57E-05	6.06E-07	1.77E-03
Research/Survey	8.18	5.05E-05	3.91E-04	3.13E-02	1.29E-01	4.04E-03	3.91E-03	7.57E-05	6.06E-07	1.77E-03

	CO2	CH4	N2O	CO	NOX	PM10	PM2.5	SO2	Lead	VOC
	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec
Total OCS Construction Emissions from Transit	2,275.63	0.01	0.11	8.07	33.92	1.14	1.10	0.15	0.00	0.67
Array Cable Installation	289.85	0.00	0.01	1.01	4.36	0.16	0.15	0.04	0.00	0.11
Export and Interconnection Cable Installation	427.16	0.00	0.02	1.51	6.32	0.22	0.21	0.04	0.00	0.14
Offshore Substations	261.00	1.61E-03	1.25E-02	0.93	4.04	0.12	0.12	5.13E-03	1.82E-05	5.82E-02
WTG and Platform Foundation Installation	514.16	0.00	0.02	1.83	7.72	0.26	0.25	0.02	0.00	0.13
WTG Construction	120.30	0.00	0.01	0.43	1.83	0.06	0.06	0.00	0.00	0.03
Construction Package	174.79	1.09E-03	8.43E-03	0.62	2.13	0.07	0.07	9.99E-03	1.19E-05	4.89E-02
HDD	220.55	1.38E-03	1.07E-02	0.79	3.36	0.11	0.11	1.66E-02	1.48E-05	6.78E-02
Fisheries Monitoring	214.25	1.34E-03	1.04E-02	0.76	3.32	0.11	0.11	1.90E-02	1.42E-05	7.00E-02
Marine Mammal Mitigation	53.56	3.35E-04	2.60E-03	0.19	0.83	2.81E-02	2.71E-02	4.75E-03	3.56E-06	1.75E-02

Construction Emissions from Vessel Engines - On-site Manuevering - Short-term

Main Engine:										
g/sec=	hrs/year x kW, main engine x load factor, propulsion engine x EF * # of Vessels *8760 hrs per year / hrs per year / 8760 hours per year / 3600 sec per hour									
	CO2	CH4	N2O	CO	NOX	PM10	PM2.5	SO2	Lead	VOC
Construction (Year 1)	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec
Cable Laying	234.87	1.48E-03	0.01	0.81	3.51	0.13	0.12	0.03	1.43E-05	0.09
Cable Laying	234.87	1.48E-03	0.01	0.81	3.51	0.13	0.12	0.03	1.43E-05	0.09
Multi-Purpose Service Vessel	109.73	6.96E-04	0.01	0.37	1.67	0.06	0.06	0.02	6.44E-06	0.05
Cable Laying	234.87	1.48E-03	0.01	0.81	3.51	0.13	0.12	0.03	1.43E-05	0.09
Tug	73.42	4.56E-04	0.00	0.26	1.09	0.04	0.04	0.00	5.11E-06	0.02
Tug	73.42	4.56E-04	0.00	0.26	1.09	0.04	0.04	0.00	5.11E-06	0.02
Anchor Tug	43.98	2.73E-04	0.00	0.16	0.65	0.02	0.02	0.00	3.06E-06	0.01
Crew	148.36	9.16E-04	0.01	0.53	1.26	0.04	0.04	0.00	1.06E-05	0.03
Guard Vessel	436.14	2.73E-03	0.02	1.54	6.74	0.23	0.22	0.04	2.84E-05	0.15
Heavy Transport Vessel	720.56	4.45E-03	0.03	2.56	11.17	0.34	0.33	0.01	5.02E-05	0.16
Heavy Transport Vessel	360.28	2.23E-03	0.02	1.28	5.58	0.17	0.17	0.01	2.51E-05	0.08
Feeder Barge Tug	145.06	9.01E-04	0.01	0.52	2.15	0.07	0.07	0.01	1.01E-05	0.04
Platform Support Vessel	161.72	1.00E-03	0.01	0.57	2.37	0.08	0.08	0.01	1.12E-05	0.04
Noise Monitoring Vessel	69.37	4.31E-04	0.00	0.25	1.03	0.04	0.03	0.00	4.83E-06	0.02
Jackup	0.00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00
Tug	146.84	9.13E-04	0.01	0.52	2.17	0.07	0.07	0.01	1.02E-05	0.04
Supply Ship	137.61	8.54E-04	0.01	0.49	2.02	0.07	0.07	0.01	9.51E-06	0.04
Crew	445.07	2.75E-03	0.02	1.58	3.78	0.11	0.11	0.00	3.19E-05	0.09
Multi-Purpose Service Vessel	109.73	6.96E-04	0.01	0.37	1.67	0.06	0.06	0.02	6.44E-06	0.05
Supply Ship	46.55	2.89E-04	0.00	0.17	0.68	0.02	0.02	0.00	3.22E-06	0.01
Guard Vessel	28.37	1.78E-04	0.00	0.10	0.44	0.02	0.01	0.00	1.85E-06	0.01
Tug	73.42	4.56E-04	0.00	0.26	1.09	0.04	0.04	0.00	5.11E-06	0.02
Support Vessel - Small	64.46	4.00E-04	0.00	0.23	0.94	0.03	0.03	0.00	4.45E-06	0.02
Support Vessel - Large	319.13	2.00E-03	0.02	1.12	4.93	0.17	0.16	0.03	2.08E-05	0.11
Research/Survey	318.78	2.00E-03	0.02	1.12	4.93	0.17	0.16	0.03	2.07E-05	0.11
Research/Survey	106.26	6.66E-04	0.01	0.37	1.64	0.06	0.05	0.01	6.91E-06	0.04

6 Number of hours per 24 hour period barges will be on-site at each WTG or OSS location during foundation installation

Auxiliary Engine:										
g/sec =	hrs/year x kW, aux engine x load factor, aux engine x EF * # of Vessels *8760 hrs per year / hrs per year / 8760 hours per year / 3600 sec per hour									
	CO2	CH4	N2O	CO	NOX	PM10	PM2.5	SO2	Lead	VOC
Construction (Year 1)	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec
Cable Laying	108.96	6.72E-04	5.21E-03	0.42	1.66	0.05	0.05	1.01E-03	8.07E-06	0.02
Cable Laying	108.96	6.72E-04	5.21E-03	0.42	1.66	0.05	0.05	1.01E-03	8.07E-06	0.02
Multi-Purpose Service Vessel	36.25	2.24E-04	1.73E-03	0.14	0.55	0.02	0.02	3.36E-04	2.68E-06	0.01
Cable Laying	108.96	6.72E-04	5.21E-03	0.42	1.66	0.05	0.05	1.01E-03	8.07E-06	0.02
Tug	8.58	5.29E-05	4.10E-04	0.03	0.13	0.00	0.00	7.94E-05	6.35E-07	0.00
Tug	8.58	5.29E-05	4.10E-04	0.03	0.13	0.00	0.00	7.94E-05	6.35E-07	0.00
Anchor Tug	12.86	7.93E-05	6.15E-04	0.05	0.20	0.01	0.01	1.19E-04	9.52E-07	0.00
Crew	14.48	8.94E-05	6.92E-04	0.06	0.12	0.00	0.00	1.34E-04	1.07E-06	0.00
Guard Vessel	64.28	3.97E-04	3.07E-03	0.25	1.01	0.03	0.03	5.95E-04	4.76E-06	0.01
Heavy Transport Vessel	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00
Heavy Transport Vessel	0.00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00
Feeder Barge Tug	6.12	3.78E-05	0.00	0.02	0.10	0.01	0.01	0.00	4.53E-07	0.00
Platform Support Vessel	58.27	3.60E-04	0.00	0.22	0.94	0.03	0.03	0.00	4.31E-06	0.01
Noise Monitoring Vessel	0.00	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00E+00	0.00
Jackup	0.00	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00

Tug	17.15	1.06E-04	8.20E-04	0.07	0.27	0.01	0.01	1.59E-04	1.27E-06	0.00
Supply Ship	31.47	1.94E-04	1.51E-03	0.12	0.51	0.02	0.02	2.91E-04	2.33E-06	0.01
Crew	43.44	2.68E-04	2.08E-03	0.17	0.37	0.01	0.01	4.02E-04	3.22E-06	0.01
Multi-Purpose Service Vessel	36.25	2.24E-04	1.73E-03	0.14	0.55	0.02	0.02	3.36E-04	2.68E-06	0.01
Supply Ship	23.44	1.45E-04	1.12E-03	0.09	0.38	0.01	0.01	2.17E-04	1.74E-06	0.01
Guard Vessel	7.20	4.44E-05	3.44E-04	0.03	0.11	0.00	0.00	6.67E-05	5.33E-07	0.00
Tug	8.58	5.29E-05	4.10E-04	0.03	0.13	0.00	0.00	7.94E-05	6.35E-07	0.00
Support Vessel - Small	32.41	2.00E-04	1.55E-03	0.12	0.52	0.02	0.02	3.00E-04	2.40E-06	0.01
Support Vessel - Large	64.82	4.00E-04	3.10E-03	0.25	1.02	0.03	0.03	6.00E-04	4.80E-06	0.01
Research/Survey	147.24	9.09E-04	7.04E-03	0.56	2.32	0.07	0.07	1.36E-03	1.09E-05	0.03
Research/Survey	49.08	3.03E-04	2.35E-03	0.19	0.77	0.02	0.02	4.54E-04	3.63E-06	0.01

	CO2	CH4	N2O	CO	NOX	PM10	PM2.5	SO2	Lead	VOC
Summary Year 1	5,840.24	0.04	0.28	20.87	84.73	2.81	2.71	0.34	0.00	1.65

Array Cable Installation	833.65	0.01	0.04	2.97	12.57	0.44	0.42	0.08	0.00	0.29
Export and Interconnection Cable Installation	1,227.92	0.01	0.06	4.39	17.60	0.59	0.57	0.09	0.00	0.37
Offshore Substations	720.56	0.00	0.03	2.56	11.17	0.34	0.33	0.01	0.00	0.16
WTG and Platform Foundation Installation	800.81	0.00	0.04	2.86	12.16	0.40	0.39	0.03	0.00	0.20
WTG Construction	163.99	0.00	0.01	0.59	2.44	0.08	0.08	0.01	0.00	0.04
Construction Package	803.57	0.00	0.04	2.86	8.90	0.28	0.27	0.03	0.00	0.20
HDD	668.38	0.00	0.03	2.40	10.25	0.34	0.33	0.05	0.00	0.20
Fisheries Monitoring	621.37	0.00	0.03	2.25	9.66	0.32	0.31	0.05	0.00	0.19
Marine Mammal Mitigation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Phase	Emission Unit	Number of Units	Engine Capacity	Engine Capacity	Number of Hours Each Unit Used	Rate Each Engine Used	Applicable Emission Standard [1]				CO2	CO	NOX[2]	PM10 [3]	PM2.5 [3]	SO2	VOC	Total HAP
							NOX + HC	NOx	PM	CO								
			hp	kW	hours/year	hp-hr/year	g/kW-hr	g/kW-hr	g/kW-hr	g/kW-hr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Construction	OSS Generator - Permanent	3	800	600	4464	3,571,200	NA	0.67	0.03	3.5	2,220.74	30.82	5.90	2.64E-01	2.64E-01	6.50E-02	3.44E+00	2.14E-02
	OSS Generator - Temporary	6	209	156	4486	937,574	NA	0.4	0.02	3.5	1,166.05	16.18	1.85	9.25E-02	9.25E-02	0.03	7.07	2.77E-02
	OSS Generator - Cable Pull-in on WTG Foundations	3	50	37	600	30,000	4.7	NA	0.03	5	18.66	0.37	0.33	2.22E-03	2.22E-03	0.00	0.11	
	Array Cable Generator - WTG	98	50	37	731	36,527	4.7	NA	0.03	5	741.99	14.71	13.14	8.83E-02	8.83E-02	2.17E-02	4.50E+00	1.76E-02
	Array Cable Generator - OSS	3	102	76	120	12,240	NA	0.4	0.02	5	7.61	0.15	0.01	6.04E-04	6.04E-04	0.00	0.05	0.00
										Total:	**4,155.04**	**62.24**	**21.23**	**0.45**	**0.45**	**1.22E-01**	**15.17**	**6.69E-02**

[1] Applicable emission standard based on LAER determination, which is Tier 4 emission standards from 40 CFR 1039.101. The Tier 4 emission standard was used to estimate PTE for the following pollutants: NO_x, PM, PM_{10}, $PM_{2.5}$ and CO. All other pollutants (CO_2, CH_4, N_2O, SO_2, and VOC) were estimated using AP-42 emission factors from Tables 3.4-1 and 3.3-1. See footnote [2] for an explanation of how NO_x emissions were estimated when the applicable standard is in terms of NO_x + NMHC. See footenote [3] for an explanation of how PM_{10} and $PM_{2.5}$ emissions were estimated from the PM standard.

[2] NO_x emissions are estimated to comprise 95% of NO_x + NMHC emissions in accordance with CARB guidance. California Air Resources Board (CARB). 2004. Policy: CARB Emission Factors for CI Diesel Engines – Percent HC in Relation to NMHC + NO_x. Retrieved from https://www.baaqmd.gov/~/media/files/engineering/policy_and_procedures/engines/emissionfactorsfordieselengines.pdf?la=en

[3] It is conservatively assumed that the PM emission standard is equal to the filterable portion of PM_{10} and $PM_{2.5}$. The condensable portion of PM_{10} and $PM_{2.5}$ was added using the AP-42 emission factor of 0.0077 lb/MMBtu from AP-42 Table 3.4-2 and converting to lb/hp-hr using the conversion factor 7,000 Btu/hp-hr from footnote 'e' of AP-42 Table 3.4-1, resulting in a condensable emission factor of 0.0000539 lb/hp-hr.

Pollutant	Emission Factor	Unit	Source
Engines 600 hp or Greater			
CO_2	163.05	lb/MMBtu	41 CFR Part 98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
CO	5.50E-03	lb/hp-hr	AP-42 Table 3.4-1
NO_X	2.40E-02	lb/hp-hr	AP-42 Table 3.4-1
PM_{10}	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
$PM_{2.5}$	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.4-1
VOC	6.42E-04	lb/hp-hr	AP-42 Table 3.4-1
Acetaldehyde	2.52E-05	lb/MMBtu	AP-42 Table 3.4-3
Acrolein	7.88E-06	lb/MMBtu	AP-42 Table 3.4-3
Benzene	7.76E-04	lb/MMBtu	AP-42 Table 3.4-3
Formaldehyde	7.89E-05	lb/MMBtu	AP-42 Table 3.4-3
Naphthalene	1.30E-04	lb/MMBtu	AP-42 Table 3.4-4
PAH, other than Napthalene	8.20E-05	lb/MMBtu	AP-42 Table 3.4-4
Toluene	2.81E-04	lb/MMBtu	AP-42 Table 3.4-3
Xylene	1.93E-04	lb/MMBtu	AP-42 Table 3.4-3
Total HAP	**1.57E-03**	**lb/MMBtu**	

Pollutant	Emission Factor	Unit	Source
Engines Less Than 600 hp			
CO_2	163.05	lb/MMBtu	98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	98 Subpart C Table C-2
CO	6.68E-03	lb/hp-hr	42 Table 3.3-1
NO_X	3.10E-02	lb/hp-hr	42 Table 3.3-1
PM_{10}	2.20E-03	lb/hp-hr	42 Table 3.3-1
$PM_{2.5}$	2.20E-03	lb/hp-hr	42 Table 3.3-1
SO_2	1.21E-05	lb/hp-hr	42 Table 3.3-1
VOC	2.51E-03	lb/hp-hr	42 Table 3.3-1
1,3-Butadi	3.91E-05	lb/MMBtu	42 Table 3.3-2
Acetaldehy	7.67E-04	lb/MMBtu	42 Table 3.3-2
Acrolein	9.25E-05	lb/MMBtu	42 Table 3.3-2
Benzene	9.33E-04	lb/MMBtu	42 Table 3.3-2
Formaldeh	1.18E-03	lb/MMBtu	42 Table 3.3-2
Napthalen	8.48E-05	lb/MMBtu	42 Table 3.3-2
PAH, other	8.32E-05	lb/MMBtu	42 Table 3.3-2
Toluene	4.09E-04	lb/MMBtu	42 Table 3.3-2
Xylenes	2.85E-04	lb/MMBtu	42 Table 3.3-2
Total HAP	**3.87E-03**	**lb/MMBtu**	

Construction Emissions from Generator Engines - Short-term [1]

Phase	Emission Unit	Number of Units	Engine Capacity		Number of Hours Each Unit Used	Rate Each Engine Used		Applicable Emission Standard				CO	NOX[2]	PM10	PM2.5	SO2
								NOX + HC	NOx	PM	CO					
			hp	kW	hours/day	hp-hr/day	kW-hr/day	g/kW-hr	g/kW-hr	g/kW-hr	g/kW-hr	g/sec	g/sec	g/sec	g/sec	g/sec
Construction	OSS Generator - Permanent	1	800	600	24	19,200	14,400	NA	0.67	0.03	3.5	0.55	0.11	2.04E-04	2.04E-04	0.00
	OSS Generator - Temporary	6	209	156	24	5,016	3,740	NA	0.4	0.02	3.5	1.06	0.10	2.13E-04	2.13E-04	0.32
	OSS Generator - Cable Pull-in on WTG Foun	1	50	37	12	600	444	4.7	NA	0.03	5	0.02	0.02	1.28E-05	1.28E-05	0.01
	Array Cable Generator - WTG	2	50	37	24	1,200	895	4.7	NA	0.03	5	8.42E-02	9.25E-02	2.55E-05	2.55E-05	2.58E-02
	Array Cable Generator - OSS	1	102	76	24	2,448	1,825	NA	0.4	0.02	5	0.09	0.01	1.74E-05	1.74E-05	0.03
											Total:	**1.80**	**0.34**	**4.73E-04**	**4.73E-04**	**0.38**

[1] This sheet calculates short-term emission rates for use in dispersion modeling for 24-hour averaging period. It is not simply a conversion of tons per year to grams per second.

[2] NO_x emissions are estimated to comprise 95% of NO_x + NMHC emissions in accordance with CARB guidance. California Air Resources Board (CARB). 2004. Policy: CARB Emission Factors for CI Diesel Engines – Percent HC in Relation to NMHC + NO_x. Retrieved from https://www.baaqmd.gov/~/media/files/engineering/policy_and_procedures/engines/emissionfactorsfordieselengines.pdf?la=en

Pollutant	Emission Factor	Unit	Source
Engines 600 hp or Greater			
CO	5.50E-03	lb/hp-hr	AP-42 Table 3.4-1
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.4-1
Engines Less Than 600 hp			
CO	6.68E-03	lb/hp-hr	AP-42 Table 3.3-1
SO_2	2.05E-03	lb/hp-hr	AP-42 Table 3.3-1

Activity	Emission Unit	Number of Units	Engine Capacity	Load Factor[1]	Number of Hours Each Unit Used	Rate Each Engine Used	Applicable Emission Standard [2]				CO2	CO	NOX[3]	PM10 [4]	PM2.5 [4]	SO2	VOC	Total HAP
							NOX + HC	NOx	PM	CO								
			hp		hours/year	hp-hr/year	g/kW-hr	g/kW-hr	g/kW-hr	g/kW-hr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Foundation Installation	Heavy Lift Installation Vessel Generator	5	5	0.43	5040	10,836	7.5	NA	0.4	8	11.23	0.36	0.32	1.81E-02	1.81E-02	3.29E-04	6.81E-02	2.67E-04
	Heavy Lift Installation Vessel Power Pack	1	1000	0.43	5040	2,167,200	NA	3.5	0.04	3.5	449.22	6.23	6.23	0.13	0.13	0.01	0.70	4.34E-03
	Secondary Steel Generator	3	5	0.43	5040	10,836	7.5	NA	0.4	8	6.74	0.21	0.19	1.10E-02	1.10E-02	1.97E-04	4.09E-02	1.60E-04
	Bubble Curtain Vessel Generator	46	480	0.43	1800	371,520	NA	0.4	0.02	3.5	3,542.43	49.17	5.62	0.29	0.29	0.10	21.48	0.08
OSS Topside	Heavy Lift Installation Vessel Generator	5	5	0.43	72	155	7.5	NA	0.4	8	0.16	5.09E-03	4.53E-03	2.59E-04	2.59E-04	4.70E-06	9.73E-04	3.81E-06
WTG Construction	Jack-up Vessel Generator	5	5	0.43	2400	5,160	7.5	NA	0.4	8	5.35	0.17	0.15	8.62E-03	8.62E-03	1.57E-04	3.24E-02	1.27E-04
	Jack-up Vessel Cherry Picker	2	90	0.43	2400	92,880	NA	0.4	0.02	5	38.50	0.76	0.06	5.56E-03	5.56E-03	0.00	0.23	9.15E-04
	Feeder Barge Generator	2	40	0.43	2400	41,280	4.7	NA	0.03	5.5	17.11	0.37	0.30	3.15E-03	3.15E-03	0.00	0.10	4.07E-04
	SOV Generator	6	5	0.43	2400	5,160	7.5	NA	0.4	8	6.42	0.20	0.18	1.03E-02	1.03E-02	1.88E-04	0.04	1.52E-04
Offshore Export Cable	Cable Laying Vessel Generator	2	100	0.43	4800	206,400	NA	0.4	0.02	5	85.57	1.70	0.14	1.23E-02	1.23E-02	0.00	0.52	2.03E-03
	Cable Laying Vessel Generator	7	250	0.43	4800	516,000	NA	0.4	0.02	3.5	748.70	10.39	1.19	0.07	0.07	0.02	4.54	1.78E-02
	Cable Laying Vessel Power Pack	1	500	0.43	4800	1,032,000	NA	0.4	0.02	3.5	213.92	2.97	0.34	4.48E-02	4.48E-02	0.01	1.30	5.08E-03
	Barge Generator	2	60.5	0.43	2208	57,441	4.7	NA	0.03	5	23.81	0.47	0.42	4.38E-03	4.38E-03	0.00	0.14	5.66E-04
	Barge Cherry Picker	1	760	0.43	2208	721,574	NA	3.5	0.04	3.5	149.57	2.08	2.08	4.32E-02	4.32E-02	4.38E-03	0.23	1.44E-03
										Total:	**5,300.66**	**75.15**	**17.28**	**0.66**	**0.66**	**0.16**	**29.44**	**0.12**

[1] Load factor obtained from MOVES and applied to estimate emissions since this eqiupment will operate at varying loads during the construction process.

[2] Applicable emission standard based on LAER determination, which is Tier 4 emission standards from 40 CFR 1039.101. The Tier 4 emission standard was used to estimate PTE for the following pollutants: NO_x, PM, PM_{10}, $PM_{2.5}$ and CO. All other pollutants (CO_2, CH_4, N_2O, SO_2, and VOC) were estimated using AP-42 emission factors from Tables 3.4-1 and 3.3-1. See footnote [3] for an explanation of how NO_x emissions were estimated when the applicable standard is in terms of NO_x + NMHC. See footenote [4] for an explanation of how PM_{10} and $PM_{2.5}$ emissions were estimated from the PM standard.

[3] NO_x emissions are estimated to comprise 95% of NO_x + NMHC emissions in accordance with CARB guidance. California Air Resources Board (CARB). 2004. Policy: CARB Emission Factors for CI Diesel Engines – Percent HC in Relation to NMHC + NO_x. Retrieved from https://www.baaqmd.gov/~/media/files/engineering/policy_and_procedures/engines/emissionfactorsfordieselengines.pdf?la=en

[4] It is conservatively assumed that the PM emission standard is equal to the filterable portion of PM_{10} and $PM_{2.5}$. The condensable portion of PM_{10} and $PM_{2.5}$ was added using the AP-42 emission factor of 0.0077 lb/MMBtu from AP-42 Table 3.4-2 and converting to lb/hp-hr using the conversion factor 7,000 Btu/hp-hr from footnote 'e' of AP-42 Table 3.4-1, resulting in a condensable emission factor of 0.0000539 lb/hp-hr.

Engines 600 hp or Greater				
CO_2	163.05	lb/MMBtu	40 CFR Part 98 Subpart C Table C-1	
CH_4	6.61E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2	
N_2O	1.32E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2	
CO	5.50E-03	lb/hp-hr	AP-42 Table 3.4-1	
NO_X	2.40E-02	lb/hp-hr	AP-42 Table 3.4-1	
PM_{10}	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1	
$PM_{2.5}$	7.00E-04	lb/hp-hr	AP-42 Table 3.4-1	
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.4-1	
VOC	6.42E-04	lb/hp-hr	AP-42 Table 3.4-1	
Acetaldehyde	2.52E-05	lb/MMBtu	AP-42 Table 3.4-3	
Acrolein	7.88E-06	lb/MMBtu	AP-42 Table 3.4-3	
Benzene	7.76E-04	lb/MMBtu	AP-42 Table 3.4-3	
Formaldehyde	7.89E-05	lb/MMBtu	AP-42 Table 3.4-3	
Naphthalene	1.30E-04	lb/MMBtu	AP-42 Table 3.4-4	
PAH, other than Napthalene	8.20E-05	lb/MMBtu	AP-42 Table 3.4-4	
Toluene	2.81E-04	lb/MMBtu	AP-42 Table 3.4-3	
Xylene	1.93E-04	lb/MMBtu	AP-42 Table 3.4-3	
Total HAP	**1.57E-03**	**lb/MMBtu**		

Engines Less Than 600 hp			
CO_2	163.05	lb/MMBtu	40 CFR Part 98 Subpart C Table C-1
CH_4	6.61E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
N_2O	1.32E-03	lb/MMBtu	40 CFR Part 98 Subpart C Table C-2
CO	6.68E-03	lb/hp-hr	AP-42 Table 3.3-1
NO_X	3.10E-02	lb/hp-hr	AP-42 Table 3.3-1
PM_{10}	2.20E-03	lb/hp-hr	AP-42 Table 3.3-1
$PM_{2.5}$	2.20E-03	lb/hp-hr	AP-42 Table 3.3-1
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.3-1
VOC	2.51E-03	lb/hp-hr	AP-42 Table 3.3-1
1,3-Butadi	3.91E-05	lb/MMBtu	AP-42 Table 3.3-2
Acetaldehy	7.67E-04	lb/MMBtu	AP-42 Table 3.3-2
Acrolein	9.25E-05	lb/MMBtu	AP-42 Table 3.3-2
Benzene	9.33E-04	lb/MMBtu	AP-42 Table 3.3-2
Formaldeh	1.18E-03	lb/MMBtu	AP-42 Table 3.3-2
Napthalen	8.48E-05	lb/MMBtu	AP-42 Table 3.3-2
PAH, other	8.32E-05	lb/MMBtu	AP-42 Table 3.3-2
Toluene	4.09E-04	lb/MMBtu	AP-42 Table 3.3-2
Xylenes	2.85E-04	lb/MMBtu	AP-42 Table 3.3-2
Total HAP	**3.87E-03**	**lb/MMBtu**	

Construction Emissions from Auxiliary Equipment Onboard Vessels - Short-term [1]

Activity	Emission Unit	Number of Units	Load Factor [2]	Engine Capacity	Number of Hours Each Unit Used	Rate Each Engine Used	Applicable 40 CFR 1042 Tier 3 Emission Standard				CO	NOX[3]	PM10 [4]	PM2.5 [4]	SO2
							NOX + HC	NOx	PM	CO					
				hp	hours/year	hp-hr/year	g/kW-hr	g/kW-hr	g/kW-hr	g/kW-hr	g/sec	g/sec	g/sec	g/sec	g/sec
Foundation Installation	Heavy Lift Installation Vessel Generator	5	0.43	5	5040	10,836	7.5		0.4	8	9.05E-03	1.56E-02	9.12E-04	9.12E-04	2.78E-03
	Heavy Lift Installation Vessel Power Pack	1	0.43	1000	5040	2,167,200	NA	3.5	0.04	3.5	3.62E-01	3.07E-01	1.03E-02	1.03E-02	1.11E-01
	Secondary Steel Generator	3	0.43	5	5040	10,836	7.5		0.4	8	5.43E-03	9.39E-03	5.61E-04	5.61E-04	1.67E-03
	Bubble Curtain Vessel Generator	46	0.43	480	1800	371,520	NA	0.4	0.02	3.5	7.99	0.78	0.04	0.04	2.45
OSS Topside	Heavy Lift Installation Vessel Generator	5	0.43	5	72	155	7.5		0.4	8	9.05E-03	1.56E-02	9.12E-04	9.12E-04	2.78E-03
WTG Construction	Jack-up Vessel Generator	5	0.43	5	2400	5,160	7.5		0.4	8	9.05E-03	1.56E-02	9.12E-04	9.12E-04	2.78E-03
	Jack-up Vessel Cherry Picker	2	0.43	90	2400	92,880	NA	0.4	0.02	5	6.51E-02	6.33E-03	9.27E-04	9.27E-04	2.00E-02
	Feeder Barge Generator	2	0.43	40	2400	41,280	4.7		0.03	5.5	2.90E-02	3.14E-02	4.82E-04	4.82E-04	8.89E-03
	SOV Generator	6	0.43	5	2400	5,160	7.5		0.4	8	1.09E-02	1.88E-02	1.09E-03	1.09E-03	3.33E-03
Offshore Export Cable	Cable Laying Vessel Generator	2	0.43	100	4800	206,400	NA	0.4	0.02	5	7.24E-02	7.03E-03	1.03E-03	1.03E-03	2.22E-02
	Cable Laying Vessel Generator	7	0.43	250	4800	516,000	NA	0.4	0.02	3.5	0.63	0.06	4.77E-03	4.77E-03	0.19
	Cable Laying Vessel Power Pack	1	0.43	500	4800	1,032,000	NA	0.4	0.02	3.5	0.18	0.02	4.27E-03	4.27E-03	5.55E-02
	Barge Generator	2	0.43	60.5	2208	57,441	4.7		0.03	5.5	4.38E-02	4.75E-02	7.30E-04	7.30E-04	1.34E-02
	Barge Cherry Picker	1	0.43	760	2208	721,574	NA	3.5	0.04	3.5	0.28	0.23	7.83E-03	7.83E-03	8.44E-02
										Total:	**9.70**	**1.57**	**7.70E-02**	**7.70E-02**	**2.98**

[1] This sheet calculates short-term emission rates for use in dispersion modeling for 24-hour averaging period. It is not simply a conversion of tons per year to grams per second.

[2] Load factor obtained from MOVES and applied to estimate emissions since this eqiupment will operate at varying loads during the construction process.

[3] NO_x emissions are estimated to comprise 95% of NO_x + NMHC emissions in accordance with CARB guidance. California Air Resources Board (CARB). 2004. Policy: CARB Emission Factors for CI Diesel Engines – Percent HC in Relation to NMHC + NO_x. Retrieved from https://www.baaqmd.gov/~/media/files/engineering/policy_and_procedures/engines/emissionfactorsfordieselengines.pdf?la=en

[4] It is conservatively assumed that the PM emission standard is equal to the filterable portion of PM_{10} and $PM_{2.5}$. The condensable portion of PM_{10} and $PM_{2.5}$ was added using the AP-42 emission factor of 0.0077 lb/MMBtu from AP-42 Table 3.4-2 and converting to lb/hp-hr using the conversion factor 7,000 Btu/hp-hr from footnote 'e' of AP-42 Table 3.4-1, resulting in a condensable emission factor of 0.0000539 lb/hp-hr.

Pollutant	Emission Factor	Unit	Source
Engines 600 hp or Greater			
CO	5.50E-03	lb/hp-hr	AP-42 Table 3.4-1
SO_2	1.21E-05	lb/hp-hr	AP-42 Table 3.4-1
Engines Less Than 600 hp			
CO	6.68E-03	lb/hp-hr	AP-42 Table 3.3-1
SO_2	2.05E-03	lb/hp-hr	AP-42 Table 3.3-1

Description of Modeled Emission Sources - On-site Maneuvering

Source Name	Construction Activity	Location	Vessel Name	Engine
OACIBLCVM1	Array Cable Installation	Array Cable Installation	Boulder Clearance Vessel - 1	Main
OACICBLM1	Array Cable Installation	Array Cable Installation	Cable Burial Vessel - 1	Main
OACICLVM1	Array Cable Installation	Array Cable Installation	Cable Laying Vessel - 1	Main
OACICREWM1	Array Cable Installation	Array Cable Installation	Crew Transport Vessel - 1	Main
OACICREWM2	Array Cable Installation	Array Cable Installation	Crew Transport Vessel - 2	Main
OACIJACKM1	Array Cable Installation	Array Cable Installation	DP2 Construction Vessel - Jack of All Trades - 1	Main
OACIPLSVM1	Array Cable Installation	Array Cable Installation	Post-Lay/Burial Inspection Survey Vessel - 1	Main
OACIPLGRM1	Array Cable Installation	Array Cable Installation	Pre-lay Grapnel Run (PLGR) Vessel - 1	Main
OACISUVYM1	Array Cable Installation	Array Cable Installation	Pre-lay Survey Vessel - 1	Main
OACISWCVM1	Array Cable Installation	Array Cable Installation	Sandwave Clearance Vessel - 1	Main
OACIWTWVM1	Array Cable Installation	Array Cable Installation	Walk to Work Vessel - 1	Main
OCPKCREWM4	Construction Package	WTG and OSS Foundation Installation	Construction Package - Crew Transportation - 4	Main
OCPKCREWM5	Construction Package	WTG Construction	Construction Package - Crew Transportation - 5	Main
OCPKCREWM6	Construction Package	OSS Construction	Construction Package - Crew Transportation - 6	Main
OCPKCREWM1	Construction Package	WTG and OSS Foundation Installation	Construction Package - Crew Transportation 1	Main
OCPKCREWM2	Construction Package	WTG Construction	Construction Package - Crew Transportation 2	Main
OCPKCREWM3	Construction Package	OSS Construction	Construction Package - Crew Transportation 3	Main
OCPKSSM1	Construction Package	Outside WTA	Construction Package - Safety Vessel - 1	Main
OCPKSOVM1	Construction Package	WTG Construction	Construction Package - Service Operation Vessel - 1	Main
OFHMSUVYM1	Fisheries Monitoring	WTA	Fishing Vessel - 1	Main
OFHMRSHM1	Fisheries Monitoring	WTA	Research Vessel Export Cable Acoustic Telemetry - 1	Main
OFHMRSHM2	Fisheries Monitoring	Great Egg Harbor Inlet	Research Vessel Lease Site Acoustic Telemetry - 1	Main
OFHMRSHM3	Fisheries Monitoring	WTA	Research Vessel Trawl Survey - 1	Main
OHDDCREWM1	HDD	HDD Installation	Crew Transport Vessel - 1	Main
OHDDDVM1	HDD	HDD Installation	Dive Vessel - 1	Main
OHDDGRDM1	HDD	HDD Installation	Guard Vessel - 1	Main
OHDDJACKM1	HDD	HDD Installation	Jack-up Vessel - 1	Main
OHDDSSM1	HDD	HDD Installation	Supply Vessel - 1	Main
OHDDSSLM1	HDD	HDD Installation	Support Vessel - Large - 1	Main
OHDDSSLM2	HDD	HDD Installation	Support Vessel - Large - 2	Main
OHDDSSLM3	HDD	HDD Installation	Support Vessel - Large - 3	Main
OHDDSSSM1	HDD	HDD Installation	Support Vessel - Small - 1	Main
OHDDSSSM2	HDD	HDD Installation	Support Vessel - Small - 2	Main
OHDDSSSM3	HDD	HDD Installation	Support Vessel - Small - 3	Main
OHDDTTM1	HDD	HDD Installation	Towing Tug - 1	Main
OMMMRSHM1	Marine Mammal Mitigation	WTA	Research Vessel - 1	Main
OOSSHTVM1	Offshore Substations	OSS Construction	Heavy Transport Vessel - 1	Main
OOSSHTVM2	Offshore Substations	OSS Construction	Heavy Transport Vessel - 2	Main
OECIAHTM1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Anchor Handling Tug - 1	Main
OECIAHTM1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Anchor Handling Tug - 1	Main
OECIBLCVM1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Boulder Clearance Vessel - 1	Main
OECIBLCVM1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Boulder Clearance Vessel - 1	Main
OECICBLM1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Cable Burial Vessel - 1	Main
OECICBLM1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Cable Burial Vessel - 1	Main
OECICLBVM1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Cable Laying and Burial Vessel - 1	Main
OECICLBVM1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Cable Laying and Burial Vessel - 1	Main

Description of Modeled Emission Sources - On-site Maneuvering

OECICREWM1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Crew Transport Vessel - 1	Main
OECICREWM1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Crew Transport Vessel - 1	Main
OECICREWM2B	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Crew Transport Vessel - 2	Main
OECICREWM2O	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Crew Transport Vessel - 2	Main
OECIGWVM1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	General Work Vessel - 1	Main
OECIGWVM1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	General Work Vessel - 1	Main
OECIGRDM1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Guard Vessel - 1	Main
OECIGRDM1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Guard Vessel - 1	Main
OECIGRDM2O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Guard Vessel - 2	Main
OECIGRDM2B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Guard Vessel - 2	Main
OECIGRDM3O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Guard Vessel - 3	Main
OECIGRDM3B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Guard Vessel - 3	Main
OECIGRDM4O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Guard Vessel - 4	Main
OECIGRDM4B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Guard Vessel - 4	Main
OECIGRDM5O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Guard Vessel - 5	Main
OECIGRDM5B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Guard Vessel - 5	Main
OECIPLSVM1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Post-Lay Inspection Survey Vessel - 1	Main
OECIPLSVM1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Post-Lay Inspection Survey Vessel - 1	Main
OECIPLSVM2O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Post-Lay Inspection Survey Vessel - 2	Main
OECIPLSVM2B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Post-Lay Inspection Survey Vessel - 2	Main
OECIPLGRM1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Pre-lay Grapnel Run (PLGR) Vessel - 1	Main
OECIPLGRM1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Pre-lay Grapnel Run (PLGR) Vessel - 1	Main
OECIPCLM1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Pull ahead export cable tug for assist CLV - 1	Main
OECIPCLM1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Pull ahead export cable tug for assist CLV - 1	Main
OECIPTM1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Pull tug to move barges - 1	Main
OECIPTM1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Pull tug to move barges - 1	Main
OFOUBCVM1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Bubble Curtain Vessel - 1	Main
OFOUCREWM1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Crew Transport Vessel - 1	Main
OFOUFBTM1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Feeder Barge Tug - 1	Main
OFOUFBTM2	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Feeder Barge Tug - 2	Main
OFOUHLIVM1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Heavy Lift Installation Vessel - 1	Main
OFOUHTVM1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Heavy Transport Vessel - 1	Main
OFOUNMVM1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Noise Monitoring Vessel - 1	Main
OFOUNMVM2	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Noise Monitoring Vessel - 2	Main
OFOUPSVM1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Platform Support Vessel - 1	Main
OFOUPSVM2	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Platform Support Vessel - 2	Main
OFOURDVM1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Rock Dumping Vessel - 1	Main
OFOUSSIM1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Secondary Steel Installation - 1	Main
OINSIVM1	WTG Construction	WTG Construction	Installation Jackup Vessel - 1	Main
OINSTTM1	WTG Construction	WTG Construction	Towing Tug - 1	Main
OINSTTM2	WTG Construction	WTG Construction	Towing Tug - 2	Main
OACIBLCVA1	Array Cable Installation	Array Cable Installation	Boulder Clearance Vessel - 1	Aux
OACICBLA1	Array Cable Installation	Array Cable Installation	Cable Burial Vessel - 1	Aux
OACICLVA1	Array Cable Installation	Array Cable Installation	Cable Laying Vessel - 1	Aux
OACICREWA1	Array Cable Installation	Array Cable Installation	Crew Transport Vessel - 1	Aux
OACICREWA2	Array Cable Installation	Array Cable Installation	Crew Transport Vessel - 2	Aux
OACIJACKA1	Array Cable Installation	Array Cable Installation	DP2 Construction Vessel - Jack of All Trades - 1	Aux

Description of Modeled Emission Sources - On-site Maneuvering

OACIPLSVA1	Array Cable Installation	Array Cable Installation	Post-Lay/Burial Inspection Survey Vessel - 1	Aux
OACIPLGRA1	Array Cable Installation	Array Cable Installation	Pre-lay Grapnel Run (PLGR) Vessel - 1	Aux
OACISUVYA1	Array Cable Installation	Array Cable Installation	Pre-lay Survey Vessel - 1	Aux
OACISWCVA1	Array Cable Installation	Array Cable Installation	Sandwave Clearance Vessel - 1	Aux
OACIWTWVA1	Array Cable Installation	Array Cable Installation	Walk to Work Vessel - 1	Aux
OCPKCREWA4	Construction Package	WTG and OSS Foundation Installation	Construction Package - Crew Transportation - 4	Aux
OCPKCREWA5	Construction Package	WTG Construction	Construction Package - Crew Transportation - 5	Aux
OCPKCREWA6	Construction Package	OSS Construction	Construction Package - Crew Transportation - 6	Aux
OCPKCREWA1	Construction Package	WTG and OSS Foundation Installation	Construction Package - Crew Transportation 1	Aux
OCPKCREWA2	Construction Package	WTG Construction	Construction Package - Crew Transportation 2	Aux
OCPKCREWA3	Construction Package	OSS Construction	Construction Package - Crew Transportation 3	Aux
OCPKSSA1	Construction Package	Outside WTA	Construction Package - Safety Vessel - 1	Aux
OCPKSOVA1	Construction Package	WTG Construction	Construction Package - Service Operation Vessel - 1	Aux
OFHMSUVYA1	Fisheries Monitoring	WTA	Fishing Vessel - 1	Aux
OFHMRSHA1	Fisheries Monitoring	WTA	Research Vessel Export Cable Acoustic Telemetry - 1	Aux
OFHMRSHA2	Fisheries Monitoring	Great Egg Harbor Inlet	Research Vessel Lease Site Acoustic Telemetry - 1	Aux
OFHMRSHA3	Fisheries Monitoring	WTA	Research Vessel Trawl Survey - 1	Aux
OHDDCREWA1	HDD	HDD Installation	Crew Transport Vessel - 1	Aux
OHDDDVA1	HDD	HDD Installation	Dive Vessel - 1	Aux
OHDDGRDA1	HDD	HDD Installation	Guard Vessel - 1	Aux
OHDDJACKA1	HDD	HDD Installation	Jack-up Vessel - 1	Aux
OHDDSSA1	HDD	HDD Installation	Supply Vessel - 1	Aux
OHDDSSLA1	HDD	HDD Installation	Support Vessel - Large - 1	Aux
OHDDSSLA2	HDD	HDD Installation	Support Vessel - Large - 2	Aux
OHDDSSLA3	HDD	HDD Installation	Support Vessel - Large - 3	Aux
OHDDSSSA1	HDD	HDD Installation	Support Vessel - Small - 1	Aux
OHDDSSSA2	HDD	HDD Installation	Support Vessel - Small - 2	Aux
OHDDSSSA3	HDD	HDD Installation	Support Vessel - Small - 3	Aux
OHDDTTA1	HDD	HDD Installation	Towing Tug - 1	Aux
OMMMRSHA1	Marine Mammal Mitigation	WTA	Research Vessel - 1	Aux
OOSSHTVA1	Offshore Substations	OSS Construction	Heavy Transport Vessel - 1	Aux
OOSSHTVA2	Offshore Substations	OSS Construction	Heavy Transport Vessel - 2	Aux
OECIAHTA1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Anchor Handling Tug - 1	Aux
OECIAHTA1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Anchor Handling Tug - 1	Aux
OECIBLCVA1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Boulder Clearance Vessel - 1	Aux
OECIBLCVA1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Boulder Clearance Vessel - 1	Aux
OECICBLA1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Cable Burial Vessel - 1	Aux
OECICBLA1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Cable Burial Vessel - 1	Aux
OECICLBVA1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Cable Laying and Burial Vessel - 1	Aux
OECICLBVA1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Cable Laying and Burial Vessel - 1	Aux
OECICREWA1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Crew Transport Vessel - 1	Aux
OECICREWA1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Crew Transport Vessel - 1	Aux
OECICREWA2B	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Crew Transport Vessel - 2	Aux
OECICREWA2O	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Crew Transport Vessel - 2	Aux
OECIGWVA1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	General Work Vessel - 1	Aux
OECIGWVA1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	General Work Vessel - 1	Aux
OECIGRDA1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Guard Vessel - 1	Aux

Description of Modeled Emission Sources - On-site Maneuvering

OECIGRDA1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Guard Vessel - 1	Aux
OECIGRDA2O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Guard Vessel - 2	Aux
OECIGRDA2B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Guard Vessel - 2	Aux
OECIGRDA3O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Guard Vessel - 3	Aux
OECIGRDA3B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Guard Vessel - 3	Aux
OECIGRDA4O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Guard Vessel - 4	Aux
OECIGRDA4B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Guard Vessel - 4	Aux
OECIGRDA5O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Guard Vessel - 5	Aux
OECIGRDA5B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Guard Vessel - 5	Aux
OECIPLSVA1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Post-Lay Inspection Survey Vessel - 1	Aux
OECIPLSVA1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Post-Lay Inspection Survey Vessel - 1	Aux
OECIPLSVA2O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Post-Lay Inspection Survey Vessel - 2	Aux
OECIPLSVA2B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Post-Lay Inspection Survey Vessel - 2	Aux
OECIPLGRA1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Pre-lay Grapnel Run (PLGR) Vessel - 1	Aux
OECIPLGRA1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Pre-lay Grapnel Run (PLGR) Vessel - 1	Aux
OECIPCLA1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Pull ahead export cable tug for assist CLV - 1	Aux
OECIPCLA1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Pull ahead export cable tug for assist CLV - 1	Aux
OECIPTA1O	Export and Interconnection Cable Installation	Export Cable Installation - Oyster Creek	Pull tug to move barges - 1	Aux
OECIPTA1B	Export and Interconnection Cable Installation	Export Cable Installation - BL England	Pull tug to move barges - 1	Aux
OFOUBCVA1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Bubble Curtain Vessel - 1	Aux
OFOUCREWA1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Crew Transport Vessel - 1	Aux
OFOUFBTA1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Feeder Barge Tug - 1	Aux
OFOUFBTA2	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Feeder Barge Tug - 2	Aux
OFOUHLIVA1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Heavy Lift Installation Vessel - 1	Aux
OFOUHTVA1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Heavy Transport Vessel - 1	Aux
OFOUNMVA1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Noise Monitoring Vessel - 1	Aux
OFOUNMVA2	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Noise Monitoring Vessel - 2	Aux
OFOUPSVA1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Platform Support Vessel - 1	Aux
OFOUPSVA2	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Platform Support Vessel - 2	Aux
OFOURDVA1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Rock Dumping Vessel - 1	Aux
OFOUSSIA1	WTG and Platform Foundation Installation	WTG and OSS Foundation Installation	Secondary Steel Installation - 1	Aux
OINSIVA1	WTG Construction	WTG Construction	Installation Jackup Vessel - 1	Aux
OINSTTA1	WTG Construction	WTG Construction	Towing Tug - 1	Aux
OINSTTA2	WTG Construction	WTG Construction	Towing Tug - 2	Aux

Description of Modeled Emission Sources - Transit

Source Name	Construction Activity	Destination	Vessel Name	Engine
TACISUVYM1	Array Cable Installation	Charleston, SC	Pre-lay Survey Vessel	Main
TACIPLGRM1	Array Cable Installation	Charleston, SC	Pre-lay Grapnel Run (PLGR) Vessel	Main
TACIBLCVM1	Array Cable Installation	Charleston, SC	Boulder Clearance Vessel	Main
TACISWCVM1	Array Cable Installation	Charleston, SC	Sandwave Clearance Vessel	Main
TACICLVM1	Array Cable Installation	Charleston, SC	Cable Laying Vessel	Main
TACICBLM1	Array Cable Installation	Charleston, SC	Cable Burial Vessel	Main
TACICREWM1	Array Cable Installation	Atlantic City, NJ1	Crew Transport Vessel	Main
TACI2CREWM1	Array Cable Installation	Atlantic City, NJ2	Crew Transport Vessel	Main
TACIWTWVM1	Array Cable Installation	Charleston, SC	Walk to Work Vessel	Main
TACIPLSVM1	Array Cable Installation	Charleston, SC	Post-Lay Inspection Survey Vessel	Main
TACIJACKM1	Array Cable Installation	Charleston, SC	DP2 Construction Vessel - Jack of All Trades	Main
TECICLBVM1	Export and Interconnection Cable Installation	Charleston, SC	Cable Lay and Burial Vessel	Main
TECICBLM1	Export and Interconnection Cable Installation	Charleston, SC	Cable Burial Vessel	Main
TECIAHTM1	Export and Interconnection Cable Installation	Charleston, SC	Anchor Handling Tug	Main
TECIPTM1	Export and Interconnection Cable Installation	Charleston, SC	Pull tug to move barges	Main
TECIPCLM1	Export and Interconnection Cable Installation	Charleston, SC	Pull ahead export cable tug for assist CLV	Main
TECIPLGRM1	Export and Interconnection Cable Installation	Charleston, SC	Pre-lay Grapnel Run (PLGR) Vessel	Main
TECIBLCVM1	Export and Interconnection Cable Installation	Charleston, SC	Boulder Clearance Vessel	Main
TECICREWM1	Export and Interconnection Cable Installation	Atlantic City, NJ1	Crew Transport Vessel	Main
TECI2CREWM1	Export and Interconnection Cable Installation	Atlantic City, NJ2	Crew Transport Vessel	Main
TECIGRDM1	Export and Interconnection Cable Installation	Charleston, SC	Guard Vessel	Main
TECIPLSVM1	Export and Interconnection Cable Installation	Charleston, SC	Post-Lay Inspection Survey Vessel	Main
TECIGWVM1	Export and Interconnection Cable Installation	Charleston, SC	General Work Vessel	Main
TOSSHTVM1	Offshore Substations	Atlantic City, NJ1	Heavy Transport Vessel	Main
TOSS2HTVM1	Offshore Substations	Atlantic City, NJ2	Heavy Transport Vessel	Main
TFOUHLIVM1	WTG and Platform Foundation Installation	Europe	Heavy Lift Installation Vessel	Main
TFOUSSIM1	WTG and Platform Foundation Installation	Europe	Secondary Steel Installation	Main
TFOUFBTM1	WTG and Platform Foundation Installation	Europe	Feeder Barge Tug	Main
TFOURDVM1	WTG and Platform Foundation Installation	Europe	Rock Dumping Vessel	Main
TFOUBCVM1	WTG and Platform Foundation Installation	Europe	Bubble Curtain Vessel	Main
TFOUHTVM1	WTG and Platform Foundation Installation	Europe	Heavy Transport Vessel	Main
TFOUCREWM1	WTG and Platform Foundation Installation	Europe	Crew Transport Vessel	Main
TFOUNMVM1	WTG and Platform Foundation Installation	Europe	Noise Monitoring Vessel	Main
TFOUPSVM1	WTG and Platform Foundation Installation	Europe	Platform Support Vessel	Main
TINSIVM1	WTG Construction	Norfolk, VA	Installation Vessel	Main
TINSTTM1	WTG Construction	Norfolk, VA	Towing Tug	Main
TCPKSSM1	Construction Package	Atlantic City, NJ1	Safety Vessel	Main
TCPK2SSM1	Construction Package	Atlantic City, NJ2	Safety Vessel	Main
TCPKCREWM1	Construction Package	Atlantic City, NJ1	Crew Transport Vessel	Main
TCPK2CREWM1	Construction Package	Atlantic City, NJ2	Crew Transport Vessel	Main
TCPKSOVM1	Construction Package	Atlantic City, NJ1	Service Operation Vessel	Main
TCPK2SOVM1	Construction Package	Atlantic City, NJ2	Service Operation Vessel	Main
THDDCREWM1	HDD	Atlantic City, NJ1	Crew Transport Vessel	Main
THDD2CREWM1	HDD	Atlantic City, NJ2	Crew Transport Vessel	Main
THDDSSM1	HDD	Paulsboro, NJ	Supply Vessel	Main
THDDGRDM1	HDD	Atlantic City, NJ1	Guard Vessel	Main

Description of Modeled Emission Sources - Transit

THDD2GRDM1	HDD	Atlantic City, NJ2	Guard Vessel	Main
THDDTTM1	HDD	Paulsboro, NJ	Towing Tug	Main
THDDSSSM1	HDD	Atlantic City, NJ1	Support Vessel - Small	Main
THDD2SSSM1	HDD	Atlantic City, NJ2	Support Vessel - Small	Main
THDDSSLM1	HDD	Atlantic City, NJ1	Support Vessel - Large	Main
THDD2SSLM2	HDD	Atlantic City, NJ2	Support Vessel - Large	Main
THDDDVM1	HDD	Paulsboro, NJ	Dive Vessel	Main
THDDJACKM1	HDD	Paulsboro, NJ	Jack-up Vessel	Main
TFHMRSHM1	Fisheries Monitoring	Paulsboro, NJ	Research Vessel	Main
TFHMSUVYM1	Fisheries Monitoring	Paulsboro, NJ	Fishing Vessel	Main
TMMMRSHM1	Marine Mammal Mitigation	Paulsboro, NJ	Research Vessel	Main
TACISUVYA1	Array Cable Installation	Charleston, SC	Pre-lay Survey Vessel	Aux
TACIPLGRA1	Array Cable Installation	Charleston, SC	Pre-lay Grapnel Run (PLGR) Vessel	Aux
TACIBLCVA1	Array Cable Installation	Charleston, SC	Boulder Clearance Vessel	Aux
TACISWCVA1	Array Cable Installation	Charleston, SC	Sandwave Clearance Vessel	Aux
TACICLVA1	Array Cable Installation	Charleston, SC	Cable Laying Vessel	Aux
TACICBLA1	Array Cable Installation	Charleston, SC	Cable Burial Vessel	Aux
TACICREWA1	Array Cable Installation	Atlantic City, NJ1	Crew Transport Vessel	Aux
TACI2CREWA1	Array Cable Installation	Atlantic City, NJ2	Crew Transport Vessel	Aux
TACIWTWVA1	Array Cable Installation	Charleston, SC	Walk to Work Vessel	Aux
TACIPLSVA1	Array Cable Installation	Charleston, SC	Post-Lay Inspection Survey Vessel	Aux
TACIJACKA1	Array Cable Installation	Charleston, SC	DP2 Construction Vessel - Jack of All Trades	Aux
TECICLBVA1	Export and Interconnection Cable Installation	Charleston, SC	Cable Lay and Burial Vessel	Aux
TECICBLA1	Export and Interconnection Cable Installation	Charleston, SC	Cable Burial Vessel	Aux
TECIAHTA1	Export and Interconnection Cable Installation	Charleston, SC	Anchor Handling Tug	Aux
TECIPTA1	Export and Interconnection Cable Installation	Charleston, SC	Pull tug to move barges	Aux
TECIPCLA1	Export and Interconnection Cable Installation	Charleston, SC	Pull ahead export cable tug for assist CLV	Aux
TECIPLGRA1	Export and Interconnection Cable Installation	Charleston, SC	Pre-lay Grapnel Run (PLGR) Vessel	Aux
TECIBLCVA1	Export and Interconnection Cable Installation	Charleston, SC	Boulder Clearance Vessel	Aux
TECICREWA1	Export and Interconnection Cable Installation	Atlantic City, NJ1	Crew Transport Vessel	Aux
TECI2CREWA1	Export and Interconnection Cable Installation	Atlantic City, NJ2	Crew Transport Vessel	Aux
TECIGRDA1	Export and Interconnection Cable Installation	Charleston, SC	Guard Vessel	Aux
TECIPLSVA1	Export and Interconnection Cable Installation	Charleston, SC	Post-Lay Inspection Survey Vessel	Aux
TECIGWVA1	Export and Interconnection Cable Installation	Charleston, SC	General Work Vessel	Aux
TOSSHTVA1	Offshore Substations	Atlantic City, NJ1	Heavy Transport Vessel	Aux
TOSS2HTVA1	Offshore Substations	Atlantic City, NJ2	Heavy Transport Vessel	Aux
TFOUHLIVA1	WTG and Platform Foundation Installation	Europe	Heavy Lift Installation Vessel	Aux
TFOUSSIA1	WTG and Platform Foundation Installation	Europe	Secondary Steel Installation	Aux
TFOUFBTA1	WTG and Platform Foundation Installation	Europe	Feeder Barge Tug	Aux
TFOURDVA1	WTG and Platform Foundation Installation	Europe	Rock Dumping Vessel	Aux
TFOUBCVA1	WTG and Platform Foundation Installation	Europe	Bubble Curtain Vessel	Aux
TFOUHTVA1	WTG and Platform Foundation Installation	Europe	Heavy Transport Vessel	Aux
TFOUCREWA1	WTG and Platform Foundation Installation	Europe	Crew Transport Vessel	Aux
TFOUNMVA1	WTG and Platform Foundation Installation	Europe	Noise Monitoring Vessel	Aux
TFOUPSVA1	WTG and Platform Foundation Installation	Europe	Platform Support Vessel	Aux
TINSIVA1	WTG Construction	Norfolk, VA	Installation Vessel	Aux
TINSTTA1	WTG Construction	Norfolk, VA	Towing Tug	Aux

Description of Modeled Emission Sources - Transit

TCPKSSA1	Construction Package	Atlantic City, NJ1	Safety Vessel	Aux
TCPK2SSA1	Construction Package	Atlantic City, NJ2	Safety Vessel	Aux
TCPKCREWA1	Construction Package	Atlantic City, NJ1	Crew Transport Vessel	Aux
TCPK2CREWA1	Construction Package	Atlantic City, NJ2	Crew Transport Vessel	Aux
TCPKSOVA1	Construction Package	Atlantic City, NJ1	Service Operation Vessel	Aux
TCPK2SOVA1	Construction Package	Atlantic City, NJ2	Service Operation Vessel	Aux
THDDCREWA1	HDD	Atlantic City, NJ1	Crew Transport Vessel	Aux
THDD2CREWA1	HDD	Atlantic City, NJ2	Crew Transport Vessel	Aux
THDDSSA1	HDD	Paulsboro, NJ	Supply Vessel	Aux
THDDGRDA1	HDD	Atlantic City, NJ1	Guard Vessel	Aux
THDD2GRDA1	HDD	Atlantic City, NJ2	Guard Vessel	Aux
THDDTTA1	HDD	Paulsboro, NJ	Towing Tug	Aux
THDDSSSA1	HDD	Atlantic City, NJ1	Support Vessel - Small	Aux
THDD2SSSA1	HDD	Atlantic City, NJ2	Support Vessel - Small	Aux
THDDSSLA1	HDD	Atlantic City, NJ1	Support Vessel - Large	Aux
THDD2SSLA1	HDD	Atlantic City, NJ2	Support Vessel - Large	Aux
THDDDVA1	HDD	Paulsboro, NJ	Dive Vessel	Aux
THDDJACKA1	HDD	Paulsboro, NJ	Jack-up Vessel	Aux
TFHMRSHA1	Fisheries Monitoring	Paulsboro, NJ	Research Vessel	Aux
TFHMSUVYA1	Fisheries Monitoring	Paulsboro, NJ	Fishing Vessel	Aux
TMMMRSHA1	Marine Mammal Mitigation	Paulsboro, NJ	Research Vessel	Aux

Orsted North America Inc.
Ocean Wind
Modeled Emission Rates of Precursors (MERP) Analysis
Summary of Results

	Facility Emissions	
VOC	80	tpy
NO_x	1,714	tpy
SO_2	7	tpy

Summary of Secondary Impacts Based on EPA Hypothetical Model Location at Kent, DE

Pollutant/Area		Maximum Impact	Units
Class I PM2.5			
	Daily	0.391	$\mu g/m^3$
	Annual	0.0193	$\mu g/m^3$
Class II PM2.5			
	Daily	0.5234	$\mu g/m^3$
	Annual	0.0358	$\mu g/m^3$
Ozone NAA Area		1.28	ppb
Class II Ozone		4.56	ppb

Orsted North America Inc.
Ocean Wind
Modeled Emission Rates of Precursors (MERP) Analysis
$PM_{2.5}$ Class I Area Impact Analyis

Secondary Impacts Based on EPA Hypothetical Model Location at Kent, DE
Based on EPA Hypothetical Impact Modeling - Worst Case at Each Distance

	Cumulative Impact (µg/m^3) [1]	
Distance (km)	Daily	Annual
10	0.523	0.03582
20	0.432	0.02446
40	0.365	0.01601
60	0.308	0.01216
80	0.287	0.00898
100	0.202	0.00649
120	0.153	0.00563
140	0.132	0.00472
160	0.122	0.00399
180	0.125	0.00369
200	0.121	0.00319
220	0.113	0.00295
240	0.101	0.00274
260	0.084	0.00257
280	0.079	0.00246
300	0.068	0.00233

Calculated Facility impact at nearest Class I Area boundary (Brigantine Wilderness) [2]

Distance (km)	Calculated Facility Impact (µg/m^3)	
	Daily	Annual
32.2	0.3911	0.01931

[1] Cumulative means the sum of the impact from NO_x emissions and the impact from SO_2 emissions.
[2] Maximum of the value linearly extrapolated from the modeled distance nearest to the Class I area and all further distances.

Orsted North America Inc.
Ocean Wind
Modeled Emission Rates of Precursors (MERP) Analysis
Class II Daily $PM_{2.5}$

Facility Emissions

NO_x	1,714	tpy
SO_2	7	tpy

Maximum Cumulative Impact: 0.523 µg/m^3

Secondary Impacts Based on EPA Hypothetical Model Location at Kent, DE
Refined Hypothetical Modeling Results Obtained from EPA's MERPS View Qlik (https://www.epa.gov/scram/merps-view-qlik).

EPA Hypothetical Modeled Site Information																Calculated Facility Impact (ppb)
METRIC	PRECURSOR	POLL	State	County	FIPS	EMISSIONS	STACKHEIGHT	CONC	MERP	LATITUDE	LONGITUDE	CZNAME	terravg	urbmax	DOMAIN	
DAILY	SO2	SULFATE	Delaware	Kent	10001	1000	10	1.1377	1055	39.1372	-75.5847	Northeast	8	8.8	12US2	0.008
DAILY	SO2	SULFATE	Delaware	Kent	10001	1000	90	0.603	1990	39.1372	-75.5847	Northeast	8	8.8	12US2	0.004
DAILY	NOX	NITRATE	Delaware	Kent	10001	1000	10	0.3008	3990	39.1372	-75.5847	Northeast	8	8.8	12US2	0.516
DAILY	NOX	NITRATE	Delaware	Kent	10001	1000	90	0.2074	5787	39.1372	-75.5847	Northeast	8	8.8	12US2	0.355

Orsted North America Inc.
Ocean Wind
Modeled Emission Rates of Precursors (MERP) Analysis
Class II Daily $PM_{2.5}$

Facility Emissions

NO_x	1,714	tpy
SO_2	7	tpy

Maximum Cumulative Impact: 0.0358 µg/m^3

Secondary Impacts Based on EPA Hypothetical Model Location at Kent, DE
Refined Hypothetical Modeling Results Obtained from EPA's MERPS View Qlik (https://www.epa.gov/scram/merps-view-qlik).

EPA Hypothetical Modeled Site Information																Calculated Facility Impact (ppb)
METRIC	PRECURSOR	POLL	State	County	FIPS	EMISSIONS	STACKHEIGHT	CONC	MERP	LATITUDE	LONGITUDE	CZNAME	terravg	urbmax	DOMAIN	
ANNAVG	SO2	SULFATE	Delaware	Kent	10001	1000	10	0.04212	4748	39.1372	-75.5847	Northeast	8	8.8	12US2	0.00029
ANNAVG	SO2	SULFATE	Delaware	Kent	10001	1000	90	0.017819	11224	39.1372	-75.5847	Northeast	8	8.8	12US2	0.00012
ANNAVG	NOX	NITRATE	Delaware	Kent	10001	1000	10	0.020731	9647	39.1372	-75.5847	Northeast	8	8.8	12US2	0.03553
ANNAVG	NOX	NITRATE	Delaware	Kent	10001	1000	90	0.008701	22986	39.1372	-75.5847	Northeast	8	8.8	12US2	0.01491

Orsted North America Inc.
Ocean Wind
EPA Hypothetical Modeled Results - Distance
24 Hour $PM_{2.5}$ Class I Area Impact Analyis

Facility Emissions		
NO_x	1,714	tpy
SO_2	7	tpy

Secondary Impacts Based on EPA Hypothetical Model Location at Kent, DE
Refined Hypothetical Modeling Results Obtained from EPA's MERPS View Qlik (https://www.epa.gov/scram/merps-view-qlik).

FROM EPA								Calculated (μg/m³)	
State	County	Distance	Metric	Precursor	Emissions	Stack	Concentration	Facility Impact	Cumulative
Delaware	Kent Co	10	Daily PM2.5	NOx	1000	10	0.301	0.516	0.523
Delaware	Kent Co	10	Daily PM2.5	NOx	1000	90	0.207	0.355	
Delaware	Kent Co	10	Daily PM2.5	SO2	1000	10	1.138	0.008	
Delaware	Kent Co	10	Daily PM2.5	SO2	1000	90	0.603	0.004	
Delaware	Kent Co	20	Daily PM2.5	NOx	1000	10	0.248	0.425	0.432
Delaware	Kent Co	20	Daily PM2.5	NOx	1000	90	0.165	0.283	
Delaware	Kent Co	20	Daily PM2.5	SO2	1000	10	1.025	0.007	
Delaware	Kent Co	20	Daily PM2.5	SO2	1000	90	0.562	0.004	
Delaware	Kent Co	40	Daily PM2.5	NOx	1000	10	0.210	0.360	0.365
Delaware	Kent Co	40	Daily PM2.5	NOx	1000	90	0.158	0.271	
Delaware	Kent Co	40	Daily PM2.5	SO2	1000	10	0.671	0.005	
Delaware	Kent Co	40	Daily PM2.5	SO2	1000	90	0.513	0.004	
Delaware	Kent Co	60	Daily PM2.5	NOx	1000	10	0.178	0.305	0.308
Delaware	Kent Co	60	Daily PM2.5	NOx	1000	90	0.169	0.289	
Delaware	Kent Co	60	Daily PM2.5	SO2	1000	10	0.455	0.003	
Delaware	Kent Co	60	Daily PM2.5	SO2	1000	90	0.374	0.003	
Delaware	Kent Co	80	Daily PM2.5	NOx	1000	10	0.158	0.271	0.287
Delaware	Kent Co	80	Daily PM2.5	NOx	1000	90	0.166	0.285	
Delaware	Kent Co	80	Daily PM2.5	SO2	1000	10	0.362	0.002	
Delaware	Kent Co	80	Daily PM2.5	SO2	1000	90	0.358	0.002	
Delaware	Kent Co	100	Daily PM2.5	NOx	1000	10	0.099	0.170	0.202
Delaware	Kent Co	100	Daily PM2.5	NOx	1000	90	0.117	0.200	
Delaware	Kent Co	100	Daily PM2.5	SO2	1000	10	0.229	0.002	
Delaware	Kent Co	100	Daily PM2.5	SO2	1000	90	0.267	0.002	
Delaware	Kent Co	120	Daily PM2.5	NOx	1000	10	0.078	0.134	0.153
Delaware	Kent Co	120	Daily PM2.5	NOx	1000	90	0.089	0.152	
Delaware	Kent Co	120	Daily PM2.5	SO2	1000	10	0.193	0.001	
Delaware	Kent Co	120	Daily PM2.5	SO2	1000	90	0.176	0.001	
Delaware	Kent Co	140	Daily PM2.5	NOx	1000	10	0.068	0.117	0.132
Delaware	Kent Co	140	Daily PM2.5	NOx	1000	90	0.076	0.131	
Delaware	Kent Co	140	Daily PM2.5	SO2	1000	10	0.156	0.001	
Delaware	Kent Co	140	Daily PM2.5	SO2	1000	90	0.156	0.001	
Delaware	Kent Co	160	Daily PM2.5	NOx	1000	10	0.071	0.121	0.122
Delaware	Kent Co	160	Daily PM2.5	NOx	1000	90	0.064	0.109	
Delaware	Kent Co	160	Daily PM2.5	SO2	1000	10	0.141	0.001	
Delaware	Kent Co	160	Daily PM2.5	SO2	1000	90	0.130	0.001	
Delaware	Kent Co	180	Daily PM2.5	NOx	1000	10	0.073	0.124	0.125
Delaware	Kent Co	180	Daily PM2.5	NOx	1000	90	0.059	0.100	
Delaware	Kent Co	180	Daily PM2.5	SO2	1000	10	0.145	0.001	
Delaware	Kent Co	180	Daily PM2.5	SO2	1000	90	0.116	0.001	
Delaware	Kent Co	200	Daily PM2.5	NOx	1000	10	0.070	0.120	0.121
Delaware	Kent Co	200	Daily PM2.5	NOx	1000	90	0.059	0.100	
Delaware	Kent Co	200	Daily PM2.5	SO2	1000	10	0.143	0.001	
Delaware	Kent Co	200	Daily PM2.5	SO2	1000	90	0.123	0.001	
Delaware	Kent Co	220	Daily PM2.5	NOx	1000	10	0.066	0.112	0.113
Delaware	Kent Co	220	Daily PM2.5	NOx	1000	90	0.056	0.097	
Delaware	Kent Co	220	Daily PM2.5	SO2	1000	10	0.120	0.001	
Delaware	Kent Co	220	Daily PM2.5	SO2	1000	90	0.111	0.001	

Delaware	Kent Co	240	Daily PM2.5	NOx	1000	10	0.059	0.100	0.101
Delaware	Kent Co	240	Daily PM2.5	NOx	1000	90	0.053	0.090	
Delaware	Kent Co	240	Daily PM2.5	SO2	1000	10	0.105	0.001	
Delaware	Kent Co	240	Daily PM2.5	SO2	1000	90	0.103	0.001	
Delaware	Kent Co	260	Daily PM2.5	NOx	1000	10	0.049	0.083	0.084
Delaware	Kent Co	260	Daily PM2.5	NOx	1000	90	0.043	0.073	
Delaware	Kent Co	260	Daily PM2.5	SO2	1000	10	0.080	0.001	
Delaware	Kent Co	260	Daily PM2.5	SO2	1000	90	0.082	0.001	
Delaware	Kent Co	280	Daily PM2.5	NOx	1000	10	0.046	0.079	0.079
Delaware	Kent Co	280	Daily PM2.5	NOx	1000	90	0.041	0.070	
Delaware	Kent Co	280	Daily PM2.5	SO2	1000	10	0.066	0.000	
Delaware	Kent Co	280	Daily PM2.5	SO2	1000	90	0.071	0.000	
Delaware	Kent Co	300	Daily PM2.5	NOx	1000	10	0.039	0.067	0.068
Delaware	Kent Co	300	Daily PM2.5	NOx	1000	90	0.036	0.061	
Delaware	Kent Co	300	Daily PM2.5	SO2	1000	10	0.057	0.000	
Delaware	Kent Co	300	Daily PM2.5	SO2	1000	90	0.061	0.000	

Orsted North America Inc.
Ocean Wind
EPA Hypothetical Modeled Results - Distance
Annual $PM_{2.5}$ Class I Area Impact Analyis

	Facility Emissions	
NO_x	1,714	tpy
SO_2	7	tpy

Secondary Impacts Based on EPA Hypothetical Model Location at Kent, DE
Refined Hypothetical Modeling Results Obtained from EPA's MERPS View Qlik (https://www.epa.gov/scram/merps-view-qlik).

FROM EPA								Calculated (µg/m^3)	
State	County	Distance	Metric	Precursor	Emissions	Stack	Concentration	Facility Impact	Cumulative
Delaware	Kent Co	10	Annual PM2.5	NOx	1000	10	0.02073	0.03553	0.03582
Delaware	Kent Co	10	Annual PM2.5	NOx	1000	90	0.00870	0.01491	
Delaware	Kent Co	10	Annual PM2.5	SO2	1000	10	0.04212	0.00029	
Delaware	Kent Co	10	Annual PM2.5	SO2	1000	90	0.01782	0.00012	
Delaware	Kent Co	20	Annual PM2.5	NOx	1000	10	0.01415	0.02426	0.02446
Delaware	Kent Co	20	Annual PM2.5	NOx	1000	90	0.00659	0.01130	
Delaware	Kent Co	20	Annual PM2.5	SO2	1000	10	0.02902	0.00020	
Delaware	Kent Co	20	Annual PM2.5	SO2	1000	90	0.01425	0.00010	
Delaware	Kent Co	40	Annual PM2.5	NOx	1000	10	0.00928	0.01591	0.01601
Delaware	Kent Co	40	Annual PM2.5	NOx	1000	90	0.00527	0.00903	
Delaware	Kent Co	40	Annual PM2.5	SO2	1000	10	0.01507	0.00010	
Delaware	Kent Co	40	Annual PM2.5	SO2	1000	90	0.00972	0.00007	
Delaware	Kent Co	60	Annual PM2.5	NOx	1000	10	0.00706	0.01210	0.01216
Delaware	Kent Co	60	Annual PM2.5	NOx	1000	90	0.00448	0.00767	
Delaware	Kent Co	60	Annual PM2.5	SO2	1000	10	0.00856	0.00006	
Delaware	Kent Co	60	Annual PM2.5	SO2	1000	90	0.00633	0.00004	
Delaware	Kent Co	80	Annual PM2.5	NOx	1000	10	0.00521	0.00893	0.00898
Delaware	Kent Co	80	Annual PM2.5	NOx	1000	90	0.00358	0.00614	
Delaware	Kent Co	80	Annual PM2.5	SO2	1000	10	0.00643	0.00004	
Delaware	Kent Co	80	Annual PM2.5	SO2	1000	90	0.00520	0.00004	
Delaware	Kent Co	100	Annual PM2.5	NOx	1000	10	0.00377	0.00645	0.00649
Delaware	Kent Co	100	Annual PM2.5	NOx	1000	90	0.00294	0.00504	
Delaware	Kent Co	100	Annual PM2.5	SO2	1000	10	0.00464	0.00003	
Delaware	Kent Co	100	Annual PM2.5	SO2	1000	90	0.00416	0.00003	
Delaware	Kent Co	120	Annual PM2.5	NOx	1000	10	0.00327	0.00561	0.00563
Delaware	Kent Co	120	Annual PM2.5	NOx	1000	90	0.00259	0.00444	
Delaware	Kent Co	120	Annual PM2.5	SO2	1000	10	0.00370	0.00003	
Delaware	Kent Co	120	Annual PM2.5	SO2	1000	90	0.00371	0.00003	
Delaware	Kent Co	140	Annual PM2.5	NOx	1000	10	0.00274	0.00470	0.00472
Delaware	Kent Co	140	Annual PM2.5	NOx	1000	90	0.00226	0.00387	
Delaware	Kent Co	140	Annual PM2.5	SO2	1000	10	0.00342	0.00002	
Delaware	Kent Co	140	Annual PM2.5	SO2	1000	90	0.00355	0.00002	
Delaware	Kent Co	160	Annual PM2.5	NOx	1000	10	0.00232	0.00397	0.00399
Delaware	Kent Co	160	Annual PM2.5	NOx	1000	90	0.00210	0.00360	
Delaware	Kent Co	160	Annual PM2.5	SO2	1000	10	0.00295	0.00002	
Delaware	Kent Co	160	Annual PM2.5	SO2	1000	90	0.00312	0.00002	
Delaware	Kent Co	180	Annual PM2.5	NOx	1000	10	0.00214	0.00367	0.00369
Delaware	Kent Co	180	Annual PM2.5	NOx	1000	90	0.00186	0.00320	
Delaware	Kent Co	180	Annual PM2.5	SO2	1000	10	0.00259	0.00002	
Delaware	Kent Co	180	Annual PM2.5	SO2	1000	90	0.00273	0.00002	
Delaware	Kent Co	200	Annual PM2.5	NOx	1000	10	0.00185	0.00318	0.00319
Delaware	Kent Co	200	Annual PM2.5	NOx	1000	90	0.00170	0.00292	
Delaware	Kent Co	200	Annual PM2.5	SO2	1000	10	0.00220	0.00002	
Delaware	Kent Co	200	Annual PM2.5	SO2	1000	90	0.00231	0.00002	
Delaware	Kent Co	220	Annual PM2.5	NOx	1000	10	0.00171	0.00293	0.00295
Delaware	Kent Co	220	Annual PM2.5	NOx	1000	90	0.00161	0.00276	
Delaware	Kent Co	220	Annual PM2.5	SO2	1000	10	0.00199	0.00001	
Delaware	Kent Co	220	Annual PM2.5	SO2	1000	90	0.00210	0.00001	

Delaware	Kent Co	240	Annual PM2.5	NOx	1000	10	0.00159	0.00273	0.00274
Delaware	Kent Co	240	Annual PM2.5	NOx	1000	90	0.00158	0.00270	
Delaware	Kent Co	240	Annual PM2.5	SO2	1000	10	0.00172	0.00001	
Delaware	Kent Co	240	Annual PM2.5	SO2	1000	90	0.00182	0.00001	
Delaware	Kent Co	260	Annual PM2.5	NOx	1000	10	0.00149	0.00255	0.00257
Delaware	Kent Co	260	Annual PM2.5	NOx	1000	90	0.00149	0.00256	
Delaware	Kent Co	260	Annual PM2.5	SO2	1000	10	0.00156	0.00001	
Delaware	Kent Co	260	Annual PM2.5	SO2	1000	90	0.00165	0.00001	
Delaware	Kent Co	280	Annual PM2.5	NOx	1000	10	0.00141	0.00242	0.00246
Delaware	Kent Co	280	Annual PM2.5	NOx	1000	90	0.00143	0.00245	
Delaware	Kent Co	280	Annual PM2.5	SO2	1000	10	0.00142	0.00001	
Delaware	Kent Co	280	Annual PM2.5	SO2	1000	90	0.00151	0.00001	
Delaware	Kent Co	300	Annual PM2.5	NOx	1000	10	0.00133	0.00229	0.00233
Delaware	Kent Co	300	Annual PM2.5	NOx	1000	90	0.00135	0.00232	
Delaware	Kent Co	300	Annual PM2.5	SO2	1000	10	0.00120	0.00001	
Delaware	Kent Co	300	Annual PM2.5	SO2	1000	90	0.00129	0.00001	

Orsted North America Inc.
Ocean Wind
Modeled Emission Rates of Precursors (MERP) Analysis
Ozone Nonattainment Area Impact Analysis

Secondary Impacts Based on EPA Hypothetical Model Location at Kent, DE
Based on EPA Hypothetical Impact Modeling - Worst Case at Each Distance

Distance (km)	Cumulative Impact (ppb) [1]
10	4.87
20	2.55
40	0.48
60	1.85
80	0.07
100	0.92
120	0.98
140	0.07
160	1.41
180	0.99
200	0.33
220	1.07
240	0.05
260	0.70
280	0.64
300	0.03

Calculated Facility impact at nearest ozone nonattainment area location [2]

Distance (km)	Calculated Facility Impact (ppb)
32.2	1.28

[1] Cumulative means the sum of the impact from NO_x emissions and the impact from VOC emissions.
[2] Linearly interpolated between nearest to distances.

Orsted North America Inc.
Ocean Wind
Modeled Emission Rates of Precursors (MERP) Analysis
Class II Ozone

Facility Emissions		
VOC	80	tpy
NOx	1714	tpy

Maximum Cumulative Impact: 4.56 ppb

Secondary Impacts Based on EPA Hypothetical Model Location at Kent, DE
Refined Hypothetical Modeling Results Obtained from EPA's MERPS View Qlik (https://www.epa.gov/scram/merps-view-qlik).

EPA Hypothetical Modeled Site Information																Calculated Facility Impact (ppb)
METRIC	PRECURSOR	POLL	State	County	FIPS	EMISSIONS	STACKHEIGHT	CONC	MERP	LATITUDE	LONGITUDE	CZNAME	terravg	urbmax	DOMAIN	
MDA8	VOC	OZONE	Delaware	Kent	10001	500	10	0.1663	3007	39.1372	-75.5847	Northeast	8	8.8	12US2	0.03
MDA8	NOX	OZONE	Delaware	Kent	10001	1000	10	2.6456	378	39.1372	-75.5847	Northeast	8	8.8	12US2	4.53
MDA8	NOX	OZONE	Delaware	Kent	10001	1000	90	2.61	383	39.1372	-75.5847	Northeast	8	8.8	12US2	4.47

Orsted North America Inc.
Ocean Wind
EPA Hypothetical Modeled Results - Distance
Ozone Nonattainment Area Impact

	Facility Emissions	
NO_x	1714	tpy
VOC	80	tpy

Secondary Impacts Based on EPA Hypothetical Model Location at Kent, DE
Refined Hypothetical Modeling Results Obtained from EPA's MERPS View Qlik (https://www.epa.gov/scram/merps-view-qlik).

FROM EPA								Calculated (ppb)	
State	County	Distance	Metric	Precursor	Emissions	Stack	Concentration	Facility Impact	Cumulative
Delaware	Kent Co	10	8-hr Ozone	NOx	1000	10	2.65	4.53	4.87
Delaware	Kent Co	10	8-hr Ozone	NOx	1000	90	2.61	4.47	
Delaware	Kent Co	10	8-hr Ozone	VOC	500	10	0.10	0.33	
Delaware	Kent Co	20	8-hr Ozone	NOx	1000	10	1.48	2.53	2.55
Delaware	Kent Co	20	8-hr Ozone	NOx	1000	90	1.45	0.12	
Delaware	Kent Co	20	8-hr Ozone	VOC	500	10	0.10	0.02	
Delaware	Kent Co	40	8-hr Ozone	NOx	1000	10	0.94	0.08	0.48
Delaware	Kent Co	40	8-hr Ozone	NOx	1000	90	0.97	0.08	
Delaware	Kent Co	40	8-hr Ozone	VOC	500	10	0.12	0.40	
Delaware	Kent Co	60	8-hr Ozone	NOx	1000	10	0.75	1.28	1.85
Delaware	Kent Co	60	8-hr Ozone	NOx	1000	90	0.73	1.24	
Delaware	Kent Co	60	8-hr Ozone	VOC	500	10	0.17	0.57	
Delaware	Kent Co	80	8-hr Ozone	NOx	1000	10	0.56	0.04	0.07
Delaware	Kent Co	80	8-hr Ozone	NOx	1000	90	0.53	0.04	
Delaware	Kent Co	80	8-hr Ozone	VOC	500	10	0.14	0.02	
Delaware	Kent Co	100	8-hr Ozone	NOx	1000	10	0.56	0.05	0.92
Delaware	Kent Co	100	8-hr Ozone	NOx	1000	90	0.53	0.92	
Delaware	Kent Co	100	8-hr Ozone	VOC	500	10	0.10	0.36	
Delaware	Kent Co	120	8-hr Ozone	NOx	1000	10	0.56	0.96	0.98
Delaware	Kent Co	120	8-hr Ozone	NOx	1000	90	0.52	0.89	
Delaware	Kent Co	120	8-hr Ozone	VOC	500	10	0.12	0.02	
Delaware	Kent Co	140	8-hr Ozone	NOx	1000	10	0.56	0.04	0.07
Delaware	Kent Co	140	8-hr Ozone	NOx	1000	90	0.53	0.04	
Delaware	Kent Co	140	8-hr Ozone	VOC	500	10	0.13	0.02	
Delaware	Kent Co	160	8-hr Ozone	NOx	1000	10	0.57	0.98	1.41
Delaware	Kent Co	160	8-hr Ozone	NOx	1000	90	0.54	0.92	
Delaware	Kent Co	160	8-hr Ozone	VOC	500	10	0.13	0.43	
Delaware	Kent Co	180	8-hr Ozone	NOx	1000	10	0.57	0.97	0.99
Delaware	Kent Co	180	8-hr Ozone	NOx	1000	90	0.54	0.04	
Delaware	Kent Co	180	8-hr Ozone	VOC	500	10	0.11	0.02	
Delaware	Kent Co	200	8-hr Ozone	NOx	1000	10	0.50	0.04	0.33
Delaware	Kent Co	200	8-hr Ozone	NOx	1000	90	0.52	0.04	
Delaware	Kent Co	200	8-hr Ozone	VOC	500	10	0.09	0.29	
Delaware	Kent Co	220	8-hr Ozone	NOx	1000	10	0.47	0.80	1.07
Delaware	Kent Co	220	8-hr Ozone	NOx	1000	90	0.48	0.83	
Delaware	Kent Co	220	8-hr Ozone	VOC	500	10	0.08	0.27	
Delaware	Kent Co	240	8-hr Ozone	NOx	1000	10	0.44	0.04	0.05
Delaware	Kent Co	240	8-hr Ozone	NOx	1000	90	0.46	0.04	
Delaware	Kent Co	240	8-hr Ozone	VOC	500	10	0.07	0.01	
Delaware	Kent Co	260	8-hr Ozone	NOx	1000	10	0.38	0.03	0.70
Delaware	Kent Co	260	8-hr Ozone	NOx	1000	90	0.41	0.70	
Delaware	Kent Co	260	8-hr Ozone	VOC	500	10	0.06	0.22	
Delaware	Kent Co	280	8-hr Ozone	NOx	1000	10	0.36	0.62	0.64
Delaware	Kent Co	280	8-hr Ozone	NOx	1000	90	0.37	0.64	
Delaware	Kent Co	280	8-hr Ozone	VOC	500	10	0.06	0.01	
Delaware	Kent Co	300	8-hr Ozone	NOx	1000	10	0.32	0.03	0.03
Delaware	Kent Co	300	8-hr Ozone	NOx	1000	90	0.33	0.03	
Delaware	Kent Co	300	8-hr Ozone	VOC	500	10	0.05	0.01	

Ocean Wind
An Ørsted & PSEG project

Appendix Q – Coastal Zone Consistency Assessment

Appendix Q, Coastal Zone Consistency Assessment
Ocean Wind Offshore Wind Farm COP

1. Coastal Zone Management Consistency Statement

The Coastal Zone Management Act (CZMA) of 1972 requires that federal actions affecting any coastal use or resource (defined as land or water use, or natural resource of a state's coastal zone), be conducted in a manner that is consistent with the enforceable policies of a state's federally approved Coastal Zone Management Program (CZMP) or Coastal Resource Management Program (CRMP).

Bureau of Ocean Energy Management (BOEM) is not requiring the submittal of a consistency certification under 30 C.F.R. 585.627(a)(9) as the Ocean Wind Offshore Wind Farm (Project) is not within a state's Geographic Location Description. Nonetheless, this Consistency Certification was prepared to demonstrate that the proposed Project within BOEM Lease Area OCS-A 0498 is consistent with the policies identified as enforceable by the Coastal Zone Management (CZM) Rules of the State of New Jersey (N.J.A.C. 7:7). As described below, the proposed activity will be conducted in a manner consistent with this program and pursuant to 15 CFR part 930, which authorizes states with approved CZM programs to conduct a coastal zone consistency review and concurrence determination of projects within or outside the state coastal zone boundary. Projects that require a federal license or permit, are federally funded, or are a direct activity of a federal agency are to be reviewed to ensure that activities in or affecting the state's coastal zone are consistent with the state enforceable program policies.

In New Jersey, federal consistency reviews are the responsibility of the New Jersey Department of Environmental Protection (NJDEP), Division of Coastal Resources, as the lead State agency that implements or coordinates the State's federally approved CZMP. Pursuant to the CZMA, New Jersey has defined its coastal zone boundaries and developed policies to be utilized to evaluate projects within the designated Coastal Zone, as set forth in New Jersey's CZM Rules (last amended on February 20, 2020). These rules provide for the issuance of permits under three CZMP areas: Waterfront Development Law (N.J.S.A. 12:5-3), Tidal Wetland Act of 1970 (N.J.S.A. 13:9A), and the Coastal Areas Facility Review Act (CAFRA; N.J.S.A. 13:19).

2. Compliance with New Jersey Rules on Coastal Zone Management

The following sections contain an evaluation of the Project's consistency with applicable NJDEP CZM Rules (**Table 1**). This document provides descriptions of how the Project will be consistent with each applicable policy or management principle. Rules not applicable to this Project have also been listed, with reasons for not including them in the CZM evaluation set forth.

Table 1 - Applicability to New Jersey's CZMA Rules February 7, 2020.

CZM Rule		Potentially Applicable		Not Applicable
		Federal Jurisdiction[1]	State Jurisdiction[2]	
SUBCHAPTER 9 - SPECIAL AREAS				
7:7-9.2	Shellfish Habitat		X	
7:7-9.3	Surf Clam Areas	X	X	
7:7-9.4	Prime Fishing Areas	X	X	
7:7-9.5	Finfish Migratory Pathways	X	X	
7:7-9.6	Submerged Vegetation Habitat		X	

CZM Rule		Potentially Applicable		Not Applicable
		Federal Jurisdiction[1]	State Jurisdiction[2]	
7:7-9.7	Navigation Channels		X	
7:7-9.8	Canals			X
7:7-9.9	Inlets			X
7:7-9.10	Marina Moorings			X
7:7-9.11	Ports			X
7:7-9.12	Submerged Infrastructure Routes	X	X	
7:7-9.13	Shipwreck and Artificial Reef Habitats	X	X	
7:7-9.14	Wet Borrow Pits			X
7:7-9.15	Intertidal and Subtidal Shallows		X	
7:7-9.16	Dunes		X	
7:7-9.17	Overwash Areas		X	
7:7-9.18	Coastal High Hazard Areas		X	
7:7-9.19	Erosion Hazard Areas		X	
7:7-9.20	Barrier Island Corridor		X	
7:7-9.21	Bay Islands			X
7:7-9.22	Beaches		X	
7:7-9.23	Filled Water's Edge		X	
7:7-9.24	Existing Lagoon Edges			X
7:7-9.25	Flood Hazard Areas		X	
7:7-9.26	Riparian Zones		X	
7:7-9.27	Wetlands		X	
7:7-9.28	Wetlands Buffers		X	
7:7-9.29	Coastal Bluffs			X
7:7-9.30	Intermittent Stream Corridors		X	
7:7-9.31	Farmland Conservation Areas			X
7:7-9.32	Steep Slopes			X
7:7-9.33	Dry Borrow Pits			X
7:7-9.34	Historic & Archaeological Resources	X	X	
7:7-9.35	Specimen Trees		X	
7:7-9.36	Endangered or Threatened Wildlife or Plant Species Habitats	X	X	
7:7-9.37	Critical Wildlife Habitat		X	
7:7-9.38	Public Open Space		X	
7:7-9.39	Special Hazard Areas	X	X	
7:7-9.40	Excluded Federal Lands			X
7:7-9.41	Special Urban Areas		X	
7:7-9.42	Pinelands National Reserve and Pinelands Protection Area		X	
7:7-9.43	Meadowlands District			X
7:7-9.44	Wild and Scenic River Corridors	X	X	
7:7-9.45	Geodetic Control Reference Marks		X	
7:7-9.46	Hudson River Waterfront Area			X
7:7-9.47	Atlantic City			X
7:7-9.48	Land and Waters Subject to Public Trust Rights		X	

CZM Rule		Potentially Applicable		Not Applicable
		Federal Jurisdiction[1]	State Jurisdiction[2]	
SUBCHAPTER 10. STANDARDS FOR BEACH & DUNE ACTIVITIES				
7:7-10.2	Standards Applicable to Routine Beach Maintenance			X
7:7-10.3	Standards Applicable to Emergency Post-Storm Beach Restoration			X
7:7-10.4	Standards Applicable to Dune Creation and Maintenance		X	
7:7-10.5	Standards Applicable to the Construction of Boardwalks			X
SUBCHAPTER 11. STANDARDS FOR CONDUCTING & REPORTING THE RESULTS OF AN ENDANGERED OR THREATENED WILDLIFE OR PLANT SPECIES HABITAT ASSESSMENT AND/OR ENDANGERED OR THREATENED WILDLIFE SPECIES HABITAT EVALUATION				
7:7-11.2	Standards for Conducting Endangered or Threatened Wildlife or Plant Species Habitat Impact Assessment	X	X	
7:7-11.3	Standards for Conducting Endangered or Threatened Wildlife Species Habitat Evaluation	X	X	
7:7-11.4	Standards for Reporting the Results of Impact Assessments and Habitat Evaluations	X	X	
SUBCHAPTER 12. GENERAL WATER AREAS				
7:7-12.2	Shellfish Aquaculture		X	
7:7-12.3	Boat Ramps			X
7:7-12.4	Docks and Piers for Cargo & Commercial Fisheries			X
7:7-12.5	Recreational Docks and Piers			X
7:7-12.6	Maintenance Dredging		X	
7:7-12.7	New Dredging	X	X	
7:7-12.8	Environmental Dredging			X
7:7-12.9	Dredged Material Disposal	X	X	
7:7-12.10	Solid Waste or Sludge Dumping			X
7:7-12.11	Filling	X	X	
7:7-12.12	Mooring	X	X	
7:7-12.13	Sand and Gravel Mining			X
7:7-12.14	Bridges			X
7:7-12.15	Submerged Pipelines			X
7:7-12.16	Overhead Transmission Lines		X	
7:7-12.17	Dams and Impoundments			X
7:7-12.18	Outfalls and Intakes		X	
7:7-12.19	Realignment of Water Areas			X
7:7-12.20	Vertical Wake or Wave Attenuation Structures			X
7:7-12.21	Submerged Cables	X	X	
7:7-12.22	Artificial Reefs			X

CZM Rule		Potentially Applicable		Not Applicable
		Federal Jurisdiction[1]	State Jurisdiction[2]	
7:7-12.23	Living Shorelines			X
7:7-12.24	Miscellaneous Uses			X
SUBCHAPTER 13. REQUIREMENTS FOR IMPERVIOUS COVER & VEGETATIVE COVER FOR GENERAL LAND AREAS & CERTAIN SPECIAL AREAS				
7:7-13.3	Impervious Cover Requirements that Apply to Sites in the Upland Waterfront Development and CAFRA Areas			X
7:7-13.4	Vegetative Cover Requirements that Apply to Sites in the Upland Waterfront Development and CAFRA Areas			X
7:7-13.5	Determining if a Site is Forested or Unforested			X
7:7-13.6	Upland Waterfront Development Area Regions and Growth Ratings			X
7:7-13.7	Determining the Environmental Sensitivity of a Site in the Upland Waterfront Development Area			X
7:7-13.8	Determining the Developmental Potential of a Site in the Upland Waterfront Development Area			X
7:7-13.9	Determining the Development Potential for Residential or Minor Commercial Site in the Upland Waterfront Development Area			X
7:7-13.10	Determining the Development Potential for a Major Commercial or Industrial Development Site in the Upland Waterfront Development Area			X
7:7-13.11	Determining the Development Potential for a Campground Development Site in the Upland Waterfront Development Area			X
7:7-13.12	Determining the Development Intensity of a Site in the Upland Waterfront Development Area			X
7:7-13.13	Impervious Cover Limits for a Site in the Upland Waterfront Development Area			X
7:7-13.14	Vegetative Cover Percentages for a Site in the Upland Waterfront Development Area			X
7:7-13.15	Coastal Planning Areas in the CAFRA Area			X
7:7-13.16	Boundaries for Coastal Planning Areas, CAFRA centers, CAFRA			X

CZM Rule		Potentially Applicable		Not Applicable
		Federal Jurisdiction[1]	State Jurisdiction[2]	
	cores, and CAFRA nodes; Non-mainland Coastal Centers			
7:7-13.17	Impervious Cover Limits for a Site in the CAFRA Area			X
7:7-13.18	Vegetative Cover Percentages for a Site in the CAFRA Area			X
7:7-13.19	Mainland Coastal Centers			X
SUBCHAPTER 14. GENERAL LOCATION RULES				
7:7-14.1	Rule on Location of Linear Development	X	X	
7:7-14.2	Basic Location Rule	X	X	
7:7-14.3	Secondary Impacts	X	X	
SUBCHAPTER 15. USE RULES				
7:7-15.2	Housing			X
7:7-15.3	Resort/Recreational			X
7:7-15.4	Energy Facility	X	X	
7:7-15.5	Transportation		X	
7:7-15.6	Public Facility			X
7:7-15.7	Industry	X	X	
7:7-15.8	Mining			X
7:7-15.9	Port		X	
7:7-15.10	Commercial Facility			X
7:7-15.11	Coastal Engineering			X
7:7-15.12	Dredged Material Placement on Land		X	
7:7-15.13	National Defense Facilities			X
7:7-15.14	High-Rise Structures			X
SUBCHAPTER 16. RESOURCE RULES				
7:7-16.2	Marine Fish and Fisheries	X	X	
7:7-16.3	Water Quality	X	X	
7:7-16.4	Surface Water Use			X
7:7-16.5	Groundwater Use		X	
7:7-16.6	Stormwater Management		X	
7:7-16.7	Vegetation		X	
7:7-16.8	Air Quality	X	X	
7:7-16.9	Public Access		X	
7:7-16.10	Scenic Resources and Design	X	X	
7:7-16.11	Buffers and Compatibility of Use		X	
7:7-16.12	Traffic	X	X	
7:7-16.13	Subsurface Sewage Disposal Systems			X
7:7-16.14	Solid & Hazardous Waste	X	X	
SUBCHAPTER 17. MITIGATION				
7:7-17.2	General Mitigation Requirements		X	
7:7-17.3	Timing of Mitigation		X	
7:7-17.4	Amount of Mitigation Required		X	
7:7-17.5	Property Suitable for Mitigation		X	

CZM Rule		Potentially Applicable		Not Applicable
		Federal Jurisdiction[1]	State Jurisdiction[2]	
7:7-17.6	Conceptual Review of a Mitigation Area		X	
7:7-17.7	Basic Requirements for Mitigation Proposals		X	
7:7-17.8	Department Review and Approval of Mitigation Proposal		X	
7:7-17.9	Requirements for Shellfish Habitat Mitigation		X	
7:7-17.10	Requirements for Submerged Aquatic Vegetation Habitat Mitigation		X	
7:7-17.11	Requirements for Intertidal and Subtidal Shallows and Tidal Water Mitigation		X	
7:7-17.12	Requirements for Riparian Zone Mitigation		X	
7:7-17.13	Requirements for Wetland Mitigation		X	
7:7-17.14	Wetlands Mitigation Hierarchy		X	
7:7-17.15	Requirements for Credit Purchase from an Approved Mitigation Bank		X	
7:7-17.16	Requirements for In-Lieu Fee Payment		X	
7:7-17.17	Financial assurance for Mitigation Projects; General Provisions			X
7:7-17.18	Financial Assurance; Fully Funded Trust Fund Requirements			X
7:7-17.19	Financial Assurance; Line of Credit Requirements			X
7:7-17.20	Financial Assurance; Letter of Credit Requirements			X
7:7-17.21	Financial Assurance; Surety Bond Requirements			X
7:7-17.22	Mitigation Banks			X
7:7-17.23	Application for a Mitigation Bank			X

Notes:

[1] Mean high water (MHW) to outer continental shelf (200 nautical miles)

[2] Within three nautical miles from shore

2.1 Subchapter 9 – Special Areas

7:7-9.2 Shellfish Habitat.

State Jurisdiction

This policy generally limits disturbance of shellfish habitat. Shellfish habitat is defined at N.J.A.C. 7:7-9.2(a) as an estuarine bay or river bottom, which currently supports or has a history of production for hard clams (*Mercenaria mercenaria*), soft clams (*Mya arenaria*), eastern oysters (*Crassostrea virginica*), bay scallops

(*Argopecten irradians*), or blue mussels (*Mytilus edulis*), or otherwise listed below in this section. A shellfish habitat area is defined as an area that meets one or more of the following criteria:

1. The area has a current shellfish density equal to or greater than 0.20 shellfish per square foot;
2. The area has a history of natural shellfish production according to data available to the New Jersey Bureau of Shellfisheries, or is depicted as having high or moderate commercial value in the Distribution of Shellfish Resources in Relation to the New Jersey Intracoastal Waterway (U.S. Department of the Interior [DOI], 1963) and/or "Inventory of New Jersey's Estuarine Shellfish Resources" (Division of Fish, Game and Wildlife [DFGW], Bureau of Shellfisheries, 1983-present);
3. The area is designated by the State of New Jersey as a shellfish culture area as authorized by N.J.S.A. 50:1 et seq. Shellfish culture areas include estuarine areas presently leased by the State for shellfish aquaculture activities or hard clam relay, transplant and transfer as well as those areas suitable for future shellfish aquaculture development; or
4. The area is designated as productive at N.J.A.C. 7:25-24, Leasing of Atlantic and Delaware Bay Bottom for Aquaculture.

Barnegat Bay contains shellfish habitat areas as defined by N.J.A.C. 7:7-9.2(a)1 through 4 above. Portions of the Bay were mapped as moderate hard clam commercial value based on available USDOI 1963 resources. The proposed offshore export cable corridors in Barnegat Bay avoid areas mapped as moderate and high shellfish density (greater than 0.2 shellfish per square foot) as mapped by DFGW 2012 shellfish resource inventories via use of trenchless technology to the greatest extent practicable. However, it does not avoid some 1986 and 1963 mapped moderate habitat. The landfall at Oyster Creek will be located to avoid impacts to existing aquaculture lease sites to the extent practicable, however an aquaculture lease in the vicinity of an Ocean Township landfall near the Holiday Harbor Marina landfall may be impacted by cable installation and anchor lines for installation vessels. Any impacts to the aquaculture lease area would be temporary and mitigation to the leaseholder will be coordinated with NJDEP Bureau of Shellfisheries.

As per N.J.A.C. 7:7-9.2(e), new dredging within shellfish habitat is prohibited. Ocean Wind will minimize adverse impacts from cable installation to shellfish habitat through the use of jetting technology and trenchless technology (such as HDD or direct pipe), where practicable. Jetting technology does not remove sediments from the trench, but rather, temporarily disturbs them as they are fluidized. While Ocean Wind considered a series of water-to-water HDDs to cross Barnegat Bay, the HDD method was ultimately determined to be infeasible.

The primary method for cable installation in Barnegat Bay will be the use of a tracked self-propelled or towed jetting tool. This self-propelled tool is the most appropriate, considering the shallow waters in Barnegat Bay. The proposed jetting tool works by fluidizing sediment along the intended path of the cable – introducing water at high pressure along the leading edge or face of two swords that straddle the cable – allowing the cable to sink into the fluidized trench under its own weight. The jetting tool's hydraulic nozzles are controlled and pointed downward so as not to produce an upward movement of sediment into the water column; the benefit of using this method is to maximize the replacement of sediments within the trench to embed the cable as jetting progresses. Cable burial depth beneath the sediment surface is determined by the length of the swords and degree to which the sediment is fluidized. This cable installation method disturbs the sediment in the trench as little as possible so that the sediment can provide future cable protection. Compared to dredging, jetting minimizes direct impacts to the seabed as well as minimizes suspended sediment and deposition associated with construction outside the trench area.

Cable installation activities will be continuously monitored and adjusted in order to ensure the cable is laid and sufficiently buried while minimizing sediment disturbance. Jetting technology has been used on other similar projects in New York and New Jersey including most recently in Delaware Bay for the Silver Run Project as approved by the NJDEP under Permit No. 1712-07-0002.3 WFD/CSW180001.

Temporary access for vessels and HDD pits will be required for cable installation in Barnegat Bay at the Lacey Township Holtec Property landfall approach which will be within shellfish habitat. All activities will be done in accordance with State and Federal regulations. As explained under policy N.J.A.C. 7:7-12.21, submerged cables are defined as "underwater telecommunication cables, and shall include all associated structures in the water such as repeaters". Therefore, the Project's electrical transmission export cables are not regulated as submerged cables and the Project's electrical transmission cable installation is not regulated as New Dredging under N.J.A.C. 7:7-12.7. As such, the Project is consistent with N.J.A.C. 7:7-9.2.

The benthic community will experience short term, direct impacts that will be limited in spatial extent. Limited direct adverse impacts, such as mortality or injury to benthic organisms in the immediate path of the jetting activities is likely. However, many benthic invertebrate species are capable of recolonizing from surrounding benthic communities (Rhoads et al. 1978, Schaffner 2001). Because the area to be jetted is small in comparison to the surrounding, unaffected habitat in Barnegat Bay, rapid recolonization following construction is expected. Therefore, the adverse direct impact to the benthic community, including shellfish habitat, from installation of the export cable will be temporary and minor. The benthic community will recover quickly to pre-construction conditions such that there will be no permanent impact.

7:7-9.3 Surf Clam Areas.

Federal and State Jurisdiction

Surf clam areas are defined as coastal waters that can be demonstrated to support significant commercially harvestable quantities of surf clams (*Spisula solidissima*), or areas important for recruitment of surf clam stocks. This policy prohibits development that would destroy, condemn, or contaminate surf clam areas.

Other than localized Project impacts to the seabed associated with installing the Project infrastructure during construction, the Project will not have long term adverse impacts to the seabed and Applicant Proposed Measures (APMs) will be implemented to reduce temporary effects of increased turbidity associated with construction (Attachment 2). The offshore export cable will be buried at a target depth of 4 ft (1.2 m) in surf clam areas as required by NJDEP regulations. Per N.J.A.C. 7:7-9.3, where it is demonstrated that achieving a depth of 4 ft (1.2 m) is not practicable, the cable will be buried as close as practicable to the target depth.

Surf clam fisheries have experienced declines in commercial landings in New Jersey from 1980 through 2016 and landings in New Jersey are at an all-time low as catches that are composed of relatively small clams are not favored by processors (Northeast Fisheries Science Center [NEFSC] 2016). One potential explanation of this is the warm water intrusion on the Mid-Atlantic shelf. Over the last decade, these warmer waters may have caused mortality in larger surf clams off the New Jersey coast and effectively shifted the population northward as indicated by the increase in New York surf clam biomass. Southern areas (Delmarva Peninsula and New Jersey) have experienced declines in surf clam biomass during recent years due primarily to poor recruitment and slow growth rates associated with warm water conditions (Weinberg 2005).

From 1988 to 2019, NJDEP's Bureau of Shellfisheries conducted an annual inventory of New Jersey's inshore (within 3 nautical miles of shore) surf clam stock. Sampling was conducted from Shark River Inlet to Cape Map Inlet between the months of June and August using a commercial hydraulic clam dredge to measure abundance at each station. Sampling of these inshore waters has shown a downward trend of the estimated standing stock from a maximum of 26.3 million bushels recorded in 1997 to just 325,020 bushels recorded in

2014 (most recent report available). Additionally, mean shell lengths have steadily increased which is reflective of poor recruitment during this time period. From 2010 through 2014, inshore surf clam harvest in New Jersey's designated "approved waters" has been practically non-existent with only 2,944 industry bushels of surf clams harvested from 2010 through 2014 (NJ Bureau of Shellfisheries 2015). Data on the adult/harvestable clams in state waters from 2009 through 2019 indicates that the total bushels harvested per 5 minute sampling effort has decreased from an average of approximately 2 bushels in 2009 to 0.03 bushels in 2019 (NJ Bureau of Shellfisheries 2019; **Figure 1a and 1b**). Recruitment data from 2015 through 2019 provided by the NJDEP's Bureau of Marine Fisheries has shown a similar trend (**Figure 2a and 2b**) when compared to data collected during the first 5 years of survey conducted from 1988 through 1992 for surf clam recruitment. Data provided is displayed as surf clams per liter of sample collected from the NJDEP surf clam recruitment surveys. Surf clam catch from 1988 through 1992 shows over 20 sampling locations within state waters in excess of 50 clams per liter. Conversely, the 2015 through 2019 surveys show a total of only two sampling locations with greater than 50 clams per liter (NJ Bureau of Shellfisheries 2019) indicating that recruitment has decreased dramatically over the 30+ years of the survey.

Furthermore, based on Vessel Monitoring System (VMS) and Vessel Trip Report (VTR) (NOAA Fisheries n.d.), the vast majority of vessel movement for the surf clam/ocean quahog harvest occurs outside of State waters and not along the proposed export cable route. VMS is a satellite surveillance system that monitors the location and movement of commercial fishing vessels. Data from 2011 to 2016 uses speed over ground information to assess the possibility of identifying transit versus fishing activity based on speed thresholds identified by industry and agency interviews. A speed threshold of less than 4 or 5 knots is considered indicative of fishing activity but may also include slower movement of vessel transit or other activities such as processing at sea. The resultant information is used to prepare density maps of fishing vessels in the vicinity of the Lease Area and export cable routes presented in Volume II Section 2.3.4 (MARCO n.d.).

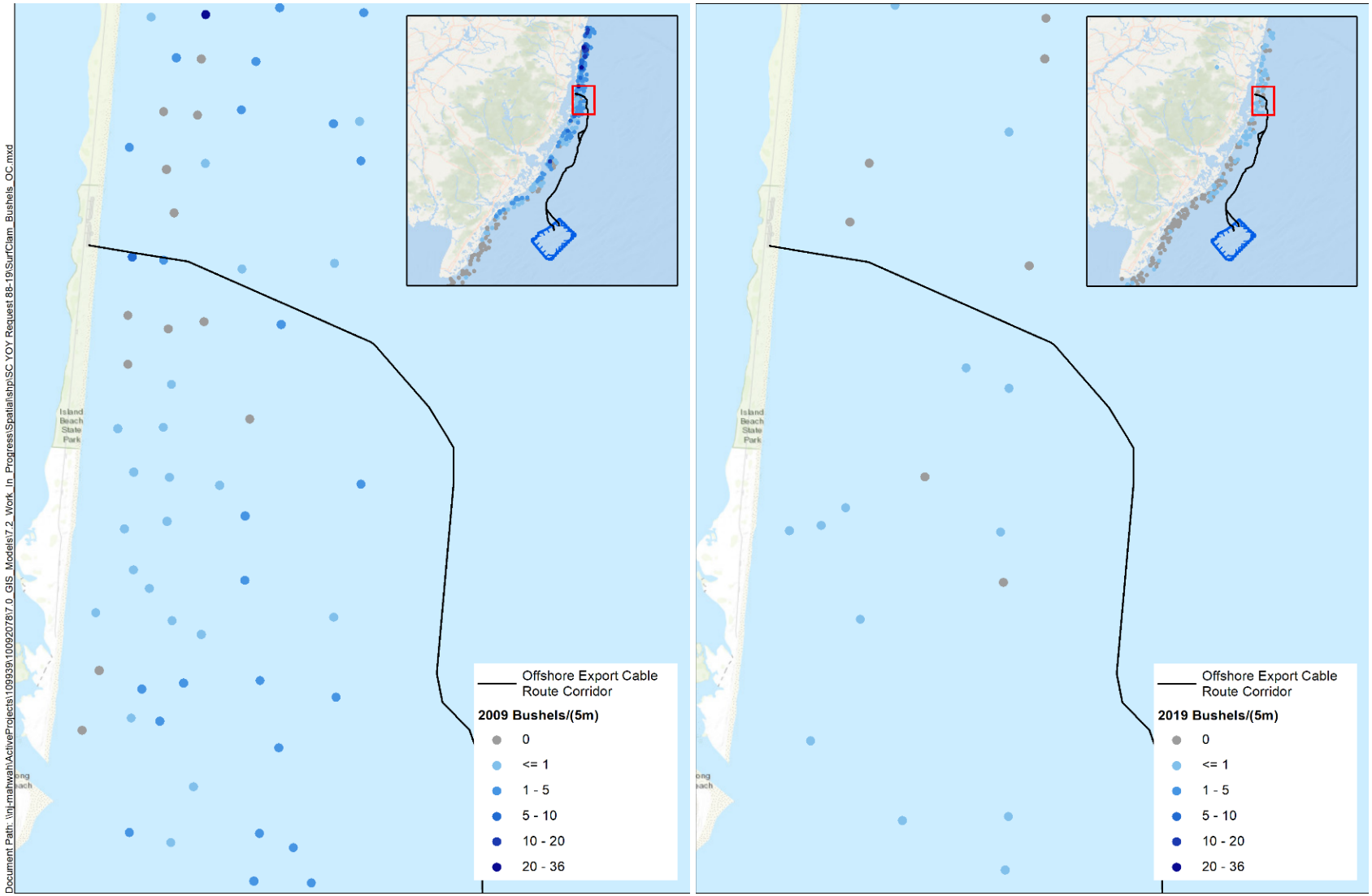


Figure 1a. NJDEP Surf Clam Surveys, bushels per 5 minute sampling effort at Oyster Creek, 2009 vs 2019.

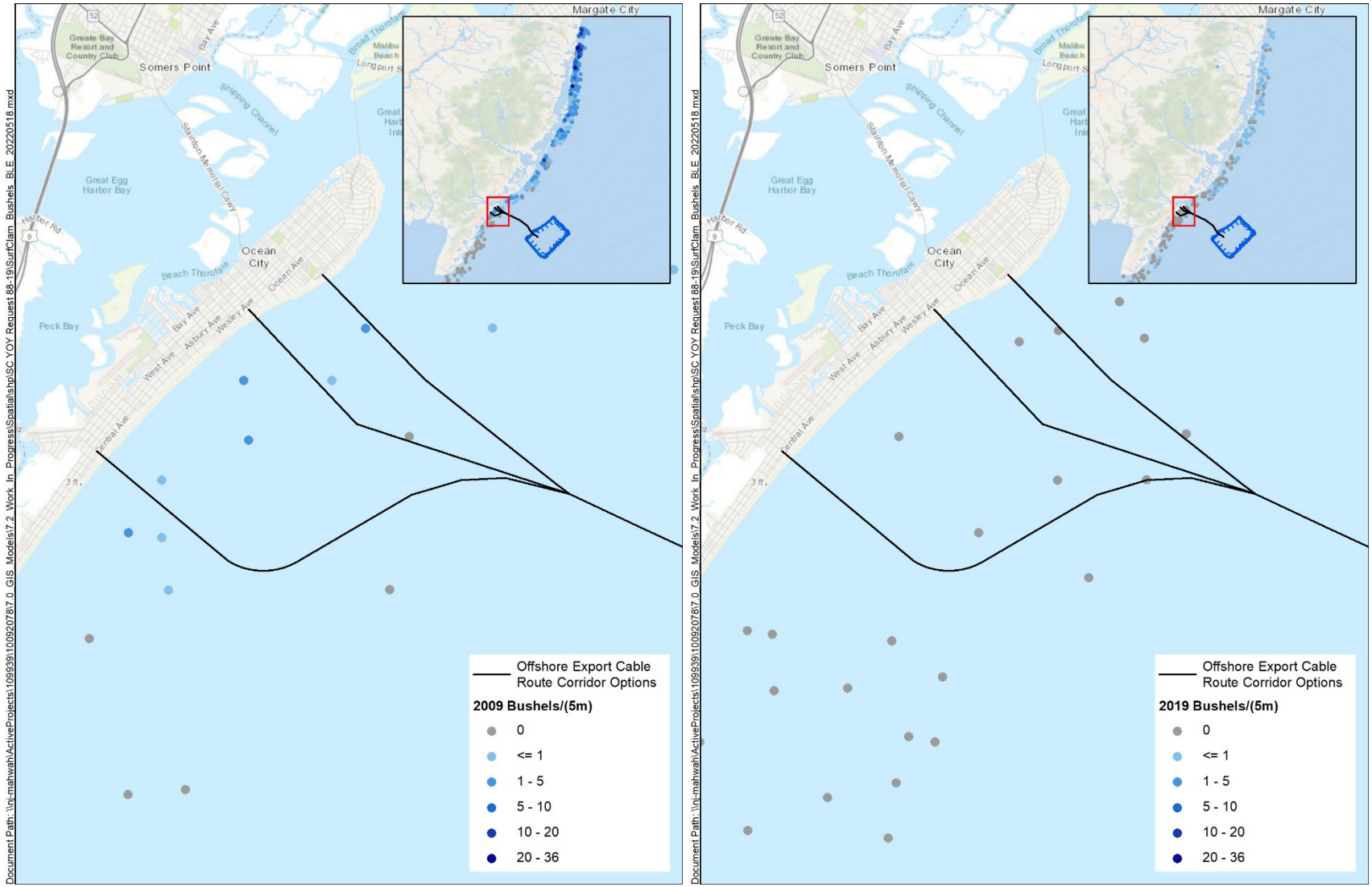


Figure 1b. NJDEP Surf Clam Surveys, bushels per 5-minute sampling effort at BL England, 2009 vs 2019.

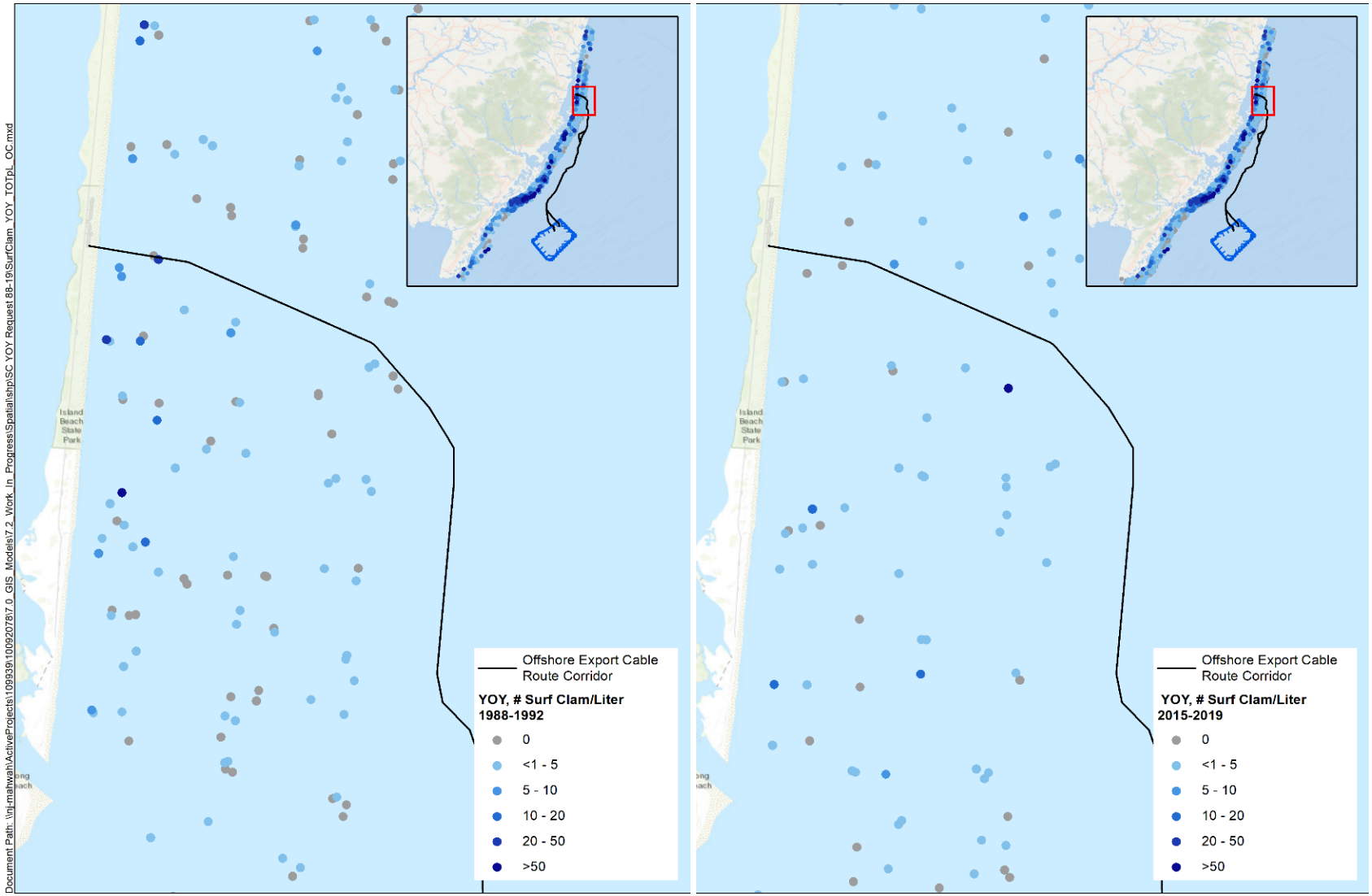


Figure 2a. NJDEP Surf Clam Recruitment Surveys, number of clams per liter of sample at Oyster Creek, 1988-1992 vs 2015-2019.

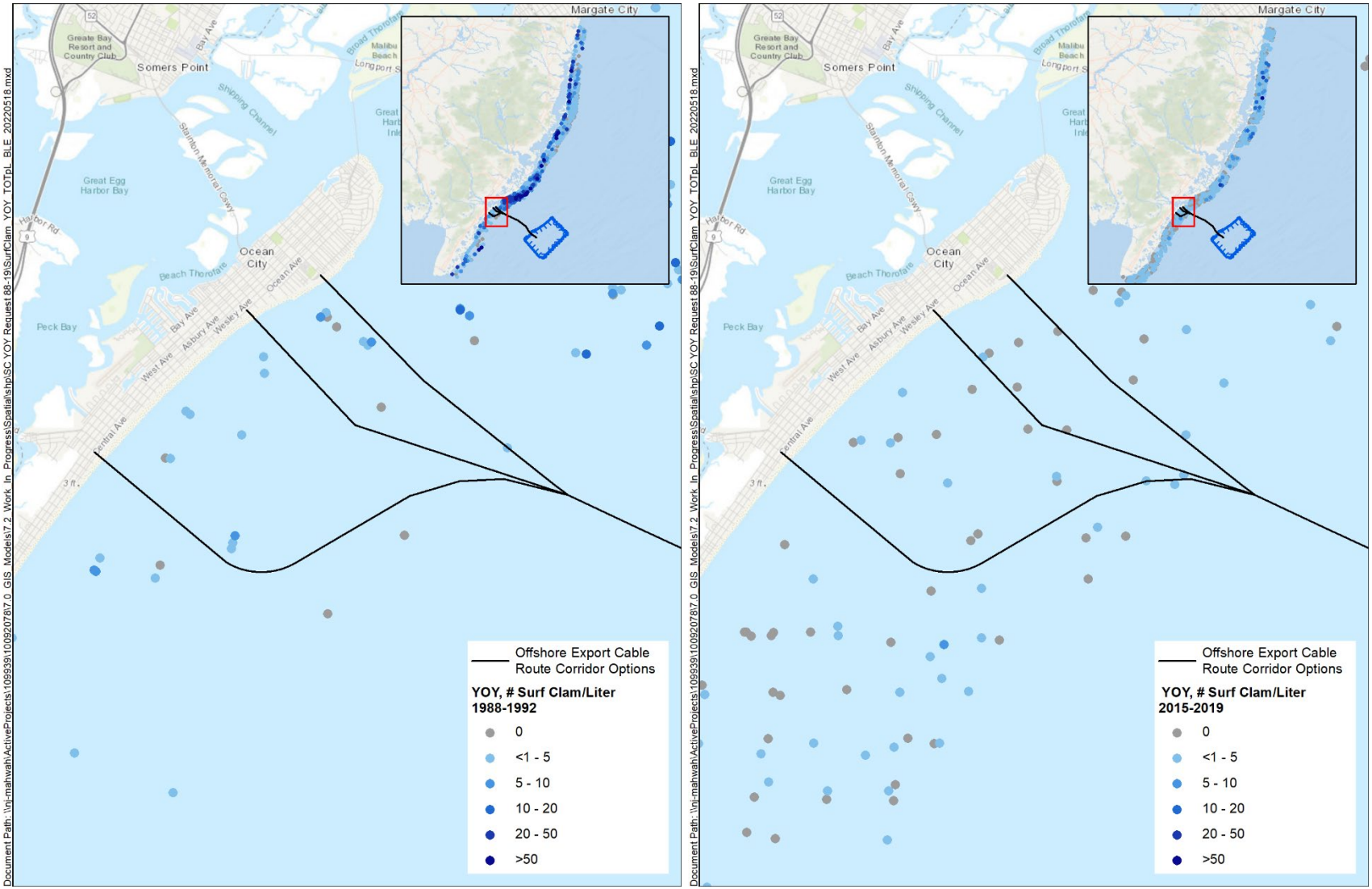


Figure 2b. NJDEP Surf Clam Recruitment Surveys, number of clams per liter of sample at BL England, 1988-1992 vs 2015-2019.

7:7-9.4 Prime Fishing Areas.

Federal and State Jurisdiction

This policy prohibits submarine mining of sand or gravel in prime fishing areas. Project activities do not include mining. The Project will avoid prime fishing areas to the maximum extent practicable. While seabed preparation, which may include seabed leveling, may be required prior to cable burial, sand or gravel submarine mining would not occur within prime fishing areas or in any part of the Project Area. Because the Project proposes to use jetting tools that will not discernably change bathymetry, fishery productivity of these areas will not be impacted. Additionally, the cables have been sited to avoid prime fishing areas mapped by the Department to the maximum extent practicable. Within the Oyster Creek offshore export cable route just prior to IBSP landfall, the cable route crosses the Cedar Creek prime fishing area. At this location the cable route makes as direct a crossing as practicable in order to make landfall via HDD within the southern auxiliary lot at Swimming Area #2 at IBSP. Along the offshore export cable corridors, bottom habitat is expected to infill to pre-existing conditions after cable burial and not cause any long-term changes to bathymetry. Public outreach and notice to mariners will occur prior to marine construction activities to minimize impacts. Therefore, the Project is consistent with this policy.

7:7-9.5 Finfish Migratory Pathways.

State Jurisdiction

This policy prohibits developments, such as dams, dikes, spillways, channelization, tide gates, and intake pipes that would create physical barriers to migratory fish. Although the cables for the Project will run through waters classified as a migratory pathway of migratory fish, the cables will be buried at target depths that will not result in a physical barrier to fish passage. Migratory fish work restriction windows (typically March through June) will be coordinated with NJDEP and U.S. Army Corps of Engineers (USACE) to avoid and minimize potential construction impacts to anadromous species. Potential impacts to migratory pathways will be limited to the areas directly around the construction and will be minimized through the use of APMs/BMPs and jetting technology where practicable to limit noise and turbidity, respectively. Jetting technology will minimize the amount of sediment disturbance around the construction location and migratory fish will be able to pass around construction. Construction will not create a physical barrier to the movement of fish along finfish migratory pathways, nor will any other aspects of the Project. Therefore, the Project is consistent with this policy.

7:7-9.6 Submerged Vegetation Habitat.

State Jurisdiction

This policy prohibits or restricts development to protect water areas that support submerged vegetation. The Project may traverse submerged vegetation habitat in Barnegat Bay. Trenchless technology methods within back bay landings in areas of submerged aquatic vegetation (SAV) will be used to the extent practicable to minimize the impact area. Based on data to be collected during geotechnical and geophysical surveys, it may not be feasible to use trenchless technology options under all of the areas covered by NJDEP's historical SAV maps in Barnegat Bay. In these areas, BMPs such as seasonal work windows will be implemented to minimize impacts upon coordination with NJDEP during the acquisition of State permits. Furthermore, jetting technology will minimize impacts to the seabed and limit resuspension and dispersal of sediments to surrounding SAV beds.

Open cut trenching will be used to install the cables from the maintenance/storage yard into a prior channel in Barnegat Bay. While this area is mapped by the NJDEP 1986 mapping as SAV habitat, mapping supplied by NJDEP from 1979 does not indicate this area is SAV habitat. Further, Ocean Wind's site-specific surveys

conducted October 2021 (underwater photography) have confirmed that this channel does not contain SAV beds (Construction and Operations Plan [COP] Appendix E). Use of open cut installation allows for a reduced cable separation (20 m for open cut rather than 50 m for HDD), which keeps the majority of workspace needed to accommodate the cable installation both in-water and at the landfall within the prior channel.

In areas overlying the cables where SAV re-establishment will not be allowed to ensure the cables and thermal load are not affected, Ocean Wind will coordinate with NJDEP, NMFS and other regulatory agencies to prepare the best practicable mitigation plan to address impacts to SAV. A restoration and mitigation plan will be prepared and approved at least 30 days prior to construction. Development of this Project is in the national interest for clean, renewable energy and is in compliance with the State of New Jersey's Executive Order No. 92 (2019) and N.J.A.C. 7:7-9.6(b). Therefore, the Project is consistent with this policy.

7:7-9.7 Navigation Channels.

Federal and State Jurisdiction

This policy prohibits construction that would extend into a navigation channel and stipulates that development that would cause siltation within navigation channels shall utilize appropriate mitigation measures. The Project would involve short term construction activities to cross New Jersey's Intracoastal Waterway, a navigation channel extending 102.3 nautical miles (nm) from Manasquan Inlet to the western entrance to the Cape May Canal. The intracoastal waterway is 100 ft wide and maintained at a depth of 6 feet below mean lower low water (MLLW). The export cable will be buried under the navigation channel and measures will be taken to avoid impacts to the maximum extent practicable. Mitigation measures will be used to minimize siltation within the navigation channel. Export cable burial will be coordinated with USACE, NJDOT, and the U.S. Coast Guard (USCG) to assure safety of navigation during and after construction and to assure proper burial depths (e.g., 6 ft below authorized depth of Intracoastal Waterway) and channel morphologies have been met so that the cable is buried at a depth that will not be impacted by future dredging operations or navigation. Temporary navigation restrictions may be imposed by the USCG during the short term. Project construction to allow for export cable installation to occur and minimize conflicts with other vessels. No permanent structures or vessels will be within the navigation channel during construction. The area that crosses the navigation channel will be small in size (approximately 0.1 acre) and all in-water operations associated with the installation will be conducted by qualified and certified vessel and equipment operators. Ocean Wind is coordinating this crossing with USACE.

Ocean Wind also proposes to perform maintenance dredging of the Oyster Creek Federal Channel near Barnegat Inlet in order to allow for the safe passage of construction vessels into Barnegat Bay. This channel is regulated by USACE under the Rivers and Harbors Act, Section 408. USACE has also solicited bids to conduct this maintenance dredging. However, the dredging may not be performed prior to construction of the Project within Barnegat Bay. All dredging will be performed in accordance with the authorized depth and width limitations of the channel and coordinated with USACE as part of the Section 408 regulatory review. Therefore, the Project is consistent with this policy.

7:7-9.8 Canals.

This policy prohibits actions that would interfere with boat traffic in canals used for navigation. The Project Area is not a canal as defined by NJDEP nor will the Project interfere with any canals used for traffic. Therefore, this policy is not applicable.

7:7-9.9 Inlets.

This policy prohibits filling and discourages submerged infrastructure in coastal inlets. Barnegat Inlet and Great Egg Harbor Inlet are inlets as defined by NJDEP; however, to avoid exposure or breakage of submerged infrastructure (i.e., export cables) from currents that could cause turbidity and cable abrasion over time, the Project will not use these inlets. Therefore, this policy is not applicable.

7:7-9.10 Marina Moorings.

This policy prohibits non-water-dependent development in marina mooring areas. The Project Area is not suitable for and does not contain marina moorings, nor would the Project involve development of marina moorings. Therefore, this policy is not applicable.

7:7-9.11 Ports.

State Jurisdiction

The policy prohibits uses that would preempt or interfere with port uses. Port locations for the Project are still being determined. Ocean Wind would use existing port and onshore office, warehouse and workshop facilities to the extent practicable. The use of the ports would not be impacted, and activities would be consistent with port operations. Therefore, the Project is consistent with this policy.

7:7-9.12 Submerged Infrastructure Routes.

State Jurisdiction

This policy prohibits any activity that would increase the likelihood of damaging submerged infrastructure (pipeline or cable that runs below a submerged land surface) or interfering with maintenance operations. Surveys for existing submerged infrastructure have been conducted and the Project designed so that no threats to existing infrastructure will result from export cable burial or maintenance activities. Ocean Wind will develop crossing agreements with utility owners prior to utility crossings. In addition, Ocean Wind has sited and designed the Project to minimize the potential for damage to this submerged infrastructure. The Project would not interfere with maintenance of other submerged infrastructure. Therefore, the Project is consistent with this policy.

7:7-9.13 Shipwrecks and Artificial Reef Habitats.

Federal and State Jurisdiction

This policy restricts the use, except for archeological research, of special areas with shipwrecks and artificial reefs that would adversely affect the usefulness of any special area as a fisheries resource. Known shipwrecks and artificial reef habitats were mapped and avoided during initial siting. A geophysical survey was conducted to identify potentially unmapped shipwrecks and artificial reef habitats. The proposed cable routes will avoid these areas to the extent practicable. If avoidance is not possible, Ocean Wind will develop a plan to mitigate impacts to shipwrecks and artificial reef habitat. Ocean Wind does not expect the Project to have adverse impacts on shipwrecks or artificial reef habitats. Therefore, the Project is consistent with this policy.

7:7-9.14 Wet Borrow Pits.

This policy restricts the use and filling of underwater borrow pits. The Project will avoid wet borrow pits. Therefore, this policy is not applicable.

7:7-9.15 Intertidal and Subtidal Shallows.

State Jurisdiction

This policy discourages disturbance of shallow-water areas (i.e., permanently or twice daily submerged areas from the spring high water to a depth of 4 ft. below MLLW). Pursuant to N.J.A.C. 7:7–9.15(e), the installation of submerged infrastructure within intertidal and subtidal shallows is conditionally acceptable, provided: (1) directional drilling is used unless it can be demonstrated that the use of directional drilling is not feasible; (2) where directional drilling is not feasible, there is no feasible alternative route that would not disturb intertidal and subtidal shallows; (3) the infrastructure is located deeply enough to avoid exposure or hazard; and (4) all trenches are backfilled to the preconstruction depth with naturally occurring sediment.

The Project will cross ISS areas. Trenchless technology will be used at the IBSP Atlantic landfall, Oyster Creek landfall, and BL England landfall to avoid impacts to ISS in these areas. If trenchless technology options are not successful, jetting technology or mechanical trenching will be used to bury cable. Jet plow will be used for offshore export cable installation from IBSP into Barnegat Bay to minimize impacts to SAV. Jetting technology will allow pre-construction depths and benthic contours to remain and minimize any impacts to the benthic habitat within ISS areas related to sediment disturbance and resuspension. The export cable will be buried at target depths that will prevent it from becoming exposed or posing a hazard risk, to the extent practicable. Where target cable burial depths are not achieved, additional armoring or other cable protection methods may be used to prevent exposure and minimize hazard risk. Off of the western shoreline of IBSP, a wave attenuation structure (rock sill) will be installed to protect the shoreline from erosion following construction and allow it to stabilize through natural revegetation. This will impact a small area of ISS.

Therefore, the Project is consistent with this policy.

7:7-9.16 Dunes.

State Jurisdiction

This policy protects and preserves ocean and bay front dunes. The export cables will pass under dunes via HDD, at approximately 50 feet below the dunes where the cables will not be vulnerable to exposure. Because of the depth of burial, the cables will not be uncovered for operations and maintenance activities in the HDD areas during the operational lifetime of the Project. Therefore, installation and maintenance will not cause adverse long-term impacts on the natural functioning of the beach and dune system. The export cable will be buried, and the cable route and any operations and maintenance access (such as a manhole) will be located in previously disturbed areas. In addition, the Project is an acceptable activity because it meets the rule on location of linear development (N.J.A.C. 7:7-14.1). Ocean Wind will continue to coordinate with NJDEP's coastal engineering group and USACE to avoid, minimize, or mitigate impacts to dunes. Therefore, the Project is consistent with this policy.

7:7-9.17 Overwash Areas.

State Jurisdiction

This policy restricts development in overwash areas because of their sensitive nature. Cables and infrastructure on land may be constructed within overwash areas. However, linear developments are allowed within these areas. The Project will minimize all construction impacts and restore the overwash areas to existing grade following construction. Because the export cable will remain buried, and the cable route and any operation and maintenance points (such as a manhole) would be located in previously disturbed areas, installation and maintenance would not cause adverse long-term impacts. Ocean Wind will coordinate with

NJDEP's coastal engineering group to avoid, minimize, or mitigate impacts to overwash areas. Therefore, the Project is consistent with this policy.

7:7-9.18 Coastal High Hazard Areas.

State Jurisdiction

This policy restricts development in coastal high-hazard areas, which are flood-prone areas subject to high velocity waters (i.e., FEMA defined Zone V). Portions of the export cable route are located within the FEMA designated Zone VE. The cable and its associated structures will be placed underground and, therefore, will not be subject to high velocity waters. Any permanent aboveground structure will be placed at least 25 feet landward of any shore protection structures such as bulkheads, revetments or seawalls. Prior to construction, the appropriate Flood Hazard Area approvals will be obtained, and the Project will be in compliance with N.J.A.C. 7:13. Therefore, the Project is consistent with this policy.

7:7-9.19 Erosion Hazard Areas.

State Jurisdiction

This policy prohibits development in erosion hazard areas under most circumstances to protect public safety. Landfalls of export cables and infrastructure are not anticipated to occur in an erosion hazard area. However, linear developments are allowed in erosion hazard areas. Therefore, the Project is consistent with this policy.

7:7-9.20 Barrier Island Corridor.

State Jurisdiction

This policy stipulates that new or expanded development within the oceanfront barrier island corridor comply with the requirements for impervious cover and vegetative cover that apply to the site under N.J.A.C. 7:7-13. The export cable corridors associated with the Project are linear developments that will not be wholly located within or solely serving a development need within the barrier island corridor. The portions of the Project that may fall within the barrier island corridor include the underground cables and their associated components. These have been sited within existing parking lots and road ROWs to the extent practicable. However, there would be no permanent impacts to vegetation and impervious surfaces as construction will take place within roadway ROWs, where practicable and impacted areas of vegetation would be replanted and restored. The Project would not alter the existing character of New Jersey's developed barrier islands and will not add appreciably to the public service costs or emergency evacuation (in time of hurricanes) problems of these islands. Therefore, the Project is consistent with this policy.

7:7-9.21 Bay Islands.

This policy restricts development on bay islands. The Project would avoid bay islands and no development is proposed on bay islands. Therefore, this policy is not applicable.

7:7-9.22 Beaches.

State Jurisdiction

This policy restricts development on beaches. The export cables will pass under the beach via trenchless technology methods to the extent practicable, at a depth where the cables will not be exposed. In the event trenchless technology methods are not feasible, trenching equipment may be used. The export cable will remain buried, and the cable route and any operations and maintenance access (such as a manhole) would be located in previously disturbed areas. Therefore, installation and maintenance would not cause adverse long-term impacts on the natural functioning of the beach and dune system because the export cable will remain

buried, and the cable route and any operation and maintenance points (such as a manhole) would be located in previously disturbed areas and not on beaches. Furthermore, the Project meets the rule on location of linear development (N.J.A.C. 7:7-14.1) authorized under this rule. Therefore, the Project is consistent with this policy.

7:7-9.23 Filled Water's Edge.

This policy seeks to promote water-dependent uses at waterfront areas that have been previously filled or modified for commercial activity. Depending on landfall location, export cables will be installed to the extent practicable via trenchless technology methods to a location beyond the filled water's edge and these areas will not be impacted. If trenchless methods are not possible, water's edge will be restored to pre-existing contours and conditions. Development will comply with public trust rights rule, N.J.A.C. 7:7-9.48, and the public access rule, N.J.A.C. 7:7-16.9. If the landfall chosen has direct water access (that is, those sites without extensive intertidal shallows or wetlands between the upland and navigable water), development will comply with the waterfront and non-waterfront use requirements. However, the long-term use of the area within filled water's edge areas will not change. Therefore, the Project is consistent with this policy.

7:7-9.24 Existing Lagoon Edges.

State Jurisdiction

This policy restricts development at lagoon edges, which are defined as existing manmade land areas resulting from the dredging and filling of wetlands, bay bottom and other estuarine water areas for the purpose of creating waterfront lots along lagoons for residential and commercial development. Existing Lagoon Edges extend upland to the limit of fill, or the first paved public road or railroad generally parallel to the water area, whichever is less. Because the cable will be placed in roadway ROWs, existing lagoon edges will not be crossed, as the existing lagoon edge would end at the first paved surface. Therefore, this policy is not applicable.

7:7-9.25 Flood Hazard Areas.

State Jurisdiction

This policy is designed to restrict development in flood hazard areas and to ensure that the waterfront is not pre-empted by uses that could function equally well at inland locations. This Project is located within a regulated Flood Hazard Area according to FEMA Flood Insurance Rate Maps. The project is consistent with Flood Hazard Area Control Act, N.J.S.A. 58:16A-50 et seq., and implementing rules at N.J.A.C. 7:13, Uniform Construction Code, N.J.A.C. 5:23, and Federal flood reduction standards, 44 C.F.R. Part 60. Therefore, the Project is consistent with this policy.

7:7-9.26 Riparian Zones.

State Jurisdiction

This policy sets the standards for development in a riparian zone. A riparian zone exists along every regulated water, except there is no riparian zone along the Atlantic Ocean nor along any manmade lagoon, stormwater management basin, or oceanfront barrier island, spit or peninsula. Within the Project Area, riparian zones are identified along Oyster Creek in Ocean County near the Oyster Creek interconnection point and the proposed substation along with the area adjacent to Crook Horn Creek in Cape May County in the BL England onshore export cable corridor. These locations have been identified to have riparian zones of either 50 or 150 feet. The Project would not permanently impact these riparian zones. By design, the Project will avoid riparian zones to the maximum extent practicable at both locations by siting the trenchless technology entry and exit launch locations outside of them or by crossing the regulated water with a utility bridge (see policy N.J.A.C. 7:7-12.14).

A small portion of riparian zone may be impacted by temporary workspace at Oyster Creek. Should these areas be impacted by entry/exit pits or other activities, Ocean Wind will obtain all permits in accordance with N.J.A.C. 7:13. Therefore, the Project is consistent with this policy.

7:7-9.27 Wetlands.

State Jurisdiction

This policy restricts disturbance in wetland areas and requires mitigation if wetlands are destroyed or disturbed. The policy also prohibits development within wetlands unless the Department can find that the proposed development meets the following conditions:

1. Requires water access or is water oriented as a central purpose of the basic function of the activity (this rule applies only to development proposed on or adjacent to waterways). This means that the use must be water dependent;
2. Has no prudent or feasible alternative on a non-wetland site;
3. Will result in minimum feasible alteration or impairment of natural tidal circulation (or natural circulation in the case of non-tidal wetlands); and
4. Will result in minimum feasible alteration or impairment of natural contour or the natural vegetation of the wetlands.

The Project's landfall areas meet the definition of a water dependent activity because the Project requires water access to the Atlantic Ocean and inland bays for cable crossings and is an offshore wind farm.

The routes and installation methods were selected to avoid and minimize impacts to wetlands and other resources to the maximum extent practicable while also incorporating engineering feasibility. N.J.A.C. 7:7a-1.3 defines a "practicable alternative" as other choices available and capable of being carried out after taking into consideration cost, existing technology, and logistics in light of overall project purposes, and may require an area not owned by the applicant which could reasonably have been or be obtained, utilized, expanded, or managed in order to fulfill the basic purpose of the proposed activity. For a more detailed assessment of the alternatives investigated, please see Volume I Section 5. HDD and BMPs will be used to further minimize impacts to NJDEP-regulated resources, including wetlands at the Holtec Property Landfall and the Oyster Creek Discharge Channel crossing in Lacey Township and at the Crook Horn Creek/Peck Bay crossing at the Roosevelt Boulevard Bridge in Ocean City/Upper Township. Site-specific wetland surveys were conducted to inform the design and exact location of the placement of infrastructure to limit impacts to wetlands to the maximum extent practicable. Following these site-specific wetland surveys, Ocean Wind coordinated with NJDEP and USACE to verify the size and location of wetlands.

Within the Oyster Creek Project Area, wetland impacts will occur at IBSP near Shore Road as a result of cable duct installation through an emergent wetland community. Cable ducts will be below grade and the area over the top of these ducts will be restored and replanted so permanent impacts will not be incurred. At this location, the two cables will be installed into two TJBs which will be below grade and transitioned into offshore cables. The cables will then be installed into Barnegat Bay shoreline via open cut installation through a berm with fringe wetlands dominated by common reed. Temporary impacts to the wetlands will occur here, but the berm will be restored to previous conditions and a living shoreline in the form of a rock wave attenuator will be established to stabilize the berm and allow the wetlands to naturally revegetate.

At the western Barnegat Bay landing, the cable will make landfall in a common reed coastal wetland. The wetland will be matted during HDD construction activities and two TJBs will be installed below grade and contours will be reestablished, allowing revegetation to occur over top of the TJBs. The only permanent surficial impacts in this area will be the at-grade access manhole covers to the TJBs. There will be no impact to tidal

hydrology as a result of this work. After installing the cables within a duct below grade through a short distance of mapped coastal wetlands and a very small area of palustrine forested wetlands (less than 3,000 square feet [0.07 acres]), the cable will be installed within previously disturbed upland dirt trails, upland forested areas, and paved roads until the Project crosses under Oyster Creek via another HDD installation, thereby avoiding wetlands to the west of Route 9 and on the southern shoreline of Oyster Creek. Impacts to coastal and freshwater wetlands will be mitigated for in accordance with N.J.A.C. 7:7-17 and N.J.A.C. 7:7A-11 and potentially require replanting of trees upon coordination with NJDEP.

Small, isolated freshwater wetlands, totaling less than 2 acres in the proposed onshore substation parcel at Oyster Creek and less than 1 acre of wetlands at BL England will be filled as a result of the construction. The substations were sited based on an existing and valid LOI issued by the Department that did not map these isolated wetlands. Because of the proximity of the substation to the interconnection point, along with the topography in the western portion of the parcel, the substation could not be sited in a different location to avoid impacts to the isolated wetlands. For more information on the alternatives assessed, please refer to Attachment 2. All impacts to the wetlands in this location will be mitigated for in accordance with N.J.A.C. 7:7-17 and N.J.A.C. 7:7A-11.

The Project route will avoid and minimize any adverse impacts to wetlands by maintaining wetland buffers, implementing APMs and BMPs for erosion and sediment control, and maintaining natural surface drainage patterns. Ocean Wind will avoid impacting tidal hydrology and wetlands to the maximum extent practicable. Ocean Wind is seeking a permit in accordance with N.J.A.C. 7:7 and N.J.A.C. 7:7A to authorize Project activities within those wetlands regulated under the Wetlands Act of 1970 and the Freshwater Wetlands Protection Act. A Mitigation Plan has been developed and will be reviewed and approved by the appropriate agencies. Therefore, the Project will be consistent with this policy.

7:7-9.28 Wetland Buffers.

State Jurisdiction

This policy restricts development in wetland buffer areas in order to protect wetlands. The Project would occur in upland buffers or areas adjacent to wetlands, as well as wetland areas where there is no feasible alternative. However, the Project would avoid and minimize impacts to wetlands and wetland buffers to the greatest extent possible by siting the majority of the onshore Project components within existing disturbed areas such as roadway rights-of-way and other paved areas such as parking lots, raised berms or trails to the maximum extent practicable. Additionally, the Project will implement APMs and BMPs for soil erosion and sediment control (SESC) and will maintain natural surface drainage features. Ocean Wind conducted site-specific wetland surveys and coordinated with NJDEP and USACE on the size, location, and approvals necessary for development in wetlands and wetland buffers. Project impacts to wetland transition area buffers will be avoided to the maximum extent practicable. For actions that will require unavoidable impacts to wetland transition area buffers, Ocean Wind is seeking permits in accordance with N.J.A.C. 7:7 and N.J.A.C. 7:7A. Therefore, the Project is consistent with this policy.

7:7-9.29 Coastal Bluffs.

This policy restricts development on coastal bluffs. The Project Area does not contain coastal bluffs. Therefore, this policy is not applicable.

7:7-9.30 Intermittent Stream Corridors.

State Jurisdiction

This policy restricts action in intermittent stream corridors. Intermittent stream corridors are areas including and surrounding surface water drainage channels in which there is not a permanent flow of water and which contain an area or areas with a seasonal high water table equal to or less than one foot. The inland extent of these corridors is either the inland limit of soils with a seasonal high water table depth equal to, or less than one foot, or a disturbance of 25 feet measured from the top of the channel banks, whichever is greater. The Project will occur in upland buffers or areas adjacent to wetlands, but no intermittent stream corridors were identified during site-specific wetland and watercourse delineations. Ocean Wind will coordinate with NJDEP and USACE during Project permitting and will accordingly comply with the rules set forth at N.J.A.C. 7:7-9.27, N.J.A.C. 7:13, N.J.A.C. 7:7A. Therefore, the Project is consistent with this policy.

7:7-9.31 Farmland Conservation Areas.

This policy seeks to preserve large parcels of land used for farming. Per N.J.A.C. 7:7–9.31(a), farmland conservation area is defined as, "any contiguous area of 20 acres or more (in single or multiple tracts of single or multiple ownership) with soils in the Capability Classes I, II and III or special soils for blueberries and cranberries as mapped by the United States Department of Agriculture (USDA), Soil Conservation Service (SCS), in National Cooperative Soil Surveys, which are actively farmed, or suitable for farming, unless it can be demonstrated by the applicant that new or continued use of the site for farming or farm dependent purposes is not economically feasible." The Project does not occur in any area that meets the criteria for farmland conservation area. Therefore, this policy is not applicable.

7:7-9.32 Steep Slopes.

This policy seeks to preserve steep slopes by restricting development in such areas. Restricting development on steep slopes helps to control erosion and reduce flooding downhill. The Project Area does not contain steep slopes. Therefore, this policy is not applicable.

7:7-9.33 Dry Borrow Pits.

This policy restricts the excavation and filling of upland or dry borrow pits. The Project Area does not contain dry borrow pits nor does Ocean Wind propose to use or fill dry borrow pits. Therefore, this policy is not applicable.

7:7-9.34 Historic and Archeological Resources.

Federal and State Jurisdiction

This policy protects the value of historic architectural and archaeological resources and may result in a need for protective measures.

The Project may affect submerged cultural resources within the offshore marine environment along the offshore export cable route. A geophysical survey was conducted to identify potential submerged cultural resources. Ocean Wind has developed and will implement an unanticipated discovery plan for offshore archaeological resources. The marine archaeological resources assessment of the HRG data within the PAPE identified 19 potential submerged cultural resources within the gradiometer, side-scan sonar, and/or multibeam echosounder datasets, 12 are located within the Wind Farm Area; three are located along the BL England export cable route corridor; and four are located along the Oyster Creek export cable route corridor. Four targets appear to represent shipwrecks in the side-scan sonar imagery and are in close proximity to reported shipwrecks. Five targets consist of magnetic anomalies that share characteristics with verified shipwreck

magnetic signatures and side-scan imagery of unknown origin, therefore, may represent a partially buried shipwreck source. The remaining 10 targets consist of magnetic anomalies that share characteristics with verified shipwreck magnetic signatures and, therefore, may represent a buried shipwreck source. The QMA recommends avoidance of these targets by a distance of 50 meters (164 feet) from the outer edge of magnetic anomalies and acoustic contacts. HRG data identified 16 geomorphic features of archaeological interest within the PAPE, 13 are located within the Wind Farm Area; one is located along the BL England export cable route corridor; and two are located along the Oyster Creek export cable route corridor, which represent relict channel margins that may have been subaerially exposed and available for past human use. The features possess archaeological potential; however, no direct evidence of associated human occupation has been documented in the geophysical or geotechnical data. The features, therefore, represent portions of buried landscapes that may be of cultural significance to Native American communities. The QMA recommends avoidance of these features. (Marine Archaeological Resources Assessment in COP Appendix F-1). Ocean Wind developed and will implement an unanticipated discovery plan for offshore archaeological resources.

Furthermore, cables and infrastructure on land may potentially affect cultural resources within the onshore environment. Ocean Wind conducted Phase 1a and Phase 1b archaeological surveys in order to identify and avoid archaeological resources within the onshore Project Area. Ocean Wind developed and will implement an unanticipated discovery plan for onshore archaeological resources (see COP Appendix F-5). Based on the findings of onshore archaeological surveys, no further studies or mitigation are recommended. Ocean Wind will coordinate with the relevant State historic and archaeological agencies and tribes through BOEM's Section 106 process. Refer to COP Appendix F-2 for the Marine and Terrestrial Archaeological Resources Assessment Reports.

Onshore and offshore infrastructure may potentially affect architectural resources. Ocean Wind conducted architectural surveys and assessed impacts to historic architectural resources. Impacts to historic architectural resources were minimized to the extent practicable through siting of the Project facilities (e.g., siting onshore substations adjacent to and within existing generation properties where they are consistent with existing conditions, and siting buried onshore infrastructure primarily within road ROWs) and by burying onshore and offshore export cables to minimize impacts to historic architectural resources. Based on the results of the assessment of visual effects to historic properties, findings are recommended as No Adverse Effect on historic properties from onshore infrastructure (COP Appendix F-3).

Ocean Wind sited offshore infrastructure approximately 15 mi from the shoreline of the barrier islands at its nearest point to minimize potential for visual impacts. To evaluate visual effects from the offshore infrastructure, 41 historic properties were reviewed within the Offshore Infrastructure PAPE, which included 7 historic districts and 34 individual properties. These 41 historic properties were evaluated for potential visual effects from the proposed Project using the Criteria of Adverse Effect in 36 CFR § 800.5. Visual effects recommendations are made of No Adverse Effect at 35 properties, and the potential for Adverse Effect at six properties. The potential for adverse effect should be considered at Riviera Apartments in Atlantic City; Vassar Square Condominiums, a house at 114 South Harveard Avenue in Ventnor City, and Charles Fischer House in Ventnor City; and Ocean City Music Pier in Ocean City Villa Maria by the Sea was originally considered here, but subsequent to field surveys it was demolished. These properties are on the seashore, all but one are within 16 miles of the Wind Farm Area, and ocean views are a character-defining feature of each property's significance. Ocean Wind has sited facilities to minimize impacts and will mitigate for Adverse Effects on historic architectural resources. Therefore, this Project is consistent with this policy.

7:7-9.35 Specimen Trees.

This policy seeks to protect specimen trees as defined by NJDEP. Specimen trees are the largest known individual trees of each species in New Jersey. The Department's Division of Parks and Forestry maintains a list of these trees (see "New Jersey's Biggest Trees," published by the Department's Division of Parks and Forestry, Summer 1991 for a listing of specimen trees). In addition, large trees approaching the diameter of the known largest tree shall be considered specimen trees. Individual trees with a circumference equal to or greater than 85 percent of the circumference of the record tree, as measured 4.5 feet above the ground surface, for a particular species shall be considered a specimen tree. No old growth trees were observed during wetland delineations. The majority of the Project will be located within existing disturbed areas. The Project will not impact specimen trees or large trees approaching the diameter of a specimen tree. Therefore, the Project is consistent with this.

7:7-9.36 Endangered and Threatened Wildlife or Vegetation Habitats.

Federal and State Jurisdiction

Agency consultations for information regarding threatened, endangered and special concern species and habitats have been coordinated with USFWS, NJDEP Natural Heritage Program (NHP) and the National Oceanic and Atmospheric Administration (NOAA). Desktop reviews have identified several species as potentially occurring within or in the vicinity of the Project Area, as outlined in **Tables 2 and 3**. Ocean Wind conducted onshore species habitat assessments to determine whether appropriate habitat for threatened and endangered species is present. The Project will avoid habitat for threatened and endangered species to the extent practicable. Ocean Wind has designed facilities and plans to utilize installation methods to minimize impacts where avoidance is not possible and coordinate with relevant agencies to develop BMPs and comply with permit conditions to demonstrate compliance with this rule. In addition, Ocean Wind will implement nearshore marine waters monitoring by approved protected species observers (PSO) to prevent adverse impacts to marine mammals, sea turtles and Atlantic sturgeon. Therefore, this Project is consistent with this policy.

Table 2. State and Federally Listed Species (not including birds*) that may occur within and in the vicinity of the Project Area.

Common Name	Scientific Name	Status
Mammals		
Bobcat	*Lynx rufus*	SE
Northern long-eared bat	*Myotis septentrionalis*	FT
Reptiles		
Loggerhead turtle	*Caretta*	FT
Green turtle	*Chelonia mydas*	FT
Kemp's Ridley turtle	*Lepidochelys kempii*	FE
Leatherback turtle	*Dermochelys coriacea*	FE
Bog turtle	*Clemys muhlenbergii*	FT, SE
Corn snake	*Pantherophis guttatus*	SE
Northern pine snake	*Pituophis melanoleucus melanoleucus*	ST
Timber rattlesnake	*Crotalus horridus horridus*	SE
Wood turtle	*Glyptemus insculpta*	ST
Amphibians		
Pine barrens treefrog	*Hyla andersonii*	ST

Common Name	Scientific Name	Status
Cope's gray treefrog (southern gray treefrog)	*Hyla chrysoscellis*	SE
Fish		
Atlantic Sturgeon	*Acipenser oxyrinchus*	FE, SE
Shortnose Sturgeon	*Acipenser brevirostrum*	FE, SE
Oceanic whitetip shark	*Caracharinus longimanus*	FT
Giant manta ray	*Manta birostris*	FT
Alewife	*Alosa pseudoharengus*	C
Blueback herring	*Alosa aestevalis*	C
Cusk	*Brosme brosme*	C
Plants		
American Chaffseed	*Schwalbea Americana*	FE
Knieskern's beaked-rush	*Rhynchospora knieskernii*	FT, SE
Seabeach Amaranth	*Amaranthus pumilus*	FT, SE
Sensitive joint-vetch	*Aeschynomene virginica*	FT
Swamp pink	*Helonias bullata*	FT, SE
Marine Mammals		
Blue whales	*Balaenoptera musculus*	FE
Fin whales	*Plegadis falcinellus*	FE
North Atlantic right whale	*Eubalaena glacialis*	FE
Sei whales	*Balaenoptera borealis*	FE
Sperm whales	*Physeter macrocephalus*	FE

Notes:

Status: FE – Federally Endangered, FT – Federally Threatened, SE- State Endangered, ST – State Threatened, C – Candidate Species

*For bird species listed in New Jersey and/or federally, see Table 4.2.3-1 in the Ocean Wind COP.

Table 3 – State and Federal Listed birds that have the potential to pass through the BL England and Oyster Creek study areas.

Common Name	Scientific Name	NJ Status*	Federal Status*
American Oystercatcher	*Haematopus palliates*	SC - Breeding + Non-breeding	BCC
Lesser Yellowlegs	*Tringa flavipes*	-	BCC - Non-breeding
Whimbrel	*Numenius phaeopus*	SC - Non-breeding	BCC - Non-breeding
Willet	*Tringa semipalmata*	-	BCC
Hudsonian Godwit	*Limosa haemastica*	-	BCC - Non-breeding
Marbled Godwit	*Limosa fedoa*	-	BCC - Non-breeding
Short-billed Dowitcher	*Limnodromus griseus*	-	BCC - Non-breeding
Piping Plover	*Charadrius melodus*	E - Breeding + Non-breeding	T
Purple Sandpiper	*Calidris maritima*	-	BCC - Non-breeding
Semipalmated Sandpiper	*Calidris pusilla*	SC - Non-breeding	BCC - Non-breeding
Spotted Sandpiper	*Actitis macularius*	SC - Breeding	-
Buff-breasted Sandpiper	*Calidris subruficollis*	-	BCC - Non-breeding

Common Name	Scientific Name	NJ Status*	Federal Status*
Upland Sandpiper	*Batramia longicauda*	E - Breeding + Non-breeding	BCC
Solitary Sandpiper	*Tringa solitaria*	-	BCC - Non-breeding
Sanderling	*Calidris alba*	SC - Non-breeding	-
Red Knot	*Calidris canutus rufa*	E - Non-breeding	T - Non-breeding
Bald Eagle	*Haliaeetus leucocephalus*	E - Breeding, T - Non-breeding	BCC
Peregrine Falcon	*Falco peregrinus*	E - Breeding, SC - Non-breeding	BCC
American Kestrel	*Falco sparverius*	T - Breeding + Non-breeding	-
Northern Goshawk	*Accipiter gentilis*	E - Breeding, SC - Non-breeding	-
Northern Harrier	*Circus cyaneus*	E - Breeding, SC - Non-breeding	-
Red-shouldered Hawk	*Buteo lineatus*	E - Breeding, SC - Non-breeding	-
Broad-winged Hawk	*Buteo platypterus*	SC - Breeding	-
Cooper's Hawk	*Accipiter cooperii*	SC - Breeding	-
Sharp-shinned Hawk	*Accipiter striatus*	SC - Breeding + Non-breeding	-
Osprey	*Pandion haliaetus*	T - Breeding	-
Snowy Owl	*Bubo scandiacus*	-	BCC
Short-eared Owl	*Asio flammeus*	E - Breeding, SC - Non-breeding	BCC - Non-breeding
Barred Owl	*Strix varia*	T - Breeding + Non-breeding	-
Long-eared Owl	*Asio otus*	T - Breeding + Non-breeding	-
Barn Owl	*Tyto alba*	SC - Breeding + Non-breeding	-
Black Rail	*Laterallus jamaicensis*	E - Breeding, T - Non-breeding	BCC
Eastern Black Rail	*Laterallus jamaicensis*	-	PT - Proposed Threatened
King Rail	*Rallus elegans*	-	BCC
American Bittern	*Botaurus lentiginosos*	E - Breeding, SC - Non-breeding	BCC
Least Bittern	*Ixobrychus exilis*	SC - Breeding + Non-breeding	BCC
Cattle Egret	*Bubulcus ibis*	T - Breeding, SC - Non-breeding	-
Snowy Egret	*Egretta thula*	SC - Breeding	BCC
Black-crowned Night-heron	*Nycticorax nycticorax*	T - Breeding, SC - Non-breeding	-
Yellow-crowned Night-Heron	*Nyctanassa violacea*	T - Breeding + Non-breeding	-
Great Blue Heron	*Ardea herodias*	SC - Breeding	-

Common Name	Scientific Name	NJ Status*	Federal Status*
Tricolored Heron	*Egretta tricolor*	SC - Breeding + Non-breeding	-
Little Blue Heron	*Egretta caerulea*	SC - Breeding + Non-breeding	-
Glossy Ibis	*Plegadis falcinellus*	SC - Breeding	-
Pied-billed Grebe	*Podilymbus podiceps*	E - Breeding, SC - Non-breeding	BCC
Horned Grebe	*Pidiceps auritus*	-	BCC - Non-breeding
Black-billed Cuckoo	*Coccyzus erythropthalmus*	SC - Breeding	BCC
Blue-headed Vireo	*Vireo solitarius*	SC - Breeding	-
Bobolink	*Dolichonyx oryzivorus*	T - Breeding, SC - Non-breeding	BCC
Brown Thrasher	*Toxostoma rufum*	SC - Breeding	-
Canada Warbler	*Cardellina canadensis*	SC - Breeding	BCC
Cerulean Warbler	*Dendroica cerulea*	SC - Breeding + Non-breeding	BCC
Prairie Warbler	*Dendroica discolor*	-	BCC
Blackburnian Warbler	*Dendroica fusca*	SC - Breeding	-
Black-throated Blue Warbler	*Dendroica caerulescens*	SC - Breeding	-
Black-throated Green Warbler	*Dendroica virens*	SC - Breeding	-
Prothonotary Warbler	*Protonotaria citrea*	-	BCC
Hooded Warbler	*Wilsonia citrina*	SC - Breeding	-
Nashville Warbler	*Oreothlypis ruficapilla*	SC - Breeding	-
Northern Parula	*Parula americana*	SC - Breeding	-
Worm-eating Warbler	*Helmitheros vermivorum*	SC - Breeding	BCC
Yellow-breasted Chat	*Icteria virens*	SC - Breeding	-
Kentucky Warbler	*Oporornis formosus*	SC - Breeding + Non-breeding	BCC
Golden-winged Warbler	*Vermivora chrysoptera*	E - Breeding, SC - Non-breeding	BCC
Blue-winged Warbler	*Vermivora cyanoptera*	-	BCC
Saltmarsh Sparrow	*Ammodramus caudacutus*	SC - Breeding	BCC
Seaside Sparrow	*Ammodramus maritimus*	-	BCC
Ipswich Sparrow	*Passerculus sandwichensis princeps*	SC - Non-breeding	-
Nelson's Sparrow	*Ammodramus nelsoni*	-	BCC
Grasshopper Sparrow	*Ammodramus savannarum*	T - Breeding, SC - Non-breeding	-
Savannah Sparrow	*Passerculus sandwichensis*	T - Breeding	-
Henslow's Sparrow	*Ammodramus henslowii*	E - Breeding + Non-breeding	BCC

Common Name	Scientific Name	NJ Status*	Federal Status*
Vesper Sparrow	*Pooecetes gramineus*	E - Breeding, SC - Non-breeding	-
Winter Wren	*Troglodytes hiemalis*	SC - Breeding	-
Sedge Wren	*Cistothorus platensis*	E - Breeding + Non-breeding	BCC
Cliff Swallow	*Petrochelidon pyrrhonota*	SC - Breeding	-
Eastern Meadowlark	*Stunella magna*	SC - Breeding + Non-breeding	-
Evening Grosbeak	*Coccothraustes vespertinus*	-	BCC
Red-headed Woodpecker	*Melanerpes erythrochephalus*	T - Breeding + Non-breeding	BCC
Rusty Blackbird	*Euphagus carolinus*	-	BCC - Non-breeding
Wood Thrush	*Hylocichla mustelina*	SC - Breeding	BCC
Gray-cheeked Thrush	*Catharus minimus*	SC - Non-breeding	-
Veery	*Catharus fuscescens*	SC - Breeding	-
Least Flycatcher	*Empidonax minimus*	SC - Breeding	-
Loggerhead Shrike	*Lanius ludovicianus*	E - Non-breeding	BCC
Horned Lark	*Eremophila alpestris*	T - Breeding, SC - Non-breeding	-
Eastern Whip-poor-will	*Antrostomus vociferus*	SC - Breeding	BCC
Common Nighthawk	*Chordeiles minor*	SC - Breeding + Non-breeding	-
Black Skimmer	*Rynchops niger*	E - Breeding + Non-breeding	BCC
Common Tern	*Sterna hirundo*	SC - Breeding	-
Gull-billed Tern	*Gelochelidon nilotica*	SC - Breeding + Non-breeding	BCC
Least Tern	*Sterna antillarum*	E - Breeding + Non-breeding	BCC
Roseate Tern	*Sterna dougallii*	E - Breeding + Non-breeding	E
Caspian Tern	*Hydroprogne caspia*	SC - Breeding	-
Red-throated Loon	*Gavia stellate*	-	BCC - Non-breeding

Source: NJDEP 2012 and USFWS IPaC database (USFWS 2018b).

* E = Endangered, T = Threatened, SC = Special Concern, BCC = Birds of Conservation Concern

7:7-9.37 Critical Wildlife Habitats.

State Jurisdiction

Critical wildlife habitats are specific areas known to serve an essential role in maintaining wildlife, particularly wintering, breeding, and migrating. Portions of the Project fall within State-priority Important Bird Areas (IBAs) and continental-priority IBAs, which are areas that provide essential habitats for sustaining bird populations; however, the Project is not expected to impact the habitat as impacts will be limited to previously disturbed areas such as pavement and roadway rights-of-way (ROW), to the extent practicable. In addition, Ocean Wind will coordinate with the USFWS and the NJDEP during the permitting phase of the Project to identify critical wildlife habitats, including known nesting habitats of migratory birds. Appropriate mitigation measures will be

taken to avoid impacts and Ocean Wind will work with the NJDEP to implement appropriate seasonal work restriction windows and identify noise ordinance requirements. Therefore, the Project is consistent with this policy.

7:7-9.38 Public Open Space.

State Jurisdiction

This policy encourages the development of new public open spaces and discourages development that might adversely affect existing public open space. Project impacts to resources will be avoided to the maximum extent possible through siting to avoid sensitive areas, trenchless technology options or other BMPs. Ocean Wind will coordinate with the State for approvals for the use of State lands and construction will be scheduled outside of the high tourism season.

Ocean Wind sited the Project facilities for BL England, selected installation techniques, and developed a schedule to reduce conflicts with open space. In portions of the Project along the BL England landfall and Peck Bay crossing that cross Green Acres encumbered parcels, HDD installation is proposed to minimize impacts to these parcels, recreational facilities (boat ramp and floating dock at Peck Bay), and use. In addition, HDD construction under the Green Acres encumbered parcels at the beach will take place outside of the summer season when use is reduced. Ocean Wind will obtain the appropriate approvals prior to construction.

Within IBSP, Ocean Wind sited the cable, selected installation techniques and developed the Project schedule to reduce conflicts with open space. The export cable will remain buried, and the cable route and any operation and maintenance points (such as a manhole) have been sited in previously disturbed areas to the extent practicable. Landfall from the Atlantic Ocean will be made using HDD from IBSP Swimming Area #2 Auxiliary parking lot (closed seasonally October through June) to minimize impacts to the beach and dunes. Should trenchless technologies not be feasible, construction will be conducted to remain consistent with the character and purpose of IBSP. The cable route in IBSP is sited within existing paved parking lots and a disturbed maintenance area to minimize impacts on the public open space to the extent practicable. In addition, construction will take place outside of the summer season when use is reduced.

Therefore, this Project is consistent with this policy.

7:7-9.39 Special Hazard Areas.

Federal and State Jurisdiction

This policy discourages development in special hazard areas. The substation and portions of the onshore export cable are within areas of known contamination. The Project linear portions will be enrolled under the NJDEP Site Remediation Program (SRP) as a linear construction project (LCP) and handled in accordance with all applicable regulations. the Project substations will manage any contamination encountered during Project construction in accordance the NJDEP SRP guidance as well as with the Materials Management Plan (MMP) and Materials Handling Plan (MHP), which will be developed prior to construction. The Project will not include residential and labor-intensive economic development within the special hazard area and all development will include appropriate mitigating measures to protect public health and safety. Therefore, the Project is consistent with this policy.

7:7-9.40 Excluded Federal Lands.

Excluded Federal lands are those lands, the use of which is, by law, subject solely to the discretion of or held in trust by the Federal Government, its officers or agents. Federal lands are beyond the jurisdiction of the New Jersey Coastal Zone in accordance with Section 304 of the CZMA. New Jersey has the authority to review

activities on Federal lands, if there may be spillover impacts on New Jersey's Coastal Zone. The Project Area contains no excluded Federal lands and Federal actions on excluded lands will not occur. Therefore, this policy is not applicable.

7:7-9.41 Special Urban Areas.

State Jurisdiction

This policy seeks to encourage waterfront development that would benefit certain municipalities that receive State aid. The Project may occur in special urban areas; however, development will not adversely affect the economic wellbeing of these areas. Secondary impacts of the Project may include an increase in employment opportunities in the Project Area and a temporary stimulating effect on the local economy due to increased demand for goods and services. Furthermore, development of the Project is in the national interest for clean, renewable energy and in compliance with the offshore wind-generated electricity goal set by the State of New Jersey's Executive Order No. 92 (2019). Therefore, the Project is consistent with this policy.

7:7-9.42 Pinelands National Reserve and Pinelands Protection Area.

State Jurisdiction

This policy allows the Pinelands Commission to serve as the reviewing agency for actions within the Pinelands National Reserve. Cables and infrastructure would be located within the Pinelands National Reserve. The onshore export cable corridor passes through Pinelands Management Areas (PMA) including Forest Areas, Rural Development Areas and Regional Growth Areas.

While portions of the BL England Project Area cross a Forest Area PMA, it is at the Garden State Parkway Crossing in Upper Township which is within the Garden State Parkway Overlay. The Garden State Parkway Overlay and Regional Growth Area allow for the development of public service infrastructure. In addition, portions of the Oyster Creek Project Area at IBSP are within a Forest Area PMA and portions within Barnegat Bay are within a Forest Area Water PMA. The landfall and a portion of the onshore cable route at the Holtec Property are within a Forest Area PMA and the remaining export cable route and substation are within a Rural Development Area. The cables are considered public service infrastructure, which is allowed in Rural Development Area PMAs. Based on the letter from the Pinelands Commission in December 2021, the proposed cables are not inconsistent with the Forest Area PMA. The Pinelands Commission notes that within the Pineland Forest Management Area, "…the proposed development does not raise an issue that rises to a level that it causes the proposed development to be inconsistent with the intent, policies and objectives of the National Parks and Recreation Act of 1978 creating the Pinelands National Reserve and the Pinelands Protection Act of 1978."

Ocean Wind will adhere to the land use standards, guidelines, and regulations of the Pinelands Comprehensive Management Plan and will coordinate with the Pinelands Commission on coastal construction permit applications. The appropriate State permit will be acquired if discharge of dredged or fill materials occurs in freshwater wetlands and/or State open waters per Section 404 of the Federal Water Pollution Control Act of 1972, as amended by the Clean Water Act of 1977, or under an individual or Statewide general permit per 33 USC 1344 and N.J.S.A. 13:9(B)-6(b).

Therefore, the Project is consistent with this policy

7:7-9.43 Meadowlands District.

This policy allows the New Jersey Meadowlands Commission to serve as the reviewing agency for actions within the Hackensack Meadowlands District. The Project is not located within the Hackensack Meadowlands

District. Therefore, this policy is not applicable.

7:7-9.44 Wild and Scenic River Corridors.

State Jurisdiction

This policy recognizes the outstanding value of certain rivers in New Jersey by restricting development to compatible uses.

A portion of the Project, the BL England onshore study area, is located upland and adjacent to the Great Egg Harbor River Wild and Scenic River Federal Boundary designated by the National Parks Service (**Figure 3**). However, the Project does not encroach into the Wild and Scenic River corridor and would avoid impacts that would adversely affect the resources for which the Great Egg Harbor River was designated into the national system through the implementation of BMPs and APMs, such as locating export cable corridors and landfall within existing rights-of-way or previously disturbed/developed lands to the extent practicable. Further, development of the Project would comply with the standards set forth in the Great Egg Harbor River Comprehensive Management Plan adopted pursuant to the National Wild and Scenic Rivers Act for the wild and scenic river corridor. Ocean Wind will coordinate with the National Park Service, the Federal river-administrating agency for Great Egg Harbor River during the permitting process as required. Therefore, this Project is consistent with this policy.

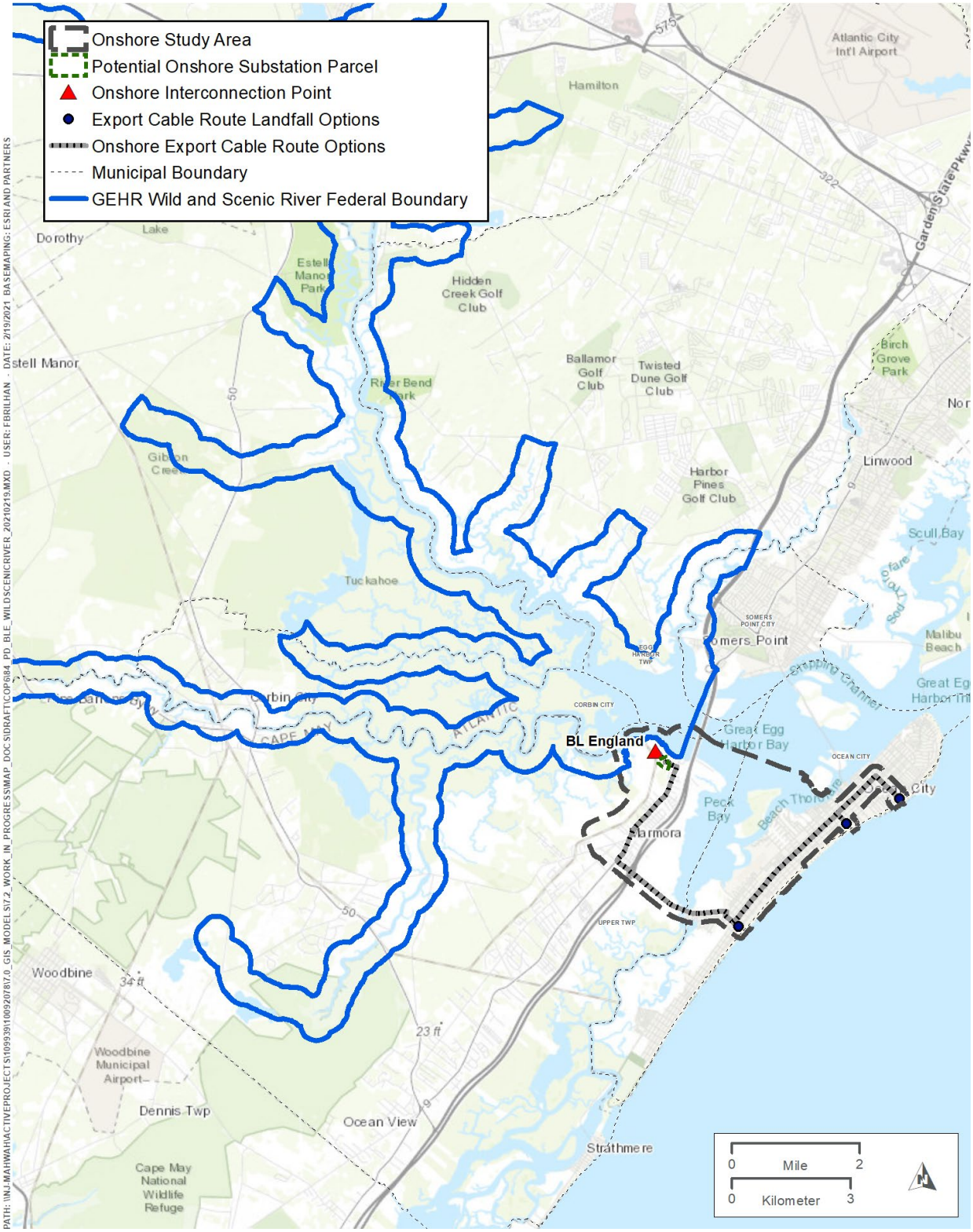


Figure 3 – Great Egg Harbor River Wild and Scenic River Federal Boundary.

7:7-9.45 Geodetic Control Reference Marks.

State Jurisdiction

This policy discourages disturbance of geodetic control reference marks. The Project may encounter geodetic control reference marks in the export cable corridor from landfall to the onshore substation; however, it is unlikely these geodetic control reference marks will be impacted. If any geodetic control reference mark must be moved, raised or lowered to accommodate construction, the New Jersey Geodetic Control Survey will be contacted at least 60 days prior to disturbance and arrangements will be made to protect the position. If impacts occur, the geodetic control reference marks will be restored to pre-construction conditions and re-surveyed by a New Jersey-licensed surveyor. Therefore, this Project is consistent with this policy.

7:7-9.46 Hudson River Waterfront Area.

This policy sets forth non-industrial and industrial development standards for public access and open space along the Hudson River Waterfront Area and requires development, maintenance, and management of a section of the Hudson Waterfront Walkway coincident with the shoreline of the property development. The Project is not located on the Hudson River waterfront. Therefore, this policy is not applicable.

7:7-9.47 Atlantic City.

State Jurisdiction

This policy sets standards for development in the City of Atlantic City. The Project Area is not located within the municipal boundary of Atlantic City and, therefore, this policy is not applicable. Moreover, because this Project does not concern the development of casinos, commercial piers, residential housing, boardwalks, or street-rights of way, this policy is not applicable.

7:7-9.48 Lands and Waters Subject to Public Trust Rights.

State Jurisdiction

Lands and waters subject to public trust rights are tidal waterways and their shores, lands now or formerly below the MHW line, and shores above the MHW line. Public trust rights include public access, which is the ability of the public to pass physically and visually to, from and along the ocean shore and other waterfronts subject to public trust rights, and to use these lands and waters. There is existing public access to the water and the shoreline of the Project Area in the vicinity of the export cable landfalls and onshore export cable corridors; however, the Project will not impact the public's rights of access to or use of natural resources in the Project Area. The Project Area is part of a working waterfront; therefore, development will be in accordance with N.J.A.C. 7:7-16.9. Public access during construction activities could pose the potential for both security threats and hazard conditions for members of the public and workers at the site; however, all existing public access to and along the waterfront will be maintained to the maximum extent practicable, including barrier free access to tidal waterways and their shores where feasible and warranted by the character of the site.

Public Access Bill 1074 (the Bill) was introduced on May 3, 2019 and went into effect on July 1, 2019. According to the Bill, for any permit or other approval to be issued by the NJDEP pursuant to the CAFRA, Wetlands Act of 1970s, Flood Hazard Control Act or Coastal Zone Management Act, or any application that provides for a change in the existing footprint of a structure, a change in use of the property, or involves beach replenishment or beach and dune maintenance, shall be reviewed by NJDEP for "existing public access provided to tidal waters and adjacent shorelines at the property and shall require as a condition of the permit or other approval that additional public access to the tidal waters and adjacent shorelines consistent with the

public trust doctrine be provided". The Project will be in compliance with this policy and any restrictions to public access to the beach will only be temporary during Project construction.

The Bill also states that if the regulated activity being proposed is on a marina property, NJDEP shall require that the existing degree of public access to the waterfront and adjacent shoreline be maintained. If the regulated activity affects or diminishes public access on the marina property, the NJDEP shall require equivalent access as a condition of the permit or other approval. Equivalent public access includes access that allows the opportunity to participate in the same activities in the same manner, by the same number of people as the existing public access. The Project is in compliance with this policy as access to the marina at the Roosevelt Boulevard Bridge crossing will not be impacted during Project construction and access to the marina will not be impeded.

Therefore, the Project is consistent with this rule.

2.2 Subchapter 10 – Standards for beach and dune activities

State Jurisdiction

These standards apply to routine beach maintenance, emergency post-storm beach restoration, dune creation and maintenance, and construction of boardwalks. The NJDEP Division of Coastal Engineering is responsible for administering beach nourishment and shore protection projects throughout the State. The NJDOT Office of Maritime Resources (OMR) is responsible for coastal dredging projects throughout the State, The Project would use trenchless technology methods HDD to the extent practicable to avoid and minimize impacts to beaches. Ocean Wind would coordinate with NJDEP's coastal engineering group and USACE to avoid impacts to beach maintenance activities or post-storm beach restoration efforts. If the Project requires creation of a boardwalk at IBSP for public access, the standards for construction of boardwalks along tidal shorelines will be completed in accordance with N.J.A.C. 7:7-10.5. Construction of a boardwalk will be coordinated with NJDEP's coastal engineering group and USACE. Therefore, the Project is consistent with these standards.

2.3 Subchapter 11 – Standards for conducting and reporting the results of an endangered or threatened wildlife or plant species habitat impact assessment and/or endangered or threatened wildlife species habitat evaluation

Federal and State Jurisdiction

This section details the performance and reporting standards for impact assessments and habitat evaluations for endangered and threatened wildlife species. The Project may occur on or adjacent to endangered or threatened wildlife or plant species habitat. Ocean Wind has coordinated with the NJDEP and USFWS and conduced onshore habitat assessments to determine whether appropriate habitat for threatened and endangered species is present Project habitat evaluations for each wildlife species identified as endangered or threatened will use scientific methodology appropriate for each species/group, will examine specific attributes that may limit or eliminate its suitability as habitat (i.e., vegetative analysis), and will include an assessment of the area surrounding the site with photographs and/or cover maps. Habitat assessments have been completed for bog turtle, Knieskern's beaked rush and swamp pink. All habitat impact assessments and evaluations conducted for the Project will comply with the standard reporting requirements of N.J.A.C. 7:7-11.4. In addition, Ocean Wind will implement offshore and nearshore marine waters monitoring by approved PSO to prevent adverse impacts to marine mammals, sea turtles and sturgeon. Therefore, the Project is consistent with these standards.

2.4 Subchapter 12 – General water areas

This section categorizes the important uses of general water areas and sets conditions or standards of acceptability for certain uses within general water areas. Only those standards applicable to the Project Area are listed.

7:7-12.2 Shellfish Aquaculture

State Jurisdiction

This policy encourages shellfish aquaculture as a means of food production that can be at least as efficient as land-based agriculture provided that it does not unreasonably affect the coastal recreational economy, the coastal ecosystem, or navigation. The study area includes an aquaculture lease area on the west side of Barnegat Bay near a potential Ocean Township landfall; however, the Project would not cause long-term impacts the aquaculture lease areas. Therefore, the Project is consistent with this policy. The Project's inshore cable route in Barnegat Bay has been sited away from lease areas where possible to avoid impacts to shellfish in areas identified as hardclam high and moderate density under the two most recent datasets published by the NJDEP to the extent practicable (1986 and 2012). The landfall at Oyster Creek will be located to avoid impacts to existing aquaculture lease sites to the extent practicable, however the aquaculture lease near the marina landfall may be impacted by cable installation and anchor lines for installation vessels. Any impacts to the aquaculture lease area would be temporary and mitigation to the leaseholder will be coordinated with the NJDEP Bureau of Shellfisheries. At BL England, the offshore cable route makes landfall within the street in Ocean City using HDD technology and remains within onshore areas to the substation, avoiding any shellfish aquaculture or lease areas. Therefore, the Project is consistent with this policy.

7:7-12.3 Boat Ramps

This policy permits private and public use boat ramps if they are constructed in an environmentally sensitive manner. The Project will not require construction of private or public use boat ramps. Therefore, this policy is not applicable.

7:7-12.4 Docks and Piers for Cargo and Commercial Fisheries

Docks and piers for cargo and passenger movement and commercial fisheries are structures supported on pilings driven into the bottom substrate or floating on the water surface, used for loading and unloading passengers or cargo, including fluids, connected to or associated with, a single industrial or manufacturing facility or to commercial fishing facilities. This policy permits the construction of docks and piers for cargo and passenger movement and commercial fisheries if they will not interfere with navigation and are associated with the aforementioned facilities. No docks and piers for cargo and commercial fisheries are proposed as part of this Project. Therefore, this policy is not applicable.

7:7-12.5 Recreational Docks and Piers

This policy generally permits the construction of recreational docks and piers, including jet ski ramps, and mooring piles. No recreational docks and piers are proposed as part of this Project. Therefore, this policy is not applicable.

7:7-12.6 Maintenance Dredging

This policy sets the rules for maintenance dredging.

Maintenance dredging is the periodic removal of accumulated sediment from previously legally dredged navigation and access channels, marinas, lagoons, canals, or boat moorings for the purpose of safe navigation.

For a project to be considered maintenance dredging, the applicant shall demonstrate through historical data, including, but not limited to, previously issued dredging permits, previous dredging contracts, historic bathymetric surveys, and/or aerial photography that:

1. The proposed dredge area is limited to the same length and width as a previous dredging operation;
2. The proposed water depth is the same as a previous dredging operation or as historical water depths within the proposed dredge area; and
3. The proposed dredge area has historically been used for navigation or mooring of vessels requiring the proposed water depth

For BL England, Ocean Wind is not proposing any maintenance dredging as part of the Project. For Oyster Creek, Ocean Wind is proposing dredging within a prior channel west of IBSP in Barnegat Bay. The Oyster Creek Federal Channel is a USACE civil works project regulated by 33 USC 408 (Section 408). Historic aerials show that the channel was dredged sometime between 1956 and 1963. It is first visible in the 1963 photo and measures approximately 4,900 ft long and about 125-130+/- ft wide in that aerial. The historic navigation chart from 1975 depicts the channel with a depth of 7ft with a note on the chart that the channel was marked by privately maintained seasonal buoys or markers indicating it was used for navigational purposes in the past. The proposed work area for the export cables follows the historic channel feature visible in recent satellite photos. In coordination with the USACE, the proposed potential dredge area is about 4,800 ft long and 125 ft wide at the base of the prism and has a proposed depth of 7ft MLLW (ends at the 7ft MLLW contour). Given that the proposed work area falls within the horizontal and vertical extents of the existing channel based on historic aerials and 1975 navigational chart, that the channel was previously used for navigation, the proposed potential dredging is consistent with this policy.

Dredged material will be disposed of in accordance with a dredged material disposal plan. Dredged material placement will comply with N.J.A.C. 7:7-12.9 and N.J.A.C. 7:7-15.12.

Therefore, the Project is consistent with this policy.

7:7-12.7 New Dredging

Federal and State Jurisdiction

New dredging is the removal of sediment that does not meet the definition of maintenance dredging at N.J.A.C. 7:7-12.6 or the definition of environmental dredging at N.J.A.C. 7:7-12.8. It also includes the temporary or permanent displacement or removal of sediment for the purpose of installing submerged pipelines and cables. As noted under policy N.J.A.C. 7:7-9.2 Shellfish Habitat, the electric transmission cable burial conducted as part of the Project would not be considered new dredging it will be performed with methods that do not remove or displace sediment as the cable to be buried is electric transmission cable, not submerged cable (which the CZM Rules define as telecommunications cable, see N.J.A.C. 7:7-12.21). Nonetheless, for areas that may require mechanical dredging, the Project will be consistent with N.J.A.C. 7:7-12.7 New Dredging, the general water area rules, and the energy facility use rule (N.J.A.C. 7:7-15.4). The dredged area will cause no significant disturbance to special water or water's edge areas and adverse environmental impacts will be minimized to the maximum extent practical. Should any part of this Project require dredging, dredged material placement will comply with N.J.A.C. 7:7-12.9 and N.J.A.C. 7:7-15.12. Therefore, the Project is consistent with this policy.

7:7-12.8 Environmental Dredging

This policy sets the rules for environmental dredging. Environmental dredging means new dredging performed in a special hazard area designated as such pursuant to N.J.A.C. 7:7-9.29 specifically to remove contaminated sediments for the purpose of remediating to an environmental standard as specified in the Department's

Technical Requirements for Site Remediation (N.J.A.C. 7:26E). Cable installation will not require environmental dredging. Therefore, this policy is not applicable.

7:7-12.9 Dredged Material Disposal

Federal and State Jurisdiction

These rules set standards for disposal and beneficial use of dredged materials. While dredging is unlikely to occur as part of cable installation within the Project Area in areas where cables are buried via jetting technology, some dredging will be required at HDD exit pits below MLLW and in select areas in Barnegat Bay. The dredged material disposal in the Project Area will be in conformance with the U.S. Environmental Protection Agency (USEPA) Guidelines, USACE Guidelines, N.J.A.C. 7:7 Appendix G for the Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters, and applicable State Surface Water Quality Standards at N.J.A.C. 7:9B. The Sediment Sampling and Analysis Plan (SSAP) has been approved by NJDEP; however, the sampling has not occurred yet. The disposal facility will be determined based on sampling results and written consent will be provided to NJDEP once acquired from the facility to document the acceptance of the material. Therefore, the Project is consistent with this policy.

7:7-12.10 Solid Waste or Sludge Dumping

The dumping of solid waste or sludge is the discharge of solid or semi-solid waste material from industrial or domestic sources or sewage treatment operations into a water area. No solid waste or sludge dumping is proposed as part of this Project. Therefore, this policy is not applicable.

7:7-12.11 Filling

Federal and State Jurisdiction

Filling is defined at N.J.A.C. 7:7-12.11(a) as "the deposition of material including, but not limited to, sand, soil, earth, and dredged material, into water areas for the purpose of raising water bottom elevations to create land areas." The turbine foundations and scour protection within the Wind Farm Area will constitute filling as defined under this rule. However, this Project meets the definition of a water dependent activity, provides a critical function that cannot be satisfied by existing facilities, limits the fill within tidal waters to the minimal necessary, and minimizes interference with special areas defined at N.J.A.C. 7:7-9. Floating structures are not feasible for the design of this Project. The export cable will be buried at target burial depths that would prevent exposure or pose a hazard risk, to the extent practicable. Where target cable burial depths are not achieved, additional armoring or other cable protection methods may be used to prevent exposure and minimize hazard risk. The filling associated with the Project would not be deposited with the intent of raising water bottom elevations to create land areas, nor would it be deposited in lakes, ponds, reservoirs, and open bays at greater than 18 feet as defined at N.J.A.C. 7:7-12.1, or in man-made lagoons. Filling would be placed in the minimum practicable area, would minimize adverse environmental impacts, and would have minimal feasible interference to special use areas, as defined at N.J.A.C. 7:7-9. Mitigation, in accordance with N.J.A.C. 7:7-17, may be necessary and will be reviewed and approved by the appropriate agencies. Therefore, the Project is consistent with this policy.

7:7-12.12 Mooring

Federal and State Jurisdiction

A boat mooring is a temporary or permanently fixed or floating anchored facility in a water body for the purpose of attaching a boat. Under this rule, moorings are conditionally acceptable in all General Water Areas. Vessels would be temporarily moored for construction of the Project. Within the Project Area, impacts to special hazard

areas would be minimized and moorings would not present a hazard to navigation. Therefore, the Project is consistent with this policy.

7:7-12.13 Sand and Gravel Mining

This policy generally restricts sand and gravel mining, which is the removal of sand or gravel from the water bottom substrate, usually by suction dredge, for the purpose of using the sand and gravel at another location. No sand or gravel mining is proposed for this Project. Therefore, this policy is not applicable.

7:7-12.14 Bridges

A bridge is any continuous structure spanning a water body, except for an overhead transmission line. This policy generally permits bridges crossing over bays, rivers, streams, and other water areas because they are often necessary to provide continuity in the transportation system and link isolated land areas between barrier islands. No bridges are proposed as part of the Project. Therefore, this policy is not applicable.

7:7-12.15 Submerged Pipelines

Submerged pipelines are underwater pipelines that transmit liquids or gas, including crude oil, natural gas, water petroleum products, or sewerage. As defined by N.J.A.C. 7:7-12.15, the Project will not include submerged pipelines. Therefore, this policy is not applicable.

7:7-12.16 Overhead Transmission Lines

State Jurisdiction

This policy regulates overhead transmission lines, which are wires hung between supporting pylons for transmission from the site of origin to the site of consumption. Overhead transmission lines include electrical, telecommunication, and cable television lines. Overhead lines are prohibited over open bays, semi-enclosed and back bays, lakes, ponds, and reservoirs. Overhead transmission lines are also discouraged over large rivers. Large rivers are defined by N.J.A.C. 7:7-12.1 as waterways with watersheds greater than 1,000 square miles and are limited to the Delaware, Hudson and Raritan Rivers. No overhead transmission lines will cross open bays, semi-enclosed or back bays (such as Barnegat Bay), lakes, ponds, reservoirs or large rivers as part of the Project. Any potential overhead transmission lines planned as part of this Project will be developed to be consistent with all federal, state, and local regulations. Therefore, the Project is consistent with this policy.

7:7-12.17 Dams and Impoundments

Dams and impoundments (i.e., dikes with sluice gates and other structures to control the flow of water) are structures that obstruct natural water flow patterns for the purpose of forming a contained volume of water. The Project will not include the construction of dams and impoundments. Therefore, this policy is not applicable.

7:7-12.18 Outfalls and Intakes

State Jurisdiction

As defined at N.J.A.C. 7:7-12.8, outfalls and intakes are pipe openings that are located in water areas for the purpose of intake of water or discharge of effluent including sewage, stormwater and industrial effluent. Outfalls or intakes may be applicable to the Project as part of onshore substation construction. Any outfalls would be installed and operated in accordance with applicable state permits. Adequate measures would be taken to encourage filtration and minimize discharge of pollutants into a water body. Therefore, the Project is consistent with this policy.

7:7-12.19 Realignment of Water Areas

Realignment of water areas means the physical alteration or relocation of the surface configuration of any water area. The Project will not result in the realignment of water areas. Therefore, this policy is not applicable.

7:7-12.20 Vertical Wake or Wave Attenuation Structures

This policy generally permits the construction of vertical wake or wave attenuation structures to protect boat moorings, including those at marinas. These structures may be fixed or floating, attached or detached, depending on the water depth, tidal range, and wave climate. Construction of a vertical wake or wave attenuation structure is proposed as part of this Project on the western shoreline of Island Beach State Park. The structure will serve to attenuate wave velocity, protecting the western shoreline of IBSP from erosion following construction at the site of the prior channel, where the export cables enter Barnegat Bay from IBSP. The structure will protect the shoreline and allow natural revegetation along the bank to stabilize the berm. The structure will also serve as a living shoreline and be consistent with N.J.A.C. 12:23. Therefore, the Project is consistent with this policy.

7:7-12.21 Submerged Cables

Federal and State Jurisdiction

This policy governs the installation and long-term maintenance of telecommunications cables, taking into account existing utilities, fishing stakeholders and practices, and burial technology, in order to minimize the conflict between the existing cables and fishing industries. The NJDEP requires submerged cables to meet specific conditions when not located within the Atlantic Ocean (inshore waters) and different conditions when located within the Atlantic Ocean.

Pursuant to N.J.A.C. 7:7-12.21, submerged cables are defined as “underwater telecommunication cables, and shall include all associated structures in the water such as repeaters.” However, the Project will include submerged electric transmission export cables, which are not considered “submerged cables” under the CZM Rules. Therefore, this policy is not applicable.

7:7-12.22 Artificial Reefs

Artificial reefs are man-made structures intended to stimulate the characteristics and functions of natural reefs. This policy generally permits the construction of new or expanded artificial reefs provided that at the time of deployment, and at all times after creation, all conditions of N.J.A.C. 7:7-12.22 are met. Under this rule, artificial reefs do not include shore protection structures, pipelines, fish aggregating devices, and other structures not constructed for the sole purpose of fish habitat. While the wind turbine foundations will act as artificial reefs, their sole purpose is not fish habitat. Therefore, this policy is not applicable.

7:7-12.23 Living Shorelines

Living shorelines address the loss of vegetated shorelines and habitat in littoral zones by providing protection, restoration, or enhancement of these habitats. A living shoreline will be established at the Island Beach State Park export cable landing as part of this Project. The living shoreline will be installed to restore the function of the existing wetlands, thereby protecting the shoreline from erosion. It will be built to be consistent with the requirements of the Wetlands Act of 1970, the Waterfront Development Act and CAFRA rules. Therefore, this policy is not applicable.

7:7-12.24 Miscellaneous Uses

This policy analyzes water dependent uses of water areas not identified in the use rules of N.J.A.C. 7:7-12 or addressed in the use rules of N.J.A.C. 7:7-15 on a case-by-case basis to ensure that adverse impacts are minimized. This policy also discourages non-water dependent uses in all water areas. The Project does not propose uses that are not water dependent in general water areas. Further, the Project's water dependent uses in water areas are in compliance with the use rules defined in N.J.A.C. 7:7-12 and N.J.A.C. 7:7-15. Therefore, this policy is not applicable; nonetheless, based upon the analysis and minimization of impacts, the Project would comply with this policy.

2.5 Subchapter 13 – Requirements for impervious cover and vegetative cover for general land areas and certain special areas

This section defines general land areas (including coastal zones) and sets forth the requirements for impervious cover and vegetative cover, particularly forested cover, on sites in upland development areas. This section does not apply to a linear development that is not wholly within or solely serving a development, nor does it apply to electrical substations. Furthermore, development of the Project is in the national interest for clean, renewable energy and would serve a public need. Therefore, the policies found within this subchapter are not applicable.

2.6 Subchapter 14 – General location rules

Federal and State Jurisdiction

The section defines rules on location of linear development, as well as setting criteria for the basic location rule and secondary impacts.

7:7-14.1 Rule on Location of Linear Development.

The rule on location of linear development states that a linear development shall comply with the specific location rules to determine the most acceptable route, to the maximum extent practicable. The electric transmission cable installation and alignment complies with the CZM location rules for determining the most acceptable route. The onshore portions of the Project have been sited within existing access roads and previously disturbed habitat to the extent possible to avoid and minimize impacts to sensitive resources; mitigation may be required where impacts cannot be avoided. Appropriate measures will be used to mitigate environmental impacts (Volume II Table 1.1-2). There will be no permanent or long-term loss of unique or irreplaceable areas. Mitigation will be carried out in coordination with the regulations and with cooperating agencies to offset any permanent impacts to regulated resources. Therefore, the Project is in compliance with this policy.

7:7-14.2 Basic Location Rule.

The basic location rule is intended to ensure development promotes public health, safety, and welfare; protects public and private property, wildlife, and marine fisheries; and preserves, protects, and enhances the natural environment. As previously discussed, the Project has been sited within existing access roads and previously disturbed habitat wherever possible to protect public and private property, wildlife, and marine fisheries. Where impacts cannot be avoided, appropriate measures will be used to mitigate environmental impacts (Volume II Table 1.1-2). Therefore, the Project is in compliance with this policy.

7:7-14.3 Secondary Impacts.

Secondary impacts are the effects of additional development likely to be constructed as a result of the approval of a particular proposal. Secondary impacts resulting from implementation of the Project include, but are not limited to, impacts to traffic along some roads and highways; impacts to terrestrial habitat that could potentially result in reduced foraging and breeding habitat and potential individual mortality for some species; temporary displacement of benthic species due to habitat change and increased turbidity, and indirect mortality; and indirect noise and vibration. These impacts will be minor and short-term. Avoidance and mitigation measures will be implemented to minimize impacts wherever possible. Additional secondary impacts include a temporary, minor increase in employment opportunities in the Project Area and a temporary stimulating effect on the local economy due to increased demand for goods and services. Therefore, the Project is consistent with this subchapter and complies with its policies.

2.7 Subchapter 15 – Use rules

7:7-15.2 Housing.

These rules set standards for housing construction in the coastal area. The Project does not involve housing construction. Therefore, this policy is not applicable.

7:7-15.3 Resort/Recreational.

Resort/recreation uses include the wide range of small and large developments attracted to and often dependent upon locations along the coast. These include hotels, motels, marinas, boating facilities, campgrounds, amusement piers, parks and recreational structures such as boathouses, natural areas, open space for active and passive recreation, and linear paths for bicycling and jogging. This policy sets standards for resort and recreational uses in the coastal area. No resort or recreation uses are proposed as part of this Project. Therefore, this policy is not applicable.

7:7-15.4 Energy Facility.

Federal and State Jurisdiction

These rules set standards for energy facility development in the coastal area. Energy facilities include facilities, plants or operations for the production, conversion, exploration, development, distribution, extraction, processing, or storage of energy or fossil fuels. Energy facilities also include onshore support bases and marine terminals. The Project is a water dependent offshore renewable energy generation facility. The Project will require the construction of an onshore substation near each interconnection point with the existing grid to allow for distribution of the power. The Oyster Creek substation uses a parcel that has been previously developed, maintained, and disturbed in association with the Oyster Creek Nuclear Generating Station and the BL England substation uses a parcel that has been previously developed, maintained, and disturbed in association with the BL England Generating Station to minimize potential impacts. Use of these sites also reduces the need for upgrades to the existing grid to accommodate the power, reducing secondary impacts. The proposed installation technologies minimize potential for restrictions on access to lands and waters under public trust. Ocean Wind will comply with N.J.A.C. 7:7-15.4(r)1viii, where these policies dictate designs, surveys, and time restrictions on wind turbine operation required to minimize adverse effects on birds, bats, and marine organisms. Therefore, the Project is consistent with this policy.

7:7-15.5 Transportation.

State Jurisdiction

These rules set standards for road construction and the development of public transport facilities, bicycle and footpaths, and parking facilities in the waterfront or coastal area. No public transportation facilities, bicycle or foot paths are proposed; however, the Project will require construction of permanent access roads at each substation (and depending on route selected, potentially at transition joint bays) for construction, operation, and maintenance, and decommissioning activities. The new road construction will comply with the rule on the location of linear development (N.J.A.C. 7:7-14.1). The Project will also require onshore cable burial within existing public roadway rights-of-way. Following installation, these roadways will be backfilled and restored to pre-existing conditions and there will be no permanent impacts to transportation. Therefore, the Project is consistent with this policy.

7:7-15.6 Public Facility.

These rules set standards for public facilities (e.g., solid waste facilities, public utilities) in the coastal area. The Project does not involve construction of a public facility. Therefore, this policy is not applicable.

7:7-15.7 Industry.

Federal and State Jurisdiction

These rules set standards for industrial uses in the coastal area. The Project would require the construction of electric generating facilities offshore on the OCS and transmission facilities from the OCS to the onshore interconnection to the electric grid. These facilities would comply with all applicable location and resource rules, including N.J.A.C. 7:7-9.16 and 9.30, which reserve the water's edge for water dependent uses; N.J.A.C. 7:7-16.11, which requires that the use be compatible with existing uses in the area or adequate buffering be provided; N.J.A.C. 7:7-9.48, the lands and waters subject to public trust rights rule; and the public access rule, N.J.A.C. 7:7-16.9. Furthermore, the onshore substation facilities will be located at or adjacent to existing utility or industrial sites. Therefore, the Project is consistent with this policy.

7:7-15.8 Mining.

These rules set standards for mining in the coastal area. The Project does not involve mining operations. Therefore, this policy is not applicable.

7:7-15.9 Port.

These rules set standards for port uses and port-related development in the coastal area. The standards are designed to ensure that port facilities retain their economic vitality. The Project will involve temporary construction laydown areas and construction ports in New Jersey and elsewhere. The Project's use would benefit, and activities would be consistent with port operations. Therefore, the Project is consistent with this policy this policy.

7:7-15.10 Commercial Facility.

These rules set standards for commercial facilities (e.g., hotels, casinos, retail trade, convention centers) in the coastal area. The Project does not involve construction of such facilities. Therefore, this policy is not applicable.

7:7-15.11 Coastal Engineering.

These rules set standards for the protection of shorelines, the maintenance of dunes, and provides for beach nourishment. The NJDEP Division of Coastal Engineering is responsible for administering beach nourishment, shore protection and coastal dredging projects throughout the State. Ocean Wind will coordinate with NJDEP's

Coastal Engineering group to avoid impacts to State-administered beach nourishment, shore protection structures, coastal dredging, aids to navigation, and bayshore floodgate facilities. Shoreline protection proposed at IBSP adjacent to the maintenance area in the prior channel will be designed to be consistent with the Division of Coastal Engineering requirements. The Project will avoid wet borrow pits. The Project does not include dry borrow pits nor does Ocean Wind propose to use or fill dry borrow pits. Therefore, this policy is not applicable.

7:7-15.12 Dredged Material Placement on Land.

These rules set standards for disposal and beneficial use of dredged materials. Dredging may occur as part of cable installation within parts of the Project Area where cable burial via jetting technology is not feasible. Disposal of dredged material on land will be in compliance with State and Federal regulations. The material will be excavated, stockpiled, dewatered and transported to an approved facility. Therefore, the Project is consistent with this policy.

7:7-15.13 National Defense Facilities.

These rules set standards for location of defense facilities in the coastal zone. The Project will not include the construction of any new defense facilities or the expansion of existing facilities. Therefore, this policy is not applicable.

7:7-15.14 High Rise Structures.

These rules set standards for high-rise structures in the coastal zone. The Project does not include construction of high-rise structures in the coastal zone. Therefore, this policy is not applicable.

2.8 Subchapter 16 – Resource rules

7:7-16.2 Marine Fish and Fisheries.

Federal and State Jurisdiction

This rule sets standards of acceptability to cause minimal interference with the reproductive and migratory patterns of estuarine and marine species of finfish and shellfish, including the catching, taking, or harvesting of marine fish. Construction of submerged cables and pipelines are conditionally acceptable provided that the activity complies with the General Water Area rules at N.J.A.C. 7:7-12. Per Section 2.4 above, the Project will comply with the rules set forth in N.J.A.C. 7:7-12. During construction, there may be short term temporary impacts to water quality and noise, as well as collision risks associated with vessel strikes, but APMs and BMPs will be employed to minimize turbidity and fish will be expected to avoid the area during construction(Volume II Table 1.1-2). Seabed disturbance including suspended sediment/sedimentation and direct mortality of sessile or slow-moving organisms could occur. Additionally, SAV surveys have been completed (COP Appendix E). SAV seasonal work restriction windows and mitigation measures may be implemented upon coordination with the NJDEP and NMFS during permit review. The proposed cable route will avoid and minimize moderate to high density shellfish habitat, as defined in 7:7-9.2, within Barnegat Bay. Mitigation, in accordance with N.J.A.C. 7:7-17.9, may be necessary. In addition, APMs and BMPs will be implemented to reduce turbidity and the Project is sited and designed to avoid, minimize, and mitigate potential impacts (Volume II Table 1.1-2). Therefore, the Project is consistent with this policy.

7:7-16.3 Water Quality.

Federal and State Jurisdiction

This rule sets standards for coastal development to limit effects on water quality. Construction could temporarily increase suspended sediments and turbidity within the water column. Compliance with NJDEP water quality standards will be coordinated with NJDEP Division of Water Quality and Office of Sediment Dredging and Technology through permit conditions. During jetting activities, water quality will be monitoring in accordance with a water quality monitoring plan that will be developed in coordination with State and Federal agencies and consistent with monitoring plans developed for other submarine cable projects. Project construction will be limited in area and temporary in nature, and APMs and BMPs will be used. Therefore, the Project is consistent with this policy.

7:7-16.4 Surface Water Use.

Federal and State Jurisdiction

This rule sets standards for coastal development to limit demands on surface water. The Project will not increase demands on surface water. Therefore, this policy does not apply.

7:7-16.5 Groundwater Use.

This rule sets standards for coastal development so as to limit effects on groundwater supplies. The Project will not use or impact groundwater supplies. The Project's anticipated groundwater withdrawal demand, alone and in conjunction with other groundwater diversions proposed or existing in the region, will not cause salinity intrusions into the groundwaters of the zone, will not degrade groundwater quality, will not significantly lower the water table or piezometric surface, or significantly decrease the base flow of adjacent water sources. Groundwater withdrawals shall not exceed the aquifer's safe yield. All appropriate approvals regarding construction dewatering will be obtained from state and federal agencies as appropriate prior to commencement of construction activities. Therefore, the Project is consistent with this policy.

7:7-16.6 Stormwater Management.

State Jurisdiction

This rule sets standards for coastal development to limit effects of stormwater runoff. The Project does meet the definition of "major development" at N.J.A.C. 7:8-1.2 and will comply with the Stormwater Management rules at N.J.A.C. 7:8. To protect environmentally sensitive water and land areas within the coastal zone, Ocean Wind will comply with the Stormwater Management Rules' standards and obtain all appropriate stormwater approvals from the Department prior to construction. Therefore, the Project is consistent with this policy.

7:7-16.7 Vegetation.

State Jurisdiction

This rule sets standards for coastal development to protect vegetation. The Project will require clearing and grading at the maintenance area at IBSP, at the Holtec Property along the Oyster Creek onshore export cable route, and at both the BL England and Oyster Creek proposed substations, which could result in temporary or permanent impacts to vegetation. Temporarily disturbed areas will be restored to pre-existing contours and vegetation will become reestablished via natural succession or by replanting with native species, to the extent practicable, once construction activities are completed. A replanting plan will be developed in coordination with the NJDEP and consistent with Federal mitigation/restoration requirements and submitted to NJDEP for approval prior to construction. Therefore, the Project is consistent with this policy.

7:7-16.8 Air Quality.

Federal and State Jurisdiction

This rule sets standards for coastal development with requirements that projects meet applicable air quality standards. During construction, operation, maintenance, and decommissioning activities, air quality may be affected. Equipment would be operated in accordance with applicable air quality standards. Ocean Wind is working with the USEPA, which will designate a Corresponding Onshore Area (COA); however, until the designation, the State of New Jersey air regulations will be applied to the Project. The air emissions from the Project will be offset by the Project's displacement of fossil fuel-generated electricity on the regional power grid. The Project will have a long-term positive impact on air quality by replacing generation that results in higher emissions, such as fossil fuels. Therefore, the Project is consistent with this policy.

7:7-16.9 Public Access.

State Jurisdiction

This rule requires that coastal development adjacent to the waterfront provide perpendicular and linear access to the waterfront to the extent practicable, including both visual and physical access. Public access during construction activities could pose the potential for both security threats and hazard conditions for members of the public and workers at the site; however, all existing public access to and along the waterfront will be maintained to the maximum extent practicable. HDD installation is proposed at the landfall locations on the waterfront to minimize impacts to beaches, including access. At IBSP, the HDD workspace will be within the southern auxiliary parking lot of Swimming Area #2 south of the park office. Additional parking lots immediately north of the park office and a portion of the Swimming Area #2 parking lot will remain available for access to the beach. Public access to the waterfront will remain available through other parking lots. In addition, the work at the landfall will be scheduled outside of the summer season when waterfront use is reduced and when Swimming Area #2 parking areas are closed (October 1 through early June), to minimize impacts to the extent practicable. Furthermore, during HDD activities, the beach will remain open for access as there will be no temporary workspace required on the beaches or dunes. The Project will be installed below the beach and dunes and, therefore, will not block views or restrict access after installation.

At BL England, HDD workspace will be within 35th Street and access to that portion of 35th Street will be temporarily restricted, but public access to the waterfront will be available from 34th Street (where a public restroom building is located at the beachfront) or from 36th Street. In addition, the work at the landfall will be scheduled outside of the summer season when waterfront use is reduced to minimize impacts to the extent practicable. Furthermore, during HDD activities, the beach will remain open for access as there will be no temporary workspace required on the beaches or dunes. Therefore, the Project is consistent with this policy.

7:7-16.10 Scenic Resources and Design.

Federal and State Jurisdiction

This rule sets standards for new coastal development to be visually compatible with its surroundings. The Project would involve new coastal development at export cable landing sites and for onshore substations and export cable installation; however, export cables would be located underground where possible to minimize visual impacts. The Project also will use existing rights-of-way and industrial zoned areas, wherever possible. Therefore, the Project will be consistent with this policy.

Additionally, the wind turbines will be located on the offshore OCS and Ocean Wind conducted an assessment of potential visual impacts associated with the Project. The visual impact assessment is provided in Appendix L of the COP. Therefore, the Project will be consistent with this policy.

7:7-16.11 Buffers and Compatibility of Uses.

State Jurisdiction

This rule sets standards for adequate buffers between uses found to be incompatible. There is potential for existing land use within the vicinity of the Project to be impacted. The Project will avoid impacts or changes to land use by utilizing existing rights-of-way and industrial zoned areas, wherever possible. If necessary, Ocean Wind will coordinate with State, Federal, county and municipal agencies or private groups on land use standards, guidelines, and regulations for buffers, including the standards for wetland buffers (N.J.A.C. 7:7-9.28). Therefore, the Project would be consistent with this policy.

7:7-16.12 Traffic.

Federal and State Jurisdiction

This rule sets standards for coastal development so as not to disturb traffic systems. Existing traffic patterns may be temporarily impacted during construction. Cable installation within the roadway will result in temporary traffic impacts; however, an Onshore Maintenance of Traffic Plan would be developed and implemented to minimize vehicular traffic impacts. Additionally, Ocean Wind would designate and utilize construction onshore vehicle traffic routes, construction parking areas, and carpool/bus plans to minimize potential impacts. Ocean Wind will schedule this landfall work outside of the peak summer season. Existing traffic patterns may be temporarily impacted along public roadways between landfall and the substation during construction. Ocean Wind will conduct studies of potential interference of proposed wind turbine generators with commercial air traffic control radar systems, national defense radar systems, and weather radar systems to identify possible solutions. The Project would avoid unreasonable interference with major ports and USCG-designated Traffic Separation Schemes. Traffic disturbance would be limited to specific areas and would be temporary. Therefore, the Project is consistent with this policy.

7:7-16.13 Subsurface Sewage Disposal Systems.

This rule sets standards for subsurface sewage disposal systems in the coastal zone. The Project does not involve sewage disposal. Therefore, this policy is not applicable.

7:7-16.14 Solid and Hazardous Waste.

Federal and State Jurisdiction

This rule defines solid and hazardous waste and sets standards for handling and disposal of such wastes. Ocean Wind will prepare waste management plans and hazardous materials plans as appropriate for the facility and will collect and properly dispose of all construction debris, both from marine and onshore environments. Therefore, the Project would be consistent with this policy.

2.9 Subchapter 17 – Mitigation

State Jurisdiction

This subchapter defines requirements for the mitigation type, location, and amount for resources lost or impacted. The Project as proposed could potentially impact shellfish habitats, SAV habitat, ISS and tidal waters, and wetlands. Subsection 7:7-17.9 details requirements for impacts to shellfish habitat; subsection 7:7-17.10 details requirements for impacts to SAV; subsection 7:7-17.11 details requirements for impacts to ISS and tidal waters; subsection 7:7-17.12 details requirements for impacts to the riparian zone; and subsection 7:7-17.13 details requirements for impacts to wetlands. The Project has been planned to minimize and offset unavoidable impacts through its design.

At this time, footprint of impacts to NJDEP regulated wetlands, wetland transition areas, State open waters, tidal water, SAV, shellfish beds, ISS, and riparian zones are not final. However, mitigation will be addressed with mitigation plans during the permitting phase of the Project in accordance with N.J.A.C. 7:7-17. Impacts to regulated areas will be minimized through implementation of BMPs, such as locating export cable corridors and landfalls within existing rights-of-way or previously disturbed/developed lands to the extent practicable, avoiding areas that would require extensive seabed or onshore alterations, use of appropriate technology (e.g., trenchless technology to the extent practicable) to minimize disturbance to seabed and sensitive habitat, avoiding anchoring on sensitive habitat, and/or implementing turbidity reduction measures to the extent practicable, and restoring impacted areas to pre-construction conditions wherever possible. If NJDEP determines that credit purchase is the appropriate mitigation alternative, Ocean Wind will meet all requirements for credit purchase from an approved mitigation bank as outlined at subsection N.J.A.C. 7:7-17.15. If NJDEP determines that in-lieu fee payment is the appropriate mitigation alternative, Ocean Wind will follow the terms of the State-approved in-lieu fee program instrument per subsection N.J.A.C. 7:7-17.16.

2.10 Consistency Evaluation

This consistency evaluation has defined the pertinent NJDEP use and resource policies related to the construction and long-term operation of the proposed Project. Based on this evaluation, the judgment of Ocean Wind is that the proposed Project complies with and will be conducted in a manner consistent with the New Jersey CZMP.

3. References

NOAA. 2011. Review of the Ecological Effects of Dredging in the Cultivation and Harvest of Molluscan Shellfish. NOAA Technical Memorandum NMFS-NE-220. Accessed online August 2020 at http://shellfish.ifas.ufl.edu/wp-content/uploads/Review-Ecological-Effects-of-Dredging-to-Harvest-Molluscs.pdf.

Northeast Fisheries Science Center (NEFSC). 2016. 61st Northeast Regional Stock Assessment Workshop (61st SAW) Assessment Summary Report. US Dept Commoner, Northeast Fish Sci Cent Ref Doc. 16-13; 26 p. Available from: National Marine Fisheries Service, Woods Hole, MA.

Rhoads, D.C., P.L. McCall, and J.Y. Yingst. 1978. "The ecology of seafloor disturbance." *American Scientist* 66: 577-586.

Schaffner, L.C. 2010. "Patterns and rates of recovery of macrobenthic communities in a polyhaline temperate estuary following sediment disturbance: Effects of disturbance severity and potential importance of non-local processes." *Estuaries and Coasts* 33: 1300-1313.

State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF THE ASSISTANT COMMISSIONER
WATERSHED AND LAND MANAGEMENT
401 EAST STATE STREET
PO BOX 401-07B
Trenton, NJ 08625

PHILIP D. MURPHY
Governor

SHEILA Y. OLIVER
Lieutenant Governor

Shawn M. LaTourette
Acting Commissioner

March 31, 2021

Amanda Lefton, Director
Bureau of Ocean Energy Management
1849 C Street, NW
Washington, D.C. 20240

James Bennett, Renewable Energy Program Manager
Bureau of Ocean Energy Management
45600 Woodland Road
Sterling, Virginia 20166

Re: Ocean Wind LLC

Dear Ms. Lefton and Mr. Bennett,

On March 30, 2021, Ocean Wind LLC submitted to the New Jersey Department of Environmental Protection ("NJDEP") a federal consistency certification and a copy of the Construction and Operation Plan ("COP") for the proposed construction and operation of the wind energy project known as the Ocean Wind project (the "Project"). The Project consists of up to ninety-eight (98) wind turbine generators that will be located in federal offshore waters approximately 15 miles southeast of Atlantic City within Bureau of Ocean Energy Management ("BOEM") Lease Area OCS-A 0498 ("Lease Area") as well as accompanying electric transmission cables from the Lease Area to two landfall points in Ocean and Cape May counties, respectively.

Although the Project's Lease Area does not fall within a Geographic Location Description for purposes of 16 USC § 1456(c)(3)(A) and the implementing regulations at 15 CFR Part 930 Subparts D and E, following a request by the NJDEP, Ocean Wind LLC voluntarily submitted the consistency certification to NJDEP to review reasonably

foreseeable effects of the Project on coastal use or resources for consistency with the enforceable policies of the New Jersey coastal zone management program.

NJDEP and Ocean Wind LLC have mutually agreed to stay the NJDEP six-month consistency review period consistent with 15 CFR§ 930.60(b) to provide sufficient time for discussions, meetings, and exchange of materials between Ocean Wind LLC and NJDEP.

The purpose of this letter is to notify BOEM of this stay agreement consistent with 15 CFR § 930.60(b). Pursuant to the attached stay agreement executed on March 31, 2021, the NJDEP consistency decision in this matter is due no later than October 28, 2022. The NJDEP will notify BOEM when it issues a final decision in this matter.

Please contact Kim Springer at (609)292-1932 or by email at Kim.Springer@dep.nj.gov should you have any questions.

Sincerely,

Vincent J. Mazzei, Jr., P.E.
Assistant Commissioner
Watershed and Land Management

cc Marc Reimer, Ocean Wind LLC
David Kaiser, NOAA
Kerry Kehoe, NOAA
Jeffrey Payne, NOAA

State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION

AGREEMENT TO STAY SIX-MONTH REVIEW PERIOD

Between

New Jersey Department of Environmental Protection

And

Ocean Wind LLC

The New Jersey Department of Environmental Protection ("NJDEP") and Ocean Wind LLC ("Ocean Wind") hereby agree as follows.

On March 30, 2021, Ocean Wind submitted a federal consistency certification to NJDEP for the proposed construction and operation of a wind energy project, known as the Ocean Wind project (the "Project"), consisting of up to ninety-eight (98) wind turbine generators that will be located in federal offshore waters approximately 15 miles southeast of Atlantic City within Bureau of Ocean Energy Management ("BOEM") Lease Area OCS-A 0498 ("Lease Area") as well as accompanying electric transmission cables from the Lease Area to two landfall points in Ocean and Cape May counties.

Although the Lease Area does not fall within a Geographic Location Description for purposes of 16 USC § 1456(c)(3)(A) and the implementing regulations at 15 CFR Part 930 Subparts D and E, following a request by the NJDEP, Ocean Wind voluntarily submitted to the NJDEP a federal consistency certification that reviews the reasonably foreseeable effects of the Project on coastal use or resources for consistency with the enforceable policies of the New Jersey coastal zone management program, therefore the proposed project is subject to NJDEP review pursuant to the Coastal Zone Management Act (CZMA), 16 U.S.C. §} 1451-1466, and the CZMA's implementing regulations at 15 CFR part 930, subpart D and subpart E. In accordance with 15 CFR § 930.60(b), and in consideration of the parties' mutual interest that the State have additional time to fully assess the proposed project's consistency with the state's enforceable policies, the NJDEP and Ocean Wind mutually agree to the following dates and to stay the NJDEP CZMA six-month review period as specified herein.

- Date the NJDEP 6-month review period commenced: March 31, 2021
- Date the 6-month review period was to end: September 30, 2021
- Date during the 6-month review period that the stay begins: March 31, 2021
- Date that the stay ends: April 28, 2022
- Date the 6-month review period ends and the NJDEP consistency decision is due: October 28, 2022

NJDEP will issue its consistency decision on or before **October 28, 2022,** unless NJDEP and Ocean Wind mutually agree in writing to another later date. The NJDEP and Ocean Wind mutually agree that the NJDEP may issue its consistency decision during the stay period and before the end of the stay if the NJDEP determines it has received sufficient information. Furthermore, should NJDEP conclude its review earlier than anticipated by this agreement, then NJDEP will issue its consistency decision at the earliest possible time prior to October 28, 2022. Any other modification or revocation of this agreement will be mutually agreed upon in writing by NJDEP and Ocean Wind.

These agreements made and entered by:

Vincent J. Mazzei, Jr, P.E
For New Jersey Department of Environmental Protection — Date: 3/31/2021

Peter Allen
For Ocean Wind LLC — Date: 3/31/2021

Marc Reimer
For Ocean Wind LLC — Date: 3/31/2021

CC: BOEM

NOAA

Table 6-4. RACT-BACT-LAER Clearinghouse (OSC Air Permit Determinations)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
12/31/2014	OCS-EPA-R4019	7/7/2016	**FL-0350**	Anadarko Petroleum, Inc. Diamond Blackhawk Drilling Project	17.110	Main Propulsion Generator Engines (6035 HP)	Diesel	Use of good combustion practices based on the most recent manufacturer's specifications issued for these engines at the time that the engines are operating under this permit	NOx: DR-ME-01 through DR-ME-08 Operating at 50% Load and Above: 10.57 g/kWh on a rolling 24-hour average basis. DR-ME-01 through DR-ME-06 Operating Below 50% Load: 57.3 lb/hr on a rolling 24-hour average basis. DR-MR-07 and DR-ME-08 Operating Below 50% Load: 103.5 lb/hr on a rolling 24-hour average basis. PM: Not Listed	Six 2012 Hyundai-HiMsen 9H32/40V 6,035 HP and two 2012 Hyundai-HiMsen 18H32/40V diesel electric engines	The facility consists of the BlackHawk drillship owned by Diamond Offshore Drilling Inc., and associated support vessels. The support vessels may include a combination of supply boats, anchor handling boats, tug boats, barges, stimulation vessels and well evaluation vessels. The proposed project will consist of three phases: the drilling phase, the well completion phase, and the production well maintenance phase. Anadarko will conduct drilling activities at multiple locations in the OCS in the Eastern Gulf of Mexico.
9/16/2014	OCS-EPA-R4015	7/6/2016	**FL-0347**	Anadarko Petroleum, Inc. - EGOM	17.110	Main Propulsion Generator Engines (9910 HP)	Diesel	Use of good combustion practices based on the most recent manufacturer's specifications issued for engines and with turbocharger, aftercooler, and high injection pressure	NOx: 12.7000 g/kWh Rolling 24-Hour Average PM_{10}: 0.24 g/kWh Rolling 24-Hour Average PM: 0.43 g/kWh Rolling 24-Hour Average $PM_{2.5}$: 0.24 g/kWh Rolling 24-Hour Average	Four 1998 Wartsila 18V32LNE 9910 HP and Two 1998 Wartsila 12V32LNE 6610 HP	The facility consists of a mobile offshore drilling unit using the Transocean Discoverer Spirit and associated support vessels. The drilling sites are located east of longitude 87.5, west of the Military Mission Line (86°41' west longitude), at least 100 miles from the Louisiana shoreline, and at least 125 miles from the Florida shoreline.
					17.110	Emergency Engine (3300 HP)	Diesel	Use of good combustion practices based on the most recent manufacturer's specifications issued for engines and with turbocharger, aftercooler, and high injection pressure	Not Listed	1998 Wartsila 6R32LNE	
					17.210	Remotely Operated Vehicle Emergency Generator (427 HP)	Diesel	Use of good combustion practices based on the most recent manufacturer's specifications issued for engines and with turbocharger, aftercooler, and high injection pressure	Not Listed	2004 Cummins QSM11-G2NR3	
5/30/2012	OCS-EPA-R4008	5/4/2016	**FL-0338**	Sake Prospect Drilling Project	17.110	Main Propulsion Engines - C.R. Luigs (5875 HP)	Diesel	Use of good combustion practices based on the current manufacturer's specifications for these engines, and additional enhanced work practice standards including an engine performance management system, positive crankcase ventilation, turbocharger with aftercooler, and high-pressure fuel injection with aftercooler.	NOx: 18.1000 g/kWh 24-Hour Rolling FPM_{10}: 0.24 g/kWh Rolling 24-Hour Average FPM: 0.43 g/kWh Rolling 24-Hour Average $FPM_{2.5}$: 0.24 g/kWh Rolling 24-Hour Average	C.R. Luigs has 8 identical MAN B&W 9L32/40-47 5,875 HP diesel electric engines	The facility consists of a mobile offshore drilling unit using either the Transocean ultra-deepwater C.R. Luigs or the Transocean semisubmersible DD1 to conduct exploratory oil and natural gas drilling in lease blocks within the DeSoto Canyon area of the Gulf of Mexico.
					17.110	Main Propulsion Engines - Development Driller 1 (5096 HP)	Diesel	Use of good combustion practices based on the current manufacturer's specifications for these engines, and additional enhanced work practice standards including an engine performance management system, positive crankcase ventilation, turbocharger with aftercooler, and high-pressure fuel injection with aftercooler.	NOx: 12.1000 g/kWh 24-Hour Rolling FPM: 0.43 g/kWh Rolling 24-Hour Average FPM_{10}: 0.43 g/kWh Rolling 24-Hour Average $FPM_{2.5}$: 0.57 g/kWh Rolling 24-Hour Average	Development Driller 1 has eight identical 2002 Caterpillar Model 3612-DITA, 5096 HP diesel electric engines.	

Table 6-4. RACT-BACT-LAER Clearinghouse (OSC Air Permit Determinations)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
					17.210	Port and Stb Fwd and Aft Crane Diesel Engines - C.R. Luigs (305 HP)	Diesel	Use of good combustion practices based on the current manufacturer's specifications for these engines, use of low sulfur diesel fuel, positive crankcase ventilation, turbocharger with aftercooler, high pressure fuel injection with aftercooler	NOx: 82.8300 tons per 12-month rolling total PM: 5.88 g/kWh Rolling 24-Hour Average PM_{10}: 5.88 g/kWh Rolling 24 Hour Average $PM_{2.5}$: 5.88 g/kWh Rolling 24 Hour Average		
5/15/2012	OCS-EPA-R4009	7/7/2016	FL-0348	Murphy Exploration & Production Co.	17.210	Main Propulsion Generators (4425 HP)	Diesel	Use of engine with turbo charger with after cooler, an enhanced work practice power management, NOx emissions maintenance system, and good combustion and maintenance practices based on the current manufacturer's specifications for each engine.	NOx: 26.0000 g/kWh Rolling 24-Hour Average PM: 9.9 tons per 12-month rolling total	Eight 1986 Wärtsilä F316A Diesel Engines	The facility consists of the dynamically positioned Diamond Offshore deepwater drilling vessel Ocean Confidence and an associated support fleet to conduct exploratory drilling and well completion for up to 90 calendar days within a 2-year period at a single well location within its Lloyd Ridge lease block 317. The drill site is located on the OCS in the Gulf of Mexico, approximately 135 miles southeast of the mouth of the Mississippi River and 180 miles from the Florida shoreline.
10/27/2011	OCS-EPA-R4007	4/14/2016	FL-0328	ENI - Holy Cross Drilling Project	17.110	Main Propulsion Engines (>500 HP)	Diesel	Use of good combustion practices based on the current manufacturer's specifications for these engines, and additional enhanced work practice standards including an engine performance management system and the Diesel Engines with Turbochargers (DEWT) measurement system.	NOx: 12.7000 g/kWh 24-Hour Rolling FPM: 0.43 g/kWh Rolling 24-Hour Average PM_{10}: 0.24 g/kWh Rolling 24-Hour Average $PM_{2.5}$: 0.24 g/kWh Rolling 24-Hour Average	Wärtsilä Vasa 18V32 LNE and Wärtsilä Vasa 12V32 LNE model engines	The project, known as the Holy Cross Drilling Project, will mobilize the Pathfinder drillship, and support vessels to drill in the Gulf of Mexico, Lloyd Ridge lease block 411, to determine the presence of natural gas. The exploratory drilling activity will consist of two phases: the initial drilling phase and the well completion phase; the Pathfinder will complete both phases. The operation will last up to two years, and based on applicable permitting regulations, is a "temporary source" for PSD permitting purposes.
					17.110	Crane Engines (units 1 and 2) (>500 HP)	Diesel	Use of certified EPA Tier 1 engines and good combustion practices based on the current manufacturer's specifications for this engine	NOx: 9.5000 Tons per Year 12-Month Rolling PM: 0.6 tons per 12-month rolling total PM_{10}: 0.6 tons per 12-month rolling total $PM_{2.5}$: 0.6 tons per 12-month rolling total	Caterpillar 3408 - 1997 model year engines	
					17.110	Crane Engines (units 3 and 4) (>500 HP)	Diesel	Use of good combustion practices, based on the current manufacturer's specifications for this engine	NOx: 9.7000 Tons per Year 12-Month Rolling PM: 1.3 tons per 12-month rolling total PM_{10}: 0.6 tons per 12-month rolling total $PM_{2.5}$: 0.6 tons per 12-month rolling total	Caterpillar 3406 - 2008 model year engines	

Table 6-4. RACT-BACT-LAER Clearinghouse (OSC Air Permit Determinations)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
6/13/2011	OCS-EPA-R4005	10/11/2012	FL-0327	Anadarko Phoenix Prospect	17.110	Main Propulsion Engines (>500 HP)	Diesel	Use of good combustion and maintenance practices, Power Management System, and NOx Concentration Maintenance System as described in the OCS permit application.	NOx: 12.7000 g/kWh 24-Hour Rolling PM: Not Listed	Wartsila 18V32 LNE and Wartsila 12V32 LNE model engines	The proposed project, known as the Phoenix Prospect, will mobilize the Discoverer Spirit, a work boat, a crew boat, and an anchor handling boat to drill a single exploration well on the OCS in Lloyd Ridge Lease Block 410 to determine if natural gas reserves are present in this location. The well's objective depth is 16,100 feet true vertical depth sub-sea or 6,300 feet below the mud line of the seafloor and will be drilled in approximately 9,800 feet of water from the dynamically positioned Discoverer Spirit. The operation is expected to last less than 92 days, and based on applicable permitting regulations, is a "temporary source" for permitting purposes.

lb/hr = pound per hour

Table 6-5. RACT-BACT-LAER Clearinghouse Determination Summary: Large Diesel Internal Combustion Engines (> 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
3/22/2018	122-17	2/19/2019	MI-0434	Flat Rock Assembly Plant	17.21	Emergency Engine (670 HP)	Diesel	Use of good combustion practices	NOx: 2.99 g/HP-hr PM: Not Listed	EULIFESAFETYENG - One (1) diesel-fueled emergency engine/generator rated at 500 kW.	The existing FRAP is an automotive manufacturing plant which consists of a stamping operation, a body shop, a paint shop, and a final assembly shop. The permit application is for the proposed installation of an electronic data center with backup emergency generators at FRAP.
9/21/2018	PDS-LA-805	2/19/2019	LA-0331	Calcasieu Pass LNG Project	17.11	Emergency Engines (5364 HP)	Diesel	Compliance with NSPS IIII, good combustion, limit normal operation to 100 hr/yr, and operating practices	NOx: 4.18 g/HP-hr PM_{10}: 0.15 g/HP-hr $PM_{2.5}$: 0.15 g/HP-hr	Large Emergency Engines (50 kW)	New LNG production, storage, and export terminal.
7/30/2018	16060032	2/19/2019	IL-0129	CPV Three Rivers Energy Center	17.11	Emergency Engine (2010 HP)	ULSD	Compliance with NSPS IIII	NOx: Not Listed PM: Not Listed	Other units include an auxiliary boiler, fuel heater, engines, natural gas piping and components, circuit breakers and roadways.	The proposed facility is designed to generate baseload power. It will consist of two combined-cycle generating units, each with a CT and associated HRSG. The turbines would burn natural gas and ULSD as a backup fuel. Other units include an auxiliary boiler, fuel heater, engines, natural gas piping and components, circuit breakers and roadways.
7/27/2018	1010524-001-AC	3/19/2019	FL-0367	Shady Hills Combined Cycle Facility	17.11	Emergency Engine (2010 HP)	ULSD	Operate and maintain the engine according to the manufacturer's written instructions	NOx: 4.78 g/HP-hr FPM: 0.15 g/HP-hr	1,500 kW Emergency Diesel Generator	A 573 MW (winter) 1-on-1 combined cycle plant which includes a HRSG with duct firing, along with supporting equipment. Natural gas is the only permitted fuel for the combined cycle unit.
7/16/2018	19-18	2/19/2019	MI-0435	Belle River Combined Cycle Power Plant	17.11	Emergency Engine (2682 HP)	Diesel	Use of good combustion practices	NOx: 4.78 g/HP-hr FPM: 0.15 g/HP-hr PM_{10}: 1.18 lb/h $PM_{2.5}$: 1.18 lb/h	EU EMENGINE: Emergency engine	Natural gas combined-cycle power plant
6/29/2018	167-17 and 168-17	2/19/2019	MI-0433	MEC North, LLC And MEC South LLC	17.11	Emergency Engine (1341 HP)	Diesel	Use of certified EPA engine per NSPS IIII and good combustion practices	NOx: 4.78 g/HP-hr FPM: 0.15 g/HP-hr PM_{10}: 0.54 lb/h $PM_{2.5}$: 0.52 lb/h	EU EMENGINE (north plant): emergency engine	Natural gas combined cycle power plant (two plants: north and south)
					17.11	Emergency Engines (1341 HP)	Diesel	Use of certified EPA engine per NSPS IIII and good combustion practices	NOx: 4.78 g/HP-hr FPM: 0.15 g/HP-hr PM_{10}: 0.54 lb/h $PM_{2.5}$: 0.52 lb/h	EU EMENGINE (south plant): emergency engine	
4/26/2018	52588	3/18/2019	VA-0328	C4GT, LLC	17.11	Emergency Engine	ULSD	Use of good combustion practices and the use of ULSD fuel oil with a maximum sulfur content of 15 parts per million weight.	NOx: 4.8 g/HP-hr FPM: 0.15 g/hp-hr PM_{10}: 0.15 g/hp-hr $PM_{2.5}$: 0.15 g/hp-hr	Emergency diesel gen	Natural gas-fired combined cycle power plant
3/22/2018	122-17	2/19/2019	MI-0434	Flat Rock Assembly Plant	17.11	Emergency Engines (3633 HP)	Diesel	Use of good combustion practices	NOx : 4.78 g/HP-hr PM: Not Listed	EUENGINE01 through EUENGINE08	The existing FRAP is an automotive manufacturing plant which consists of a stamping operation, a body shop, a paint shop, and a final assembly shop. The permit application is for the proposed installation of an electronic data center with backup emergency generators at FRAP.

Table 6-5. RACT-BACT-LAER Clearinghouse Determination Summary: Large Diesel Internal Combustion Engines (> 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
12/18/2017	309-0075	1/11/2018	AL-0318	Talladega Sawmill	17.11	Emergency Engine (250 HP)	Diesel	None Listed	NOx: Not Listed PM: Not Listed	250 HP Emergency CI, Diesel-fired RICE	A sawmill that produces kiln dried dimensional lumber.
9/15/2017	R14-0015M	5/1/2018	WV-0027	Inwood	17.11	Emergency Engine (900 HP)	ULSD	Engine Design	NOx: 4.77 g/HP-hr $PM_{10:}$: 0.2 g/HP-hr	Emergency generator - esdg14	Insulation manufacturing facility
6/30/2017	PSD-LA-780(M-1)	2/13/2019	LA-0312	St. James Methanol Plant	17.11	Emergency Engine (1474 HP)	Diesel	Compliance with NSPS IIII	NOx: 19.23 lb/hr $PM_{10:}$: 0.08 lb/hr $PM_{2.5}$: 0.08 lb/hr	DEG1-13 - diesel fired emergency generator engine (EQT0012)	New Meoh plant designed to produce 5,275 metric tons per day of refined methanol from natural gas and CO_2 feedstock
6/30/2017	AQ0934CPT01	6/22/2018	AK-0084	Donlin Gold Project	17.11	Emergency Engines (2010 HP)	Diesel	Use of good combustion practices and NSPS Subpart IIII engines.	NOx: 5.97 g/HP-hr PM: 0.19 g/HP-hr $PM_{10:}$: 0.19 lb/hr $PM_{2.5}$: 0.19 lb/hr	Black Start and Emergency ICEs	The Donlin Gold Project is a gold mine located 12 miles north of Crooked Creek, Alaska on the Kuskokwim River, about 280 miles northwest of Anchorage. The deposit has proven and probable reserves estimated at 33.9 million ounces of gold at 2.1 grams per ton and could produce up to 1.5 million ounces annually.
					17.11	Dual Fuel ICEs (22797 HP)	Diesel and Natural Gas	SCR and good combustion practices	NOx 0.4 g/HP-hr PM: 0.22 g/HP-hr FPM: 0.11 lb/hr $PM_{10:}$: 0.22 lb/hr $PM_{2.5}$: 0.22 lb/hr	12 large ULSD/natural gas-fired ICEs	
6/21/2017	NE-15-018	11/27/2017	MA-0043	MIT Central Utility Plant	17.11	Cold Start Engine	ULSD	None listed	NOx: 35.09 lb/hr PM_{10}: 0.4 lb/hr $PM_{2.5}$: 0.4 lb/hr	Cold start engine	MIT proposes to construct and operate two new 22-MW combined heat and power CTs/HRSGs and a new cold start engine at its existing central utility plant.
5/9/2017	59-16A	11/15/2017	MI-0425	Grayling Particleboard	17.11	Emergency Engine (2010 HP)	Diesel	EPA certified engines and limited operating hours.	NOx: 21.2 lb/hr FPM: 0.66 lb/hr PM_{10}: 0.66 lb/hr $PM_{2.5}$: 0.66 lb/hr	EUEMRGRICE1 in FGRICE (Emergency diesel generator engine)	Particleboard manufacturing.
					17.11	Emergency Engine (2010 HP)	Diesel	EPA certified engines and limited operating hours.	NOx: 4.4 lb/hr FPM: 0.18 lb/hr PM_{10}: 0.18 lb/hr $PM_{2.5}$: 0.18 lb/hr	EUEMRGRICE2 in FGRICE (Emergency Diesel Generator Engine)	
3/23/2017	129-36943-00059	8/22/2017	IN-0263	Midwest Fertilizer Company LLC	17.11	Emergency Engines (3600 HP)	Diesel	Use of good combustion practices	NOx: 4.42 g/HP-hr PM: 0.15 g/HP-hr PM_{10}: 0.15 g/HP-hr $PM_{2.5}$: 0.15 g/HP-hr	Emergency generators (eu014a and eu-014b)	Stationary nitrogen fertilizer manufacturing facility
2/17/2017	PSD-LA-766(M3)	4/28/2017	LA-0316	Cameron LNG Facility	17.11	Emergency Engines (3353 HP)	Diesel	Compliance with NSPS IIII	Not Listed	Emergency generator engines (6 units)	Facility to liquefy natural gas for export (5 trains)

Table 6-5. RACT-BACT-LAER Clearinghouse Determination Summary: Large Diesel Internal Combustion Engines (> 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
1/4/2017	75-16	3/8/2018	MI-0423	Indeck Niles, LLC	17.11	Emergency Engine (2992 HP)	Diesel	Use of certified EPA engine per NSPS IIII and good combustion practices	NOx: 4.78 g/HP-hr FPM: 0.15 g/HP-hr PM_{10}: 1.58 lb/hr $PM_{2.5}$: 1.58 lb/hr	EUEMENGINE (Diesel fuel emergency engine)	Natural gas combined cycle power plant.
12/22/2016	PSD-LA-761(M4)	4/28/2017	LA-0317	Methanex - Geismar Methanol Plant	17.11	Emergency Engines (2 @ 2346 HP, 1 @ 755 HP, 1 @ 1193 HP)	Diesel	Compliance with NSPS IIII and 40 CFR 63 Subpart ZZZZ	Not Listed	Emergency Generator Engines (4 units)	Methanol plant (Unit I and Unit II) to produce 6,000 metric tons of methanol by steam reforming natural gas
9/2/2016	11-00536A	12/21/2018	PA-0310	CPV Fairview Energy Center	17.11	Emergency Engines (2010 HP)	ULSD	None Listed	NOx: 4.8 g/HP-hr PM: 0.15 g/HP-hr	Two (2) 1,500-ekW diesel-fired emergency genset engines. One (1) 422 BHP diesel-fired fire water pump engine.	This plan approval authorizes CPV Fairview, LLC to construct and temporarily operate the Fairview Energy Center. Air contamination sources and air cleaning devices authorized for construction and temporary operation under this plan approval include: A combined cycle electric generating unit consisting of two GE CTs each with maximum fuel type-based heat input of 3,338-MMBtu/hr (natural gas), 3,274-MMBtu/hr (ULSD), 3,199 MMBtu/hr (ethane blend), and equipped with dry low-NOx combustors and evaporative turbine intake cooling; two HRSGs each equipped with a low-NOx duct burner with maximum heat input of 425-MMBtu/hr, and a common STG. Exhaust emissions from each combined cycle electric generating unit will be controlled by oxidation catalyst and SCR.
8/31/2016	PSD-LA-804	4/28/2017	LA-0313	St. Charles Power Station	17.11	Emergency Engine (2584 HP)	Diesel	Good combustion practices, compliance with NESHAP 40 CFR 63 Subpart ZZZZ and NSPS 40 CFR 60 Subpart IIII and use of ULSD	NOx: 27.34 lb/hr FPM: 0.86 lb/hr $FPM_{2.5}$: 0.86 lb/hr	St. Charles Power Station emergency diesel generator 1	The St. Charles Power Station is a new electric power generating facility consisting of two natural gas-fired combined cycle gas turbines, each with a HRSG unit equipped with duct burners, and one steam generator turbine. The St. Charles Power Station will have a predicted net nominal output of 980 MW at iso conditions with supplemental duct firing.
8/26/2016	59-16	7/20/2017	MI-0421	Grayling Particleboard	17.11	Emergency Engine (2144 HP)	Diesel	EPA certified engines and limited operating hours	NOx: 22.6 lb/hr FPM: 1.41 lb/hr PM_{10}: 1.41 lb/hr $PM_{2.5}$: 1.41 lb/hr	Emergency diesel generator engine (EUEMRGRICE in FGRICE)	Particleboard manufacturing
6/30/2016	PSD-LA-803(M1)	4/28/2017	LA-0305	Lake Charles Methanol Facility	17.11	Emergency Engines (4023 HP)	Diesel	Compliance with NSPS IIII	Not Listed	Diesel engines (emergency)	Proposed facility to produce methanol, hydrogen, sulfuric acid, CO_2, argon, and electricity from pet coke.
6/17/2016	52525	2/24/2017	VA-0325	Greensville Power Station	17.11	Emergency Engine (4020 HP)	Diesel	Use of good combustion and maintenance practices and Ultra Low Sulfur Diesel/Fuel (15 ppm max)	NOx: 6.4 G/kW PM_{10}: 0.4 G/kW $PM_{2.5}$: 0.4 G/kW	Diesel-fired emergency generator 3000 kW (1)	The proposed project will be a new, nominal 1,600 MW combined-cycle electrical power generating facility utilizing three CTs each with a duct-fired HRSG with a common reheat condensing STG (3 on 1 configuration). The proposed fuel for the turbines and duct burners is pipeline-quality natural gas.

Table 6-5. RACT-BACT-LAER Clearinghouse Determination Summary: Large Diesel Internal Combustion Engines (> 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
3/10/2016	18068/BOP150001	4/17/2018	NJ-0084	PSEG Fossil LLC Sewaren Generating Station	17.11	Emergency Engine	ULSD	Use of ULSD	NOx: 42.3 lb/hr FPM: 0.26 lb/hr PM_{10}: 0.26 lb/hr $PM_{2.5}$: 0.26 lb/hr	Diesel-fired emergency generator	PSEG Fossil LLC Sewaren Generating Station is located in Middlesex County, New Jersey. This project to be built at Sewaren would be a 1-on-1 (1 CT and a single steam turbine) combined-cycle electric generating unit including its ancillary equipment. The electric output of the CCCT at ISO conditions will be approximately 345 MW and the approximate output of the steam turbine at these conditions and with 100% supplemental heat input will be 240 MW.
2/3/2016	3-1326-00275/ 00009	9/28/2017	NY-0103	Cricket Valley Energy Center	17.11	Emergency Engine (4020 HP)	ULSD	SCR and Good Combustion Practices	NOx: 2.11 g/HP-hr FPM: 0.15 g/HP-hr	The facility will include a natural gas-fired auxiliary boiler, four ULSD-fired black-start generator engines and a ULSD-fired emergency fire pump engine.	Cricket Valley Energy Center LLC constructed the Cricket Valley Energy Center (the Facility), a nominal net 1,000 MW combined-cycle gas turbine electric generating facility, on a site located in Dover, Dutchess County, New York. The Facility consists of three GE Model 7FA.05 CTGs operating in combined-cycle mode with supplemental firing of the HRSGs; natural gas will be the sole fuel fired in the CTGs and duct burners. In addition to the air emitting equipment, the Facility will include three STGs, an ACC and associated auxiliary equipment and systems. Each combined cycle generating unit consisting of the CTG, HRSG and STG will be exhausted through its own stack. Air emissions from the proposed Facility primarily consist of products of combustion from the CTGS, HRSG duct burners, and ancillary combustion sources.
1/22/2016	PSD-LA-769(M-1)	9/19/2016	LA-0292	Holbrook Compressor Station	17.11	Emergency Engines (1341 HP)	Diesel	Use of certified EPA engine per NSPS IIII, use of ULSD, and good combustion practices based on the most recent manufacturer's specifications issued for these engines at the time that the engines are operating under this permit	NOx: 14.16 lb/hr $PM_{2.5}$: 0.44 lb/hr	Emergency generators no. 1 no. 2	Natural gas compressor station supporting the Cameron LNG Facility in Hackberry, Cameron Parish, Louisiana
1/7/2016	PSD-LA-747(M5)	4/28/2017	LA-0318	Flopam Facility	17.11	Generator Engine	Diesel	Compliance with NSPS IIII	Not Listed	Diesel engines	An existing chemical manufacturing facility
12/23/2015	35-00069A	12/21/2018	PA-0309	Lackawanna Energy Ctr./Jessup	17.11	Emergency Engine (2680 HP)	ULSD	None Listed	NOx: 5.45 g/HP-hr FPM: 0.025 g/HP-hr PM_{10}: 0.025 g/HP-hr $PM_{2.5}$: 0.025 g/HP-hr	Additional equipment includes: one 2,000 kW diesel-fired emergency generator one 315 HP diesel-fired emergency fire water pump one 184.8 MMBtu/hr natural gas fired boiler one 12 MMBtu/hr natural gas fuel gas heater two diesel fuel storage tanks four lubricating oil tanks one aqueous ammonia storage tank	This plan approval is for the construction and temporary operation of three identical GE Model 7HA.02 natural gas-fired CTs and HRSG with duct burners. Each CT/HRSG combined-cycle process block includes one combustion gas turbine and one HRSG with duct burners with all three CT/HRSG sharing one steam turbine. The entire power block is rated at 1,500 MW.

Table 6-5. RACT-BACT-LAER Clearinghouse Determination Summary: Large Diesel Internal Combustion Engines (> 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
11/13/2015	PSC Case No. 9330	5/13/2016	MD-0045	Mattawoman Energy Center	17.21	Emergency Engines (1490 HP)	ULSD	Good combustion practices and exclusive use of ULSD	NOx: 4.78 g/HP-hr FPM: 0.15 g/HP-hr PM_{10}: 0.18 g/HP-hr $PM_{2.5}$: 0.18 g/HP-hr	Emergency generator	990 MW combined-cycle natural gas-fired power plant
9/1/2015	40-00129A	12/21/2018	PA-0311	Moxie Freedom Generation Plant	17.11	Emergency Engine	Diesel	None Listed	NOx: 4.93 g/HP-hr PM: 0.04 g/HP-hr PM_{10}: 0.04 g/HP-hr $PM_{2.5}$: 0.04 g/HP-hr	One fuel gas dew-point heater - natural gas fired; two CT inlet evaporative coolers; two ACCs; one auxiliary boiler, natural gas-fired; one diesel engine-powered emergency generator; one diesel engine-powered fire water pump; diesel fuel, lubricating oil, and aqueous ammonia storage tanks	The project is for the construction and operation of two identical 1 x 1 power blocks, each consisting of a CGT or CT and a steam turbine configured in single shaft alignment, where each CT and steam turbine train share one common electric generator. The turbines to be used for this project are two GE 7HA.02 CTS, each in 1 x 1 single shaft combined-cycle power islands. Each CT and duct burner will exclusively fire pipeline-quality natural gas. The HRSGs will be equipped with SCR to minimize NOx emissions and oxidation catalysts to minimize CO and VOC emissions from the CTs and duct burners. The project will also include several pieces of ancillary equipment.
6/4/2015	PSD-LA-774(M1)	4/28/2017	LA-0309	Benteler Steel Tube Facility	17.11	Emergency Engines (2922 HP)	Diesel	Compliance with NSPS IIII	NOx: 4.78 g/HP-hr PM_{10}: 0.15 g/HP-hr $PM_{2.5}$: 0.15 g/HP-hr	Emergency generator engines	A facility to produce 600,000 metric tons per year of seamless steel pipe from purchased billets. A steel production facility (including an electric arc furnace) was added.
4/1/2015	118239, N200	5/16/2016	TX-0728	Peony Chemical Manufacturing Facility	17.11	Emergency Engine (1500 HP)	Diesel	Use of certified EPA Tier 2 engine and minimal hours or operation	0.0218 g/HP-hr FPM: 0.15 lb/hr FPM_{10}: 0.15 lb/hr $FPM_{2.5}$: 0.15 lb/hr	Emergency diesel generator	Ammonia production with hydrogen imported
1/23/2015	AQ1201CPT03	2/19/2016	AK-0082	Point Thomson Production Facility	17.11	Emergency Engines (2695 HP)	ULSD	None Listed	NOx: 4.8 g/HP-hr FPM_{10}: 0.15 g/HP-hr $FPM_{2.5}$: 0.15 g/HP-hr	Emergency camp generators	Oil gas exploration and production facility
					17.11	Bulk Tank Generator Engines (891 HP)	ULSD	None Listed	4.8 g/HP-hr FPM_{10}: 0.15 g/HP-hr $FPM_{2.5}$: 0.15 g/HP-hr	Bulk tank generator engines	
1/14/2015	160-11B	7/6/2016	MI-0418	Warren Technical Center	17.11	Emergency Engines (4676.6 HP)	Diesel	ITR is good design. Engines are tuned for low-NOx operation versus low CO operation.	NOx: 5.97 g/HP-hr PM: Not Listed	Fg-backup generators (nine DRUPS emergency engines)	Automotive research
					17.11	Emergency Engines (3631.4 HP)	Diesel	ITR is good design. Engines are tuned for low-NOx operation versus low CO operation.	NOx: 5.32 g/HP-hr PM: Not Listed	Four emergency engines in FG-BACKUPGENS	
12/1/2014	108446/PSDTX1352	3/6/2019	TX-0671	Project Jumbo	17.11	Emergency Engines (5360 HP)	ULSD	Use of certified EPA Tier 2 engine	NOx: 4.05 g/HP-hr PM: Not Listed	Engines	Plastic Resin Manufacturing Plant

Table 6-5. RACT-BACT-LAER Clearinghouse Determination Summary: Large Diesel Internal Combustion Engines (> 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
11/21/2014	R14-0030	5/1/2018	WV-0025	Moundsville Combined Cycle Power Plant	17.11	Emergency Engine (2015.7 HP)	Diesel	None Listed	Not Listed	Emergency generator	Nominal 549 MW (output) natural gas-fired combined cycle power plant.
11/5/2014	P0116610	2/25/2019	OH-0363	NTE Ohio, LLC	17.11	Emergency Engine (1474 HP)	Diesel	Compliance with NSPS IIII, emergency operation only, less than 500 hr/yr each for maintenance checks and readiness testing.	NOx: 29.01 lb/hr PM: 0.77 lb/hr PM_{10}: 0.77 lb/hr $PM_{2.5}$: 0.77 lb/hr	Emergency generator (P002)	Combined-cycle, natural gas-fired power plant
10/31/2014	PSC CASE NO. 9297	5/13/2016	MD-0046	Keys Energy Center	17.21	Emergency Engine (2010 HP)	ULSD	Good combustion practices, use of ULSD, and compliance with NSPS IIII and 40 CFR 63 Subpart ZZZZ	NOx: 4.78 g/HP-hr FPM: 0.15 g/HP-hr PM_{10}: 0.15 g/HP-hr	Two diesel-fired auxiliary generators (emergency generators), each rated at nominal 1,500 kW	735 MW combined-cycle natural gas-fired power plant
9/5/2014	13060007	5/5/2016	IL-0114	Cronus Chemicals, LLC	17.11	Emergency Engine (3755 HP)	Diesel	Use of certified EPA Tier IV engines for non-road engines	NOx: 0.5 g/HP-hr FPM: 0.07 g/HP-hr PM_{10}: 0.07 g/HP-hr $PM_{2.5}$: 0.07 g/HP-hr	Emergency generator	Plant will produce urea and ammonia, but ammonia production will be limited to a maximum of 3 months of the year (4,880 tpd urea and 2,789 tpd ammonia).
7/22/2014	413-0033-X014 - X020	6/8/2016	AL-0301	Nucor Steel Tuscaloosa, Inc.	17.11	Emergency Engine (800 HP)	Diesel	None Listed	NOx: 6.8 g/HP-hr FPM: 0.32 g/hp-hr	Diesel fired emergency generator	Steel mill adding second baghouse to electric arc furnace, austenitizing furnace, tempering furnace, vacuum degasser, plasma torches, and emergency generators.
7/1/2014	PSC CASE NO. 9136	7/25/2016	MD-0043	Perryman Generating Station	17.11	Emergency Engine (1300 HP)	ULSD	Good combustion practices, limited hours of operation, and exclusive use of ULSD	NOx: 4.8 g/HP-hr PM_{10}: 0.17 g/HP-hr	Emergency generator	120 MW simple cycle natural gas fired power plant Perryman 6 project-wide emission limits: NOx = 58.5 tpy
6/9/2014	PSC CASE NO. 9318	5/14/2018	MD-0044	Cove Point LNG Terminal	17.11	Emergency Engine (1550 HP)	ULSD	Good combustion practices , designed to achieve emission limit, and exclusive use of ULSD	NOx: 4.8 g/HP-hr FPM: 0.15 g/HP-hr PM_{10}: 0.17 g/HP-hr $PM_{2.5}$: 0.17 g/HP-hr	Emergency generator	Liquified natural gas processing facility and 130 MW generating station
6/4/2014	129-33576-00059	5/4/2016	IN-0173	Midwest Fertilizer Corporation	17.11	Emergency Engine (3600 HP)	Diesel	Use of good combustion practices	NOx: 4.46 g/HP-hr FPM: 0.15 g/HP-hr PM_{10}: 0.15 g/HP-hr $PM_{2.5}$: 0.15 g/HP-hr	Diesel fired emergency generator	A stationary nitrogen fertilizer manufacturing facility
6/4/2014	129-33576-00059	5/5/2016	IN-0180	Midwest Fertilizer Corporation	17.11	Emergency Engine (3600 HP)	Diesel	Use of good combustion practices	NOx: 4.46 g/HP-hr FPM: 0.15 g/HP-hr PM_{10}: 0.15 g/HP-hr $PM_{2.5}$: 0.15 g/HP-hr	Diesel fired emergency generator	A stationary nitrogen fertilizer manufacturing facility

Table 6-5. RACT-BACT-LAER Clearinghouse Determination Summary: Large Diesel Internal Combustion Engines (> 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
5/23/2014	PSD-LA-778	9/14/2016	LA-0288	Lake Charles Chemical Complex	17.11	Emergency Engines (2682 HP)	Diesel	Use of certified EPA engine per NSPS IIII and good combustion practices based on the most recent manufacturer's specifications issued for these engines at the time that the engines are operating under this permit	NOx: 27.37 lb/hr PM_{10}: 0.88 lb/hr $PM_{2.5}$: 0.88 lb/hr	Emergency diesel generators (EQTs 629, 639, 838, 966, 1264)	Not listed
5/23/2014	PSD-LA-779	4/28/2017	LA-0296	Lake Charles Chemical Complex LDPE Unit	17.11	Emergency Engines (2682 HP)	Diesel	Use of certified EPA engine per NSPS IIII and good combustion practices based on the most recent manufacturer's specifications issued for these engines at the time that the engines are operating under this permit	NOx: 27.37 lb/hr PM_{10}: 0.88 lb/hr $PM_{2.5}$: 0.88 lb/hr	Emergency Diesel Generators (EQTs 622, 671, 773, 850, 994, 995, 996, 1033, 1077, 1105, 1202)	The low-density polyethylene (LDPE) unit will produce LDPE by the high pressure polymerization of ethylene.
5/23/2014	PSD-LA-781	3/16/2017	LA-0315	G2G Plant	17.11	Emergency Engine (5364 HP)	Diesel	Compliance with NSPS IIII and 40 CFR 63 Subpart ZZZZ, proper design and operation and use of ultra-low sulfur diesel	NOx: 52.58 lb/hr PM_{10}: 1.76 lb/hr $PM_{2.5}$: 1.76 lb/hr	Emergency diesel generator 1	The G2G plant will be a natural gas to gasoline production facility which will use natural gas to produce methanol that will be subsequently converted into gasoline.
					17.11	Emergency Engine (5364 HP)	Diesel	Compliance with NSPS IIII and 40 CFR 63 Subpart ZZZZ, proper design and operation and use of ultra-low sulfur diesel	NOx: 52.58 lb/hr PM_{10}: 1.76 lb/hr $PM_{2.5}$: 1.76 lb/hr	Emergency diesel generator 2	
4/23/2014	PSC CASE NO. 9280	4/26/2018	MD-0041	CPV St. Charles	17.21	Emergency Engine (2010 HP)	ULSD	Good combustion practices, limited hours of operation, and exclusive use of ULSD	NOx: 4.8 g/HP-hr FPM: 0.15 g/HP-hr PM_{10}: 0.15 g/HP-hr	Emergency generator	725 MW combined-cycle natural gas-fired power plant
4/10/2014	R2-PSD 1	5/5/2016	PR-0009	Energy Answers Arecibo Puerto Rico Renewable Energy Project	17.11	Emergency Engine (670 HP)	ULSD	None Listed	NOx: 2.85 g/HP-hr FPM: 0.15 g/HP-hr	Emergency diesel generator	Energy Answers Arecibo is a new resource recovery facility capable of producing up to 77 MW of electrical power while combusting municipal solid waste, as the primary fuel.
4/8/2014	CPCN CASE NO. 9327	3/23/2018	MD-0042	Wildcat Point Generation Facility	17.11	Emergency Engine (3015 HP)	ULSD	Good combustion practices, limited hours of operation, and exclusive use of ULSD	NOx: 4.8 g/HP-hr FPM: 0.15 g/HP-hr PM_{10}: 0.15 g/HP-hr $PM_{2.5}$: 0.15 g/HP-hr	Emergency generator 1	1000 MW combined cycle natural gas-fired power plant facility-wide sulfuric acid mist emission limit = 96 tpy facility-wide CO_2 equivalent emission limit = 3,498,026 tpy
1/30/2014	NE-12-022	5/5/2016	MA-0039	Salem Harbor Station Redevelopment	17.11	Emergency Engine (1005 HP)	ULSD	None Listed	NOx: 4.8 g/HP-hr PM_{10}: 0.15 g/HP-hr $PM_{2.5}$: 0.15 g/HP-hr	Two 315 MW GE Model 107F Series 5 CTGs, each with dedicated HRSG, duct burner and 31 MW STG, dispatchable independently of one another by ISO-NE; one 80 MMBtu/hr auxiliary boiler, one 750 kW	Footprint Power Salem Harbor Development LP (the Permittee) proposes to construct and operate a nominal 630 MW natural gas fired, quick start (capable of producing 300 MW within 10 minutes of startup) combined cycle electric generating facility at Salem Harbor Station. With duct firing, the proposed facility will be capable of generating an additional 62 MW, for a total of 692 MW.

Table 6-5. RACT-BACT-LAER Clearinghouse Determination Summary: Large Diesel Internal Combustion Engines (> 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
										emergency engine-generator, and one 371 BHP emergency engine-fire-pump.	
11/5/2013	P0113762	2/22/2019	OH-0360	Carroll County Energy	17.11	Emergency Engine (1490.08 HP)	Diesel	Compliance with NSPS IIII	NOx: 13.74 lb/hr PM_{10}: 0.49 lb/hr $PM_{2.5}$: 0.49 lb/hr	Emergency generator (P003)	Natural gas fired combined cycle gas turbine electric generating station of nominal capacity of 742 MW
11/1/2013	51-13	7/7/2016	MI-0406	Renaissance Power LLC	17.11	Emergency Engines (1340 HP)	Diesel	Use of good combustion practices	NOx: 4.8 g/HP-hr FPM: 0.15 g/HP-hr PM_{10}: 0.15 g/HP-hr $PM_{2.5}$: 0.15 g/HP-hr	FG-EMGEN7-8; Two 1,000 kW diesel-fueled emergency reciprocating ICEs	For technical questions regarding this permit contact the permit engineer.
9/26/2013	PSD-LA-767	4/28/2017	LA-0308	Morgan City Power Plant	17.11	Emergency Engine (2680 HP)	Diesel	Use of certified EPA engine per NSPS IIII and good combustion and maintenance practices	NOx: 33.07 lb/hr FPM_{10}: 1.06 lb/hr $FPM_{2.5}$: 1.06 lb/hr	2000 kW diesel-fired emergency generator engine	Not listed
9/25/2013	147-32322-00062	5/4/2016	IN-0179	Ohio Valley Resources, LLC	17.11	Emergency Engine (4690 HP)	Diesel	Use of good combustion practices	NOx: 4.46 g/HP-hr FPM: 0.15 g/HP-hr PM_{10}: 0.15 g/HP-hr $PM_{2.5}$: 0.15 g/HP-hr	Diesel-fired emergency generator	Nitrogenous fertilizer production plant
7/2/2013	2008-302-C(M-1)PSD	7/29/2016	OK-0154	Mooreland Generating Station	17.11	Emergency Engine (1341 HP)	Diesel	Use of good combustion practices	NOx: 4.99 g/HP-hr $PM_{2.5}$: 0.44 lb/hr	Diesel-fired emergency generator engine	WFEC operates the Mooreland Generating Station to generate wholesale electricity which is transmitted over WFEC's system. The facility was originally constructed in 1963. The electricity is sold in rural areas of approximately 3/4 of the state of Oklahoma and part of New Mexico. The Mooreland Generating Station currently consists of three high-pressure boilers that burn locally-produced natural gas. The three high-pressure boilers used to generate electricity and the auxiliary boiler used to heat the facility were constructed before May 31, 1972 and are considered grandfathered from construction permitting requirements.
6/18/2013	P0110840	5/4/2016	OH-0352	Oregon Clean Energy Center	17.11	Emergency Engine (3015 HP)	Diesel	Compliance with NSPS IIII	NOx: 27.8 lb/hr PM_{10}: 0.99 lb/hr	Emergency generator	799 MW CCCT Power Plant
4/23/2013	37-337A	5/27/2016	PA-0291	Hickory Run Energy Station	17.11	Emergency Engine (1135 HP)	ULSD	None Listed	NOx: 9.89 lb/hr PM: 0.005 lb/hr	The project will also include a natural gas-fired auxiliary boiler; a diesel engine-driven emergency generator; a diesel engine-driven firewater pump; a multi-cell evaporative cooling tower; and associated emission control systems, tanks, and	Natural gas-fired combined-cycle electric generation facility that is designed to generate up to 900 MW nominal, using 2 CTGs and 2 HRSGs that will provide steam to drive a single STG. Each HRSG will be equipped with a duct burner which may be utilized at time of peak power demands to supplement power output.

Table 6-5. RACT-BACT-LAER Clearinghouse Determination Summary: Large Diesel Internal Combustion Engines (> 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
										other balance of plant equipment.	
3/27/2013	PSD-LA-768	5/4/2016	LA-0272	Ammonia Production Facility	17.11	Emergency Engines (1200 HP)	Diesel	Use of certified EPA engine per NSPS IIII, limiting operational hours to 500 hr/yr, and good combustion practices	Not Listed	Emergency diesel generator (2205-B)	2780 ton per day ammonia production facility
3/18/2013	C-10656	8/25/2017	KS-0036	Westar Energy – Emporia Energy Center	17.11	Engine associated with fossil fuel power generation facility (900 HP)	Diesel	Use of good combustion practices	NOx: 14 lb/hr PM: 0.066 g/HP-hr PM_{10}: 0.066 g/HP-hr	Caterpillar C18DITA diesel engine generator	The Westar Energy – Emporia Energy Center (source id: 1110046) is a fossil fuel power generation facility located in Emporia, Kansas.
12/3/2012	141-31003-00579	5/4/2016	IN-0158	St. Joseph Energy Center, LLC	17.11	Emergency Engines (1006 HP)	Diesel	Use of good combustion practices and usage limits	NOx: 4.8 g/HP-hr FPM: 0.15 g/HP-hr FPM_{10}: 0.15 g/HP-hr $FPM_{2.5}$: 0.15 g/HP-hr	Two emergency diesel generators	Stationary electric utility generating station
					17.11	Emergency Engine (2012 HP)	Diesel	Use of good combustion practices and usage limits	NOx: 4.8 g/HP-hr FPM: 0.15 g/HP-hr FPM_{10}: 0.15 g/HP-hr $FPM_{2.5}$: 0.15 g/HP-hr	Emergency diesel generator	
11/1/2012	08857/BOP110001	4/17/2018	NJ-0080	Hess Newark Energy Center	17.11	Emergency Engine	ULSD	Use of ULSD	NOx: 18.53 lb/hr FPM: 0.59 lb/hr FPM_{10}: 0.66 lb/hr	Supporting ancillary equipment includes a natural gas fired auxiliary boiler, a 12-cell mechanical draft cooling tower, an emergency diesel generator and an emergency diesel fire pump.	Combined Cycle Electric Generating Facility Hess Newark Energy Center, proposed at Newark, New Jersey, would be a new, highly efficient, 655 MW combined-cycle power generating facility. Hess Newark Energy Center will consist of two GE CTGs with a heat input rate of 2,320 MMBtu/hr, that will utilize pipeline natural gas only. HRSGs downstream of the CTs will recover heat from the exhaust gases to generate steam. The HRSGs will be equipped with natural gas-fired duct burners for supplementary firing and will share a single STG.
10/26/2012	12-219	8/13/2013	IA-0105	Iowa Fertilizer Company	17.11	Emergency Engine (2680 HP)	Diesel	Use of good combustion practices	NOx: 4.48 g/HP-hr PM: 0.15 g/HP-hr PM_{10}: 0.15 g/HP-hr $PM_{2.5}$: 0.15 g/HP-hr	Emergency generator	Nitrogenous fertilizer manufacturing
10/10/2012	08Â·00045A	4/3/2015	PA-0278	Moxie Liberty LLC/Asylum Power PL T	17.11	Emergency Engine	Diesel	None Listed	NOx: 4.93 g/HP-hr PM_{10}: 0.02 g/HP-hr $PM_{2.5}$: 0.02 g/HP-hr	Emergency generator	Not listed
8/28/2012	CT-12636	5/11/2018	WY-0070	Cheyenne Prairie Generating Station	17.11	Emergency Engine (839 HP)	ULSD	Use of certified EPA Tier 2 engine	Not Listed	Diesel emergency generator (EP15)	A nominal 220 MW gross electrical facility. The station is to consist of five 40 MW GE LM6000 CTGs with two of the turbines operating in combined cycle mode for an additional 20 MW in generation.

Table 6-5. RACT-BACT-LAER Clearinghouse Determination Summary: Large Diesel Internal Combustion Engines (> 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
8/20/2012	AQ1201CPT01	5/30/2013	AK-0076	Point Thomson Production Facility	17.11	Engine Associated With Oil Gas Exploration and Production (2345 HP)	ULSD	None Listed	NOx: 4.78 g/HP-hr $PM_{2.5}$: 0.15 g/HP-hr	Combustion of diesel by ICEs	Oil gas exploration and production facility
7/25/2012	18940 – BOP110003	4/17/2018	NJ-0079	Woodbridge Energy Center	17.11	Emergency Engine	ULSD	Use of ULSD	NOx: 21.16 lb/hr PM_{10}: 0.13 lb/hr $PM_{2.5}$: 0.13 lb/hr	Supporting ancillary equipment includes a natural gas fired auxiliary boiler, one small dew point fuel gas heater (fuel gas heater), a mechanical draft cooling tower, an emergency diesel generator and an emergency diesel fire pump.	Woodbridge Energy Center, proposed in Woodbridge Township, New Jersey, would be a new, highly efficient, 700 MW combined-cycle power generating facility. Woodbridge Energy Center will consist of two GE CTGs with a heat input rate of 2,307 MMBtu/hr, that will utilize pipeline natural gas only. HRSGs downstream of the CTs will recover heat from the exhaust gases to generate steam. The HRSGs will be equipped with natural gas-fired duct burners for supplementary firing and will share a single STG.
7/13/2012	160-11A	8/13/2013	MI-0395	Warren Technical Center	17.11	Emergency Engines (4033.4 HP)	Diesel	ITR is good design. Engines are tuned for low-NOx operation versus low CO operation.	NOx: 4.46 g/HP-hr PM: Not Listed	Nine DRUPS emergency generators	Automotive research
					17.11	Emergency Engines (3350 HP)	Diesel	ITR is good design. Engines are tuned for low-NOx operation versus low CO operation.	NOx: 5.32 g/HP-hr PM: Not Listed	Four emergency generators	
7/9/2012	2012–APP-002009	7/25/2017	CA-1219	City Of San Diego PUD (Pump Station 1)	17.11	Emergency Engine (2722 HP)	Diesel	Use of certified EPA Tier 2 engines operational restriction of 50 hr/yr for maintenance and testing.	NOx: 4 g/HP-hr PM: Not Listed	IC engine	Not Listed
6/27/2012	T147-30464-00060	5/4/2016	IN-0166	Indiana Gasification, LLC	17.11	Emergency Engines (1341 HP)	Diesel	Use of good combustion practices and limited hours of non-emergency operation to 52 hr/yr	NOx: Not Listed PM_{10}: 15 PPM sulfur $PM_{2.5}$: 15 PPM sulfur	Two emergency generators	The permittee owns and operates a stationary substitute natural gas and liquefied CO_2 production plant.
6/1/2012	15-0027K	5/22/2018	PA-0282	Johnson Matthey Inc./Catalytic Systems Div.	17.11	Emergency Engine (871 HP)	Diesel	None Listed	NOx: 6.9 g/HP-hr PM: Not Listed	650 kW backup diesel generator	This plan approval has been issued to Johnson Matthey, Inc. To establish a plant-wide applicability limit for NOx emissions from the facility.
					17.21	Emergency Engine (536 HP)		Shall be fueled by No. 2 fuel oil with the sulfur content less than or equal to 0.2% by weight and limit operation to 50 hr/yr.	NOx: 6.9 g/HP-hr PM: Not Listed	400 kW diesel emergency generator	
6/1/2012	09-0142B	5/22/2018	PA-0292	ML 35 LLC/Phila Cybercenter	17.11	Emergency Engines (3017.25 HP)	Diesel	SCR	NOx: 0.5 g/HP-hr PM: 0.28 lb/hr	Diesel generator (2.25 MW each) – 5 units	Installation of five 2 MW electric generators with the associated storage tanks and air pollution control devices including SCR system and oxidation catalysts; conversion of six existing emergency generators to peak shaving generators; and a facility wide NOx emissions cap.

Table 6-5. RACT-BACT-LAER Clearinghouse Determination Summary: Large Diesel Internal Combustion Engines (> 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
3/15/2012	6372-A1	7/29/2016	DC-0009	Blue Plains Advanced Wastewater Treatment Plant	17.11	Emergency Engine (2682 HP)	ULSD	None Listed	NOx: 5.39 g/HP-hr PM: Not Listed	Diesel emergency generator	Wastewater treatment plant using thermal hydrolysis pretreatment process prior to digesting wastewater sludge with anaerobic digesters. Digester gas is used as fuel for combined heat and power process.
2/29/2012	160-11	8/13/2013	MI-0394	Warren Technical Center	17.11	Emergency Engines (3055.2 HP)	Diesel	ITR is good design. Engines are tuned for low-NOx operation versus low CO operation.	NOx: 5.17 g/HP-hr PM: Not Listed	Four emergency generators	Automotive research
					17.11	Emergency Engines (4033.4 HP)	Diesel	ITR is good design. Engines are tuned for low-NOx operation versus low CO operation.	NOx: 4.46 g/HP-hr PM: Not Listed	Nine DRUPS emergency generators	
2/8/2012	0160-0023	10/17/2012	SC-0113	Pyramax Ceramics, LLC	17.11	Emergency Engines (757 HP)	Diesel	Compliance with NSPS IIII	NOx: 2.99 g/HP-hr PM: Not Listed	Emergency generators 1 through 8	Pyramax ceramics plans to construct a manufacturing facility for the production of proppant beads for use in the oil and gas industry. The major raw material is clay. The clay is mixed with chemicals and then fired in a kiln to produce ceramic beads.
12/5/2011	2011-APP-001776	7/25/2017	CA-1221	Pacific Bell	17.11	Emergency Engine (3634 HP)	Diesel	Use of certified EPA Tier 2 engines operational restriction of 50 hr/yr for maintenance and testing.	NOx: 3.5 g/HP-hr PM: Not Listed	ICE: emergency-CI	Not listed
11/17/2011	81-11	5/4/2016	MI-0402	Sumpter Power Plant	17.11	Emergency Engine (732 HP)	Diesel	Use of good combustion practices	NOx: 4.85 g/HP-hr FPM: 0.05 g/HP-hr PM_{10}: 0.0573 lb/MMBTU $PM_{2.5}$: 0.0573 lb/MMBTU	Diesel fuel-fired combustion engine (RICE)	Utility–natural gas-fired CT
10/18/2011	SE 09-01	1/27/2014	CA-1212	Palmdale Hybrid Power Project	17.11	Emergency Engine (2683 HP)	Diesel	Use of ULSD	NOx: 4.78 g/HP-hr PM: 0.15 g/HP-hr PM_{10}: 0.15 g/HP-hr $PM_{2.5}$: 0.15 g/HP-hr	Emergency IC engine	570 MW natural gas fired combined cycle power plant with an integrated 50 MW solar thermal plant
10/3/2011	2011-APP-001787	7/25/2017	CA-1220	San Diego International Airport	17.11	Emergency Engine (1881 HP)	Diesel	Use of certified EPA Tier 2 engines operational restriction of 50 hr/yr for maintenance and testing	NOx: 3.9 g/HP-hr PM: Not Listed	ICE: emergency-CI	Not listed
9/23/2011	PSD-FL-416, 0550063-001-AC	10/11/2012	FL-0332	Highlands Biorefinery And Cogeneration Plant	17.11	Emergency Engine (2680 HP)	ULSD	Compliance with NSPS IIII	NOx: 4.78 g/HP-hr PM: 0.15 g/HP-hr	2000 kW emergency equipment	This project involves the construction of a sugarcane and sweet sorghum-to-ethanol advanced biorefinery with a maximum annual ethanol production rate of 36 million gallons per year. The cane (i.e. the sugarcane and sorghum) will be grown on nearby farmland. The juice will be squeezed from the feedstock stalks, fermented, distilled and blended to make a range of ethanol/gasoline products, including e-85 (an 85/15 ethanol/gasoline blend). The leftover stalk fiber (bagasse) will be combusted in a cogeneration biomass boiler (458.5 MMBtu/hr on a 24-hour basis) to make process steam and up to 30 MW (gross) of electricity. In addition to bagasse, the boiler will use supplemental biomass consisting of energy crops, wood chips and vegetative debris. Natural gas will be used for startup

Table 6-5. RACT-BACT-LAER Clearinghouse Determination Summary: Large Diesel Internal Combustion Engines (> 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
											shutdown and flame stabilization and during a disruption in the biomass supply.
7/14/2011	AQ0215CPT03	11/18/2011	AK-0072	Dutch Harbor Power Plant	17.11	Rural Diesel-electric Power Plant Engineer (5896 HP)	ULSD	Turbocharger and Aftercooler and compliance with NSPS IIII	NOx: 7.31 g/HP-hr $FPM_{2.5}$: 0.37 g/HP-hr	Eu 15 caterpillar c-280-16	Rural diesel-electric power plant
4/26/2011	PSD-LA-747(M1)	12/12/2011	LA-0251	Flopam Inc. Facility	17.11	Large Generator Engines (11 @ 591 HP, 1 @ 755 HP, 6 @ 1175 HP)	Diesel	None Listed	NOx: 6.32 lb/hr FPM_{10}: 0.01 lb/hr	Large Generator Engines (17 units)	A chemical manufacturing complex is under construction (PSD-LA-747 – LA0240). equipment is added or redesigned. (engines, cooling towers, material handling). Permit PSD-LA-747(M2) was issued July 5, 2012 for additional dust filters to control PM/PM_{10} from the permitted powder plants. similar dust filters were determined as BACT for same powder plants. No additional BACT analysis is required.
12/23/2010	PSD-FL-412 (0510032-001-AC)	7/6/2011	FL-0322	Sweet Sorghum-To-Ethanol Advanced Biorefinery	17.11	Emergency Engines (2682 HP)	ULSD	Compliance with NSPS IIII	NOx: 4.78 g/HP-hr PM: 0.15 g/HP-hr	Emergency generators, two at 2682 HP each	The SRF facility will be located just east of County Road 835 at the intersection with Hill Grade Road and approximately 13 miles south southwest of Clewiston/Lake Okeechobee in Hendry County. Hendry County is bounded by Lee County to the west, Glades County to the north, Collier County to the south, Palm Beach County to the east and Broward County to the southeast. Lake Okeechobee is located immediately northeast of Hendry County. The Big Cypress Seminole Indian Reservation is located approximately 18 miles south southeast of the site entrance. Most of Hendry County is agricultural.
12/20/2010	AQ0164CPT01	3/27/2012	AK-0071	International Station Power Plant	17.11	Combined Cycle Power Plant Engine (2010 HP)	ULSD	Turbocharger ,aftercooler, and good combustion	NOx: 4.78 g/HP-hr PM: 0.03 g/HP-hr PM_{10}: 0.03 g/HP-hr $PM_{2.5}$: 0.03 g/HP-hr	Caterpillar 3215c black start generator (1)	Combined cycle power plant
12/20/2010	AQ0164CPT01	1/8/2014	AK-0073	International Station Power Plant	17.11	Black Start Engine (2010 HP)	Diesel	Turbocharger and Aftercooler	NOx: 4.78 g/HP-hr PM_{10}: 0.03 g/HP-hr	Fuel combustion	Power plant that contains four CTs, four duct burners, a black start generator, and an auxiliary heater.
6/29/2010	28.0505-PSD	3/23/2018	SD-0005	Deer Creek Station	17.11	Emergency Engine (2680 HP)	Diesel	Compliance with NSPS IIII	Not Listed	Emergency generator	Natural gas-fired CT and HRSG for electricity production. The facility has a maximum net output of 300 MW.
6/25/2010	P-2009.0092	10/5/2010	ID-0018	Langley Gulch Power Plant	17.11	Emergency Engine (1005 HP)	Diesel	Use of certified EPA Tier 2 engine and good combustion practices	NOx: 4.78 g/HP-hr PM: 0.15 g/HP-hr	Ancillary equipment includes one diesel-fired emergency generator, one diesel-fired fire pump, one wet cooling tower, and six dry chemical storage silos	One-on-one combined cycle plant consisting of one natural gas-fired CT and one steam turbine. The CT is equipped with one HRSG and duct burner. Ancillary equipment includes one diesel-fired emergency generator, one diesel-fired fire pump, one wet cooling tower, and six dry chemical storage silos.
3/11/2010	SE 07-02	12/14/2017	CA-1191	Victorville 2 Hybrid Power Project	17.11	Emergency Engine (2680 HP)	Diesel	Operational Restriction of 50 hr/yr	NOx: 4.48 g/HP-hr PM: 0.15 g/HP-hr $PM_{2.5}$: 0.15 g/HP-hr	Emergency engine	563 MW power plant comprised of a hybrid of natural gas-fired combined cycle generating equipment integrated with solar thermal components

Table 6-5. RACT-BACT-LAER Clearinghouse Determination Summary: Large Diesel Internal Combustion Engines (> 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
11/30/2009	825	3/15/2010	NV-0050	MGM Mirage	17.11	Emergency Engines (2206 HP)	Diesel	Turbocharger, after-cooler, and lean burn technology	NOx: 5.94 g/HP-hr FPM_{10}: 0.05 g/HP-hr	Emergency generators – units lx024 and lx025 at luxor	The facility is a major source for CO, NOx, PM_{10}, and a non-major source for SO_2, VOC, and HAP. The facility is a conglomerate of hotels and casinos located in a contiguous area, which air quality is non-attainment for CO, ozone, and PM_{10}, and attainment for the other criteria air pollutants.
8/20/2009	257	12/1/2009	NV-0049	Harrah's Operating Company, Inc.	17.11	Emergency Engines (1232 HP)	Diesel	Turbocharger	NOx: 10.89 g/HP-hr FPM_{10}: 0.32 g/HP-hr	Large ICEs (600 HP) – unit HA13	The facility consists of seven contiguous hotel and casino businesses owned and operated by Harrah's Operating Company, Inc. Boilers and heaters are the primary emission units. The facility is a major source for NOx, a synthetic minor source for CO, and a minor source for all the other criteria air pollutants. The facility is located in a non-attainment area for ozone.
6/22/2009	PSD-LA-742	5/17/2010	LA-0231	Lake Charles Gasification Facility	17.11	Emergency Engines (1341 HP)	Diesel	Compliance with NSPS IIII	NOx: 17.09 lb/hr PM: 0.06 lb/hr	Emergency diesel power generator engines (2)	A facility to convert approximately 7400 tpd of petroleum coke to natural gas and sulfuric acid. Permit PSD-LA-742(M1), December 30, 2010, allows the facility to produce 2.3 million tons of methanol, instead of natural gas.
6/15/2009	AQ0181CPT06, REVISION 2	8/6/2009	AK-0066	Endicott Production Facility, Liberty Development Project	17.11	Main Engine to Support Operations (1041 HP)	Diesel	Use of good combustion practices	NOx: 4.7 g/HP-hr PM: Not Listed	EU ID 58, camp engine 3	At Endicott, BPXA processes crude oil production fluids received from various crude oil accumulations located on the north slope of Alaska. The stationary source is currently situated on two off-shore production islands, which are located in the Beaufort Sea, and connected by a 3.5-mile causeway. Endicott is currently capable of processing 120,000 barrels of crude oil per day and 480 million standard cubic feet of gas. Production fluids consist mainly of crude oil, hydrocarbon gas, and water. The crude oil is processed to remove hydrocarbon gas and water in order to meet specific crude-oil sales specifications. The hydrocarbon gas is dehydrated, stripped of heavier hydrocarbons that may be present and compressed for re-injection into the oil-bearing reservoir or used as fuel. Water is processed to remove entrained crude oil before re-injection. The energy needed to support operations comes primarily from the combustion of produced hydrocarbon gas.
2/27/2009	PSD-LA-709(M-1)	8/6/2009	LA-0204	Plaquemine PVC Plant	17.11	Emergency Engines (1 @ 685 HP, 1 @ 1709 HP, 2 @ 805 HP, 1 @ 1389 HP)	Diesel	Use of good combustion practices	NOx: 3.2 lb/MMBtu PM_{10}: 0.1 lb/MMBtu	Large emergency engines	New 1.3 billion pound per year PVC plant consisting of a chlor-alkali unit, and ethylene dichloride/vinyl chloride monomer unit, and a PVC unit.

Table 6-5. RACT-BACT-LAER Clearinghouse Determination Summary: Large Diesel Internal Combustion Engines (> 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
					17.21	Emergency Engines (1341 HP)	Diesel	Compliance with NSPS IIII	NOx: 4.41 lb/MMBtu PM_{10}: 0.31 lb/MMBtu	Small emergency engines u-7a, u-7b, u-7c: 420 HP each; u-8a, u-8b, u-8c: 442 HP each; u-9: 450 HP; m-16b: 439 HP; m-16c, m-16d, m-16e: 180 HP each; p-28a: 540 HP; p-28b: 340 HP; p28c: 180 HP	
2/27/2009	TP-0014	1/23/2014	NH-0015	Concord Steam Corporation	17.11	Emergency Engine	Diesel	Operational restriction of 500 hr/yr	NOx: 1.98 lb/MMBtu PM: Not Listed	Emergency generator 1	19.7 MW biomass power plant
					17.11	Emergency Engine	Diesel	Operational Restriction of 500 hr/yr	NOx: 1.98 lb/MMBtu PM: Not Listed	Emergency generator 2	
2/10/2009	P-2008.0066	2/5/2010	ID-0017	Power County Advanced Energy Center	17.11	Emergency Engines (2680 HP)	Diesel	Use of certified EPA engine per NSPS IIII and good combustion practices	Not Listed	2 MW emergency generator, src25	Coal/petcoke gasification plant producing ammonia, urea, UAN, and elemental sulfur.
2/10/2009	0680-0046-CB	10/16/2012	SC-0115	GP Clarendon LP	17.11	Emergency Engine (1400 HP)	Diesel	Tune-ups and inspections to be performed as outlined in the Good Management Practice Plan.	NOx: 11.41 lb/hr PM: 0.25 lb/hr FPM_{10}: 0.2 lb/hr	Diesel emergency generator	GP produces oriented strand board. Facility was originally permitted as a synthetic minor facility and began construction. Sister facility in Allendale began operation before clarendon construction was complete. It was discovered through source testing that the Allendale facility had major PSD source emissions. Construction on Clarendon had stopped and has not been completed as of May 2012. PSD construction permit was issued to Clarendon also.
1/23/2009	2007-115-C(M-1)PSD	2/18/2010	OK-0129	Chouteau Power Plant	17.11	Emergency Engine (2200 HP)	Low Sulfur Diesel	None Listed	NOx: 4.78 g/HP-hr PM_{10}: 0.15 g/HP-hr	Emergency diesel generator (2200 HP)	Not listed
1/12/2009	PSD-FL-402	1/26/2010	FL-0310	Shady Hills Generating Station	17.11	Emergency Engine (3352.5 HP)	ULSD	Purchase an EPA-certified model at least as stringent as the BACT values	NOx: 6.9 g/HP-hr PM_{10}: 0.4 g/HP-hr	2.5 MW emergency generator	This facility consists of three, dual-fuel, nominal 170 MW GE model PG7241FA (GE 7FA) simple cycle CTs-electrical generators, three exhaust stacks that are 18 feet in diameter and 75 feet tall, and one 2.8-million gallon distillate fuel oil storage tank. The CT units can operate in simple-cycle mode and intermittent duty mode. The units are equipped with dry low-NOx combustors and water injection capability. The three CTs are regulated under Phase II of the Federal Acid Rain Program. This facility operates during peak hours of electrical use.

ACC = air-cooled condenser
BHP = brake horsepower
CCCT = combined-cycle combustion turbine
CT = combustion turbine
CTG = combustion turbine generator
FRAP = Flat Rock Assembly Plant
GE = General Electric
hr/yr = hour per year
HRSG = heat recovery steam generator
ITR = ignition timing retardation
lb/MMBtu = pounds per million British thermal units
LNG = liquefied natural gas
MMBtu/hr = million British thermal units per hour
PVC = polyvinyl chloride
STG = steam turbine generator
tpd = tons per day

Table 6-6. RACT-BACT-LAER Clearinghouse Determination Summary: Small Diesel Internal Combustion Engines (< 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
5/2/2018	PSD-LA-709(M-3)	2/19/2019	LA-0328	Plaquemines Plant 1	17.21	Emergency Engines (375 HP)	Diesel	Good combustion practices and compliance with NSPS IIII	NOx: 2.99 g/HP-hr PM_{10}: 0.15 g/HP-hr $PM_{2.5}$: 0.15 g/HP-hr	Emergency Diesel Engine Pump P-39A	PVC production
					17.21	Emergency Engines (300 HP)	Diesel	Good combustion practices and compliance with NSPS IIII	NOx: 2.99 g/HP-hr PM_{10}: 0.15 g/HP-hr $PM_{2.5}$: 0.15 g/HP-hr	Emergency Diesel Engine Pump P-39B	
2/23/2018	063-37891-00037	2/19/2019	IN-0295	Steel Dynamics, Inc. - Engineered Bar Products Division	17.21	Emergency Engine (2 at 75 HP, 1 at 150 HP)	Diesel	None Listed	NOx: 14.06 g/HP-hr FPM: 1.0 g/HP-hr PM_{10}: 1.0 g/HP-hr	Emergency Diesel Generators 2 units at 75 HP, 1 unit at 150 HP	Steel Mini Mill
					17.21	Emergency Engines (250 HP)	Diesel	None Listed	NOx: 6.87 g/HP-hr PM_{10}: 1.0 g/HP-hr	Emergency Diesel Generators 2 units	
1/9/2017	PSD-LA-890	5/11/2018	LA-0323	Monsanto Luling Plant	17.21	Emergency Engine (400 HP)	Diesel	Proper operation practices, compliance with NSPS 40 CFR 60 Subpart IIII, and limits of hours of operation.	NOx: Not Listed FPM: Not Listed PM_{10}: Not Listed	Standby Generator No. 9 Engine Operating hours limited to 100 hr/yr for ready testing.	Chemical Manufacture
8/3/2016	PSD-LA-813	4/28/2017	LA-0314	Indorama Lake Charles Facility	17.21	Emergency Engines (350 HP)	Diesel	Compliance with 40 CFR 63 Subpart ZZZZ	NOx: Not Listed FPM: Not Listed PM_{10}: Not Listed	Diesel emergency generator engine - EGEN	Modify and restart-up a mothballed facility to produce 1,009 million lbs/yr of ethylene
7/19/2016	19149/ PCP150001	11/3/2016	NJ-0085	Middlesex Energy Center, LLC	17.21	Emergency Engine	Diesel	Limited hours of operation and exclusive use of ULSD	NOx: 20.6 lb/hr FPM: 0.661 lb/hr PM_{10}: 0.661 lb/hr	Emergency generator diesel	New 633 MW gross facility consisting of one GE 7HA.02 CCCT nominally rated at 380 MW at ISO conditions without duct firing with a maximum heat input rate of: 3,462 MMBtu/hr (HHV) at 0 degrees Fahrenheit, 100% load combusting natural gas -- 3,613 MMBtu/hr (HHV) at 0 degrees Fahrenheit, 100% load combusting ULSD which will be the backup fuel. Other equipment includes: one natural gas-fired duct burner (maximum heat input of 599 MMBtu/hr [HHV]) for supplemental firing; one 97.5 MMBtu/hr (HHV) natural gas fired auxiliary boiler, equipped with low NOx burners and flue gas recirculation for control of NOx emissions; one 2.25 MMBtu/hr (HHV), 327 BHP, ULSD-fired emergency fire pump; one 14.4 MMBtu/hr (HHV), approximately 1,500 kW ULSD-fired emergency generator; and one 8-cell, 124,800 gallons per minute mechanical induced draft cooling tower.
1/23/2015	MD-12620	2/19/2016	AK-0082	Point Thomson Production Facility	17.21	Airstrip generator engine (490 HP)	ULSD	None Listed	NOx: 4.8 g/HP-hr FPM_{10}: 0.15 g/HP-hr $FPM_{2.5}$: 0.15 g/HP-hr	One 490 HP airstrip generator engine	Oil gas exploration and production facility
					17.21	Agitator generator engine (98 HP)	ULSD	None Listed	NOx: 5.6 g/HP-hr FPM_{10}: 0.3 g/HP-hr $FPM_{2.5}$: 0.3 g/HP-hr	Agitator generator engine ULSD-fired 98 HP	

Table 6-6. RACT-BACT-LAER Clearinghouse Determination Summary: Small Diesel Internal Combustion Engines (< 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
					17.21	Incinerator generator engine (102 HP)	ULSD	None Listed	NOx: 4.9 g/HP-hr FPM_{10}: 0.22 g/HP-hr $FPM_{2.5}$: 0.22 g/HP-hr	Incinerator generator engine ULSD-fired 102 HP	
1/23/2014	102482, PSDTX1292	5/16/2016	TX-0706	Natural Gas Fractionation	17.21	Emergency engines	ULSD	None Listed	NOx: 0.33 tpy PM: Not Listed	Emergency Engines	Occidental will build an NGL Fractionation Plant that will receive natural gas liquids by pipeline and fractionate these liquids into commercial grade products, including ethane, propane, butanes, and natural gasoline
10/15/2012	MD-12620	4/14/2016	WY-0071	Sinclair Refinery	17.21	Emergency air compressor (400 HP)	ULSD	Use of certified EPA Tier 3 engine	Not Listed	Emergency Air Compressor	Crude Oil Refinery
8/23/2012	2012--APP-002157	7/25/2017	CA-1217	Bea San Diego Ship Repair	17.21	Generator engine (450 HP)	Diesel	None Listed	NOx: 1.34 g/HP-hr FPM: Not Listed PM_{10}: Not Listed	ICE - 450 BHP Model QSX15-C - Cummins	
2/8/2012	0160-0023	10/17/2012	SC-0113	Pyramax Ceramics, LLC	17.21	Emergency engines (29 HP)	Diesel	Use of certified EPA engine	NOx: 5.6 g/HP-hr FPM: Not Listed PM_{10}: Not Listed	Emergency engines 1 through 8	Pyramax ceramics plans to construct a manufacturing facility for the production of proppant beads for use in the oil and gas industry. The major raw material is clay. The clay is mixed with chemicals and then fired in a kiln to produce ceramic beads. Initial construction permit for a greenfield facility.
10/18/2011	SE 09-01	1/27/2014	CA-1212	Palmdale Hybrid Power Project	17.21	Emergency Engine (182 HP)	Diesel	NOx: None Listed PM: use of ultra-low sulfur fuel	NOx: 2.99 g/HP-hr PM: 0.15 g/HP-hr PM_{10}: 0.15 g/HP-hr $PM_{2.5}$: 0.15 g/HP-hr	Unit is 135 kW	570 MW natural gas fired combined cycle power plant with an integrated 50 MW solar thermal plant
4/26/2011	PSD-LA-747(M1)	12/12/2011	LA-0251	Flopam Inc. Facility	17.21	Emergency engine (193 HP)	Diesel	None Listed	NOx: 1.28 lb/hr PM_{10}: 0.01 lb/hr	Small generator engine	A chemical manufacturing complex is under construction (PSD-LA-747 - LA0240). Equipment is added or redesigned (engines, cooling towers, material handling). Permit PSD-LA-747(M2) was issued July 5, 2012 for additional dust filters to control PM/PM_{10} from the permitted powder plants. Similar dust filters were determined as BACT for same powder plants. No additional BACT analysis is required.
12/23/2010	PSD-FL-413	12/8/2011	FL-0324	Palm Beach Renewable Energy Park	17.21	Emergency engine (335 HP)	ULSD	Good combustion practices and exclusive use of ULSD	NOx: 2.99 g/HP-hr PM: 0.15 g/HP-hr	250 kW emergency generator	The existing Palm Beach Renewable Energy Facility consists of Class I and Class III landfills, a biosolids pelletizer facility, a compost facility and a waste-to-energy plant known as the North County Resource Recovery Facility. The new facility will consist of: Three nominal 1,000 tpd mass burn municipal waste combustor, each with an estimated maximum continuous rating of 416.7 MMBtu/hr and a peak rating of 458.3 MMBtu/hr; a 100 MW STG with an ACC; one ash building and handling system; three lime storage silos and one carbon storage silo; and two 250 HP diesel-fired pumps and one 250 kW emergency generator.

Table 6-6. RACT-BACT-LAER Clearinghouse Determination Summary: Small Diesel Internal Combustion Engines (< 500 HP)

Permit Date	Permit No.	Last Updated	Determination Number	Facility Name	Process Code	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
12/21/2010	93-09A	4/14/2016	MI-0399	Detroit Edison--Monroe	17.21	Emergency quench pumps (252 HP)	Diesel	Good combustion practices, limited to emergency use, and compliance with NSPS IIII	NOx: 7.8 g/HP-hr FPM: 0.4 g/hp-hr PM_{10}: 0.4 g/hp-hr $PM_{2.5}$: 0.4 g/hp-hr	Four diesel-fired quench pumps; each pump engine is 252 HP	Utility—Coal-fired power plant

HHV = higher heating value

Table 6-7. California BACT Clearinghouse Determination Summary (CARB and SCAQMD)

Permit Date	Permit No.	Last Updated	Facility Name	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
2/1/2019	A/N 594294	2/1/2019	Sunshine Canyon Landfill	Emergency Portable CI Diesel Engine (123.4 HP)	Diesel	Tier 4 Final Limits. CI naturally aspirated with SCR, oxidation catalyst, and ammonia oxidation catalyst.	NOx: 2.5 g/HP-hr PM/PM_{10}: 0.01 g/HP-hr	Caterpillar Portable IC Engine Model C4.4	Drives landfill refuse truck tipper which powers a hydraulic pump that raises and lowers two hydraulic cylinders and tipper platform.
12/10/2015	A/N 516409	12/2/2016	U.S. Government VA Medical Center	Emergency CI Diesel Engine (374 HP)	Diesel	Turbocharger and aftercooler. Limited to 200 hr/yr which includes no more than 50 hr/yr and 4.2 hour/month for maintenance and testing. Engine shall not be operated in idle mode for more than 240 consecutive minutes. Diesel particulate filter required to reduce toxic risk from diesel particulate emissions, but also reduces PM_{10}.	NOx+VOC: 3 g/HP-hr PM/PM_{10}: 0.15 g/HP-hr	Caterpillar IC Engine Model C9	Drives an emergency electricity generator.
12/10/2015	A/N 558397	12/2/2016	University of Southern California	Emergency CI Diesel Engine (755 HP)	Diesel	Turbocharger and aftercooler. Limited to 200 hr/year which includes no more than 50 hr/yr and 4.2 hours per month for maintenance and testing. Diesel particulate filter required to reduce toxic risk from diesel particulate emissions, but also reduces PM_{10}	NOx+VOC: 4.8 g/HP-hr PM/PM_{10}: 0.01 g/HP-hr PM or PM_{10}	Cummins IC Engine Model QSX15-G9	Drives an emergency electricity generator.
12/10/2015	A/N 516708	12/2/2016	Los Angeles County Sheriff's Department	Emergency CI Diesel Engine (2,220 HP)	Diesel	Turbocharger and aftercooler. Limited to 200 hr/yr which includes no more than 50 hr/yr and 4.2 hours per month for maintenance and testing. Diesel particulate filter required to reduce toxic risk from diesel particulate emissions, but also reduces PM_{10}.	NOx+VOC: 4.8 g/HP-hr NOx+VOC: PM/PM_{10}: 0.15 g/HP-hr PM or PM_{10}	Cummins IC Engine Model QSK50-g4	Drives an emergency generator.
8/23/2012	2012-APP-002157	8/23/2012	BAE San Diego Ship Repair	Prime engine driving a track mounted crane at a stationary source (450 HP)	Diesel	Subject to a 37,000-gallon per year fuel limit. BACT for NOx determined to be an EPA certified current tier engine (interim tier 4). SCR determined not feasible due to too-low exhaust temperatures.	NO_x: 1.8 g /HP-hr	Cummins IC Engine Model QSX15-C	This was a replacement. Lifting equipment and supplies at a ship repair yard
07/09/2012	2012-APP-002009	07/09/2012	City of San Diego PUD (Pump Station 1)	Two backup engines for a sewage pump station (2,722 HP)	Diesel	No add-on controls, but certified engine includes turbocharger and charge air cooler. SCR determined to be not technologically feasible.	NO_x: 4 g/HP-hr	Caterpillar IC Engine Model 3516C	Provide backup power for a sewage pump terminal
12/5/2011	2011-APP-001776	12/5/2011	Pacific Bell	Emergency Diesel Engine driving a 2.5 MW generator (3,634 HP)	Diesel	No add-on controls, but certified engine includes turbocharger and charge air cooler. SCR determined to be not technologically feasible. Propane or natural gas-fired engine not cost effective. Passed an AQIA for NO_2 impacts.	NO_x: 3.5 g/HP-hr	Caterpillar IC Engine Model 3516DITA	Provide backup power to an office complex
10/3/2011	2011-APP-001787	10/3/2011	San Diego International Airport	Emergency diesel engine equipped with a Johnson Matthey DPF (1,881 HP)	Diesel	No add-on controls, but certified engine includes turbocharger and charge air cooler. SCR determined to be not technologically feasible. Propane or natural gas-fired engine not cost effective.	NO_x: 3.9 g/HP-hr	Mitsubishi IC Engine Model S12R-Y2PTAW-1	Provide backup power for an airport terminal
8/2/2006	A/N C-1010958	8/2/2006	Kings County Department of Public Works	Emergency CI Diesel Engine (2,848 HP)	Diesel	Engine must be equipped with turbocharger, aftercooler, positive crankcase ventilation or 90% control of crankcase emissions, and oxidation catalyst/particulate filter. Operation is restricted to 614 hr/yr. Emission limits (g/BHP-hr): NOx-5.187	NOx: 5.187 g/HP-hr PM_{10}: 0.0116 g/HP-hr	Caterpillar IC Engine Model 3516B	Drives electric generator used for emergency and peaking power. Enables facility to be on Southern California Edison interruptible rate schedule.
5/16/2006	11971	5/16/2006	Cottage Health Care - Pueblo Street	Emergency/Standby Diesel IC Engine (2,937 HP)	Diesel	Certified Tier 2 engine. Maintenance and testing limited to 50 hr/yr. Unlimited emergency use	NO_x: 4.5 g/HP-hr PM: Not listed	4 Caterpillar IC Engines Model 3516C	
8/26/2003	418235	8/26/2003	Snow Summit, Inc.	Diesel engine (2,835 HP)	Diesel	Turbocharged, aftercooled, lean-burn. Permit limits were considered BACT. The NOx BACT limits were based on maximum emissions estimated by the catalyst vendor. Comments App. No.: 418235 SCAQMD's Clean Fuels Policy would normally require a stationary, non-emergency engine to be natural gas-fired. However, natural gas is not available in this mountain community.	NOx: 50 g/HP-hr PM_{10}: 0.045 g/HP-hr	Cummins IC Engine Model QSK78-G6	
8/25/2003	A/N 418235	8/6/2004	Snow Summit	Stationary Engine, Non-Emergency Diesel (2,835 HP)	Diesel	SCR catalyst, turbocharged, aftercooled, lean burn. Parts per million by volume, dry at 15% O_2: NOx -50 g/BHP-hr. Operation restricted to 1600 hr/yr. Source test initially and every 3 years. Continuous NOx monitor (not CEMS).	NOx: 50 g/HP-hr PM_{10}: 0.045 g/HP-hr	Cummins IC Engine Model QSK78-G6	Provides power for snow making equipment.

Table 6-7. California BACT Clearinghouse Determination Summary (CARB and SCAQMD)

Permit Date	Permit No.	Last Updated	Facility Name	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
9/26/2002	975360, 975361	9/26/2002	National Steel and Shipbuilding	Diesel engine to power crane (1,030 HP)	Diesel	NOx: 18.36 parts per million by volume at 15% oxygen	NOx: 54 g/HP-hr	Cummins IC Engine Model QST30-G1	Two Identical crane engines with same permit limits.
7/26/2002	387480	7/26/2002	Claremont Manor	Diesel engine (550 HP)	Diesel	The engine shall not operate more than 200 hr/yr.	No Data	Detroit Diesel IC Engine Model 6063-TK35	Drive an electrical generator - Emergency use only
11/7/2001	392542	11/7/2001	Power System Associates/Johnson Power Systems	Diesel engine (764 HP)	Diesel	Turbocharged and aftercooled. CARB-certified emissions for this engine family (1CPXL15.8ERK) are: NOx 6.19 g/BHP-hr. Standard conditions for CI engine used to drive emergency generator including: less than 199 hr/yr operation and EPA non-road certified as evidenced by manufacturer tag.	NO_x: 6.19 g/HP-hr	Caterpillar IC Engine Model 3456 DITA-AA	Drive an electrical generator - Emergency use only
12/4/2001	390213	12/4/2001	Cummins Cal-Pacific, Inc.	Diesel engine (470 HP)	Diesel	Turbocharged and aftercooled. The EPA engine family (1CEXL0661AAC) to which this engine belongs has been certified to meet 2001 EPA Tier 2 standards for non-road engines. For 300 to 600 BHP engine ratings, in 2001, Tier 2 standards are (g/BHP-hr): (NOx + HC) <4.8. Standard conditions are: <199 hr/yr operation, fuel sulfur <0.05%. Also, engine must be an EPA non-road certified as evidenced by manufacturer tag.	NO_x: 4.8 g/HP-hr	Cummins IC Engine Model QSM11-G2	Drive an electrical generator - Emergency use only
	390214			Diesel engine (395 HP)				Cummins IC Engine Model QSM11-G1	
11/21/2001	393278	11/21/2001	Generac Corp.	Diesel engine (295 HP)	Diesel	Turbocharged and aftercooled. EPA certified emissions for this engine family (1GNXL07.5FAA) are (g/BHP-hr): NOx 4.72. Certified equipment permit. Standard conditions are: <199 hr/yr operation, fuel sulfur <0.05%. Also, engine must be an EPA non-road certified as evidenced by manufacturer tag.	NO_x: 4.72 g/HP-hr	Generac IC Engine Model 7.5 DTA	Drive an electrical generator - Emergency use only
	393278			Diesel engine (267 HP)					
07-11-2001	392544	07-11-2001	Power System Associates/Johnson Power Systems	Diesel engine (610 HP)	Diesel	Turbocharged and aftercooled. CARB-certified emissions for this engine family (1CPXL15.8ESK) are (g/BHP-hr): NOx 4.17. Standard conditions for CI engine used to drive emergency generator including: less than 199 hr/yr operation, fuel sulfur less than 0.05% and EPA nonroad certified as evidenced by manufacturer tag.	NO_x: 4.17 g/HP-hr	Caterpillar IC Engine Model 3456 DITA-AA	Drive an electrical generator - Emergency use only
	392545			Diesel engine (536 HP)		Turbocharged and aftercooled. The EPA engine family to which this engine belongs has been certified to meet 2001 EPA Tier 2 standards for non-road engines. For 300 to 600 BHP engine ratings in 2001, Tier 2 standards are (g/BHP-hr): (NOx+HC)<4.8. Standard conditions for CI engine used to drive emergency generator including: less than 199 hr/yr operation and EPA non-road certified as evidenced by manufacturer tag.	NO_x: 4.8 g/HP-hr		
	392546			Diesel engine (471 HP)					
03-30-2000	365785	03-30-2000	Cucumonga County Water District	Diesel engine (890 HP)	Diesel	The engine shall not operate more than 200 hr/yr. The engine emissions, as provided by the engine manufacturer: NOx: 5.77 g/BHP-hr	NO_x: 6.9 g/HP-hr	Caterpillar IC Engine Model 3412 DITA	The engine drives a standby generator.
3/28/2000	366730	3/28/2000	Walt Disney Pictures and Television	Diesel engine (1,109 HP)	Diesel	The engine shall not operate more than 200 hr/yr. The engine emissions, as provided by the engine manufacturer: NOx: 5.93 g/BHP-hr	NO_x: 6.9 g/HP-hr	Caterpillar IC Engine Model 3412 DITA	The engine drives a standby generator.
2/22/2000	364327	2/22/2000	Homegrocer.com	Diesel engine (1,480 HP)	Diesel	The engine shall not operate more than 200 hr/yr. The engine emissions, as provided by the engine manufacturer: NOx: 5.9 g/BHP-hr	NO_x: 6.9 g/HP-hr	Caterpillar IC Engine Model 3508B SCAC	The engine drives a standby generator.
2/1/2000	363589	2/1/2000	City of Corona	Diesel engine (2,155 HP)	Diesel	The engine shall not operate more than 200 hr/yr. The engine emissions, as provided by the engine manufacturer: NOx: 6.2 g/BHP-hr	NO_x: 6.9 g/HP-hr	Caterpillar IC Engine Model 3512B SCAC	The engine drives a standby generator.
1/18/2000	363918	1/18/2000	Homegrocer.com	Diesel engine (883 HP)	Diesel	The engine shall not operate more than 200 hr/yr. The engine emissions, as provided by the engine manufacturer: NOx: 5.9 g/BHP-hr	NO_x: 6.9 g/HP-hr	Mitsubishi IC Engine Model S6R-PTA	The engine drives a standby generator.
11/9/1999	361707	11/9/1999	Ingram Book Company	Diesel engine (1,448 HP)	Diesel	200 hr/yr and 4-degree timing retard	NO_x: 6.9 g/HP-hr	Mitsubishi IC Engine Model 37 ODTA	Drive an electrical generator-emergency use only

Table 6-7. California BACT Clearinghouse Determination Summary (CARB and SCAQMD)

Permit Date	Permit No.	Last Updated	Facility Name	Equipment Description	Fuel	LAER/BACT Control Method Determination	Emission Information	Equipment Detailed Description	Extended Facility Description
10/7/1999	359675	10/7/1999	U.S. Government Naval Air Station, North Island	Diesel engine (100 HP)	Diesel	CI-turbocharger. The engine shall not operate more than 200 hr/yr. The engine timing be retard by 4 degrees relative to standard timing. The emission data being reported by the engine manufacturer are: NOx: 6.808 g/BHP-hr.	NO_x: 6.9 g/HP-hr	John Deere IC Engine Model 4045TF	Drive an electrical generator-emergency use only
8/18/1999	356816	8/18/1999	Cummins Cal Pacific, Inc	Diesel engine (68 HP)	Diesel	None stated	NO_x: 6.9 g/HP-hr	Cummins IC Engine Model 4B3.9-G2	Drive an electrical generator-emergency use only

Note: the search parameters were for ICE with CI < 175 HP; CI >= 175 HP; Emergency, CI; and Emergency, Spark Ignition.

g/BHP-hr = grams per brake horsepower-hour

Ocean Wind
An Ørsted & PSEG project

Ocean Wind Offshore Wind Farm

AQRV Modeling Protocol

OCS Air Permit Application

July 6, 2022

Table of Contents

1. Introduction 3

2. Analysis Metrics and Models 3

2.1 Plume Blight 3

2.2 Regional Haze 4

2.3 Deposition Analysis 5

3. CALPUFF Input Files 5

Appendices

Appendix A Ocean Wind Modeling Protocol Revised June 17, 2022

Appendix B CALPUFF Model Input Files (electronic)

Table of Abbreviations

AQRV	Air Quality Related Values
BART	Best Available Retrofit Technology
CALPUFF	California Puff Model
EPA	Environmental Protection Agency
FWS	Fish and Wildlife Service
HDD	Horizontal Directional Drilling
NH_3	Ammonia
NAAQS	National Ambient Air Quality Standards
NM	Nautical Mile
NO_x	Nitrogen Oxides
OCD	Offshore and Costal Dispersion Model
OLM	Ozone Limiting Method
OSS	Offshore Substations
PM	Particulate Matter
PM_{10}	Particulate Matter with Diameter 10 Micrometer or Less
$PM_{2.5}$	Particulate Matter with Diameter 2.5 Micrometer or Less
PSD	Prevention of Significant Deterioration
SO_2	Sulfur Dioxide
VISTAS	Visibility Improvement State and Tribal Association of the Southeast
WRF	Weather Research and Forecasting Model
WTG	Wind Turbine Generator

1. Introduction

Ocean Wind, LLC is proposing to install wind turbine generators (WTGs) and offshore infrastructure required to transmit power generated by the WTGs to onshore interconnection point(s). The offshore components of Ocean Wind (Ocean Wind or Project) include WTGs, three offshore substations installed on platforms (OSSs), array cabling connecting WTGs, substation interconnector cable linking two OSSs to each other, offshore export cabling connecting OSSs to land, and emergency generators installed on a portion of the WTGs. The Project will install up to 98 WTGs which will be constructed on monopile support structures anchored to the ocean floor. The Project will be located approximately 13 nautical miles (nm) southeast of the Atlantic City, New Jersey shoreline.

Not far north of Atlantic City, along and just inland from the coast, is the Brigantine Division of the Edwin B. Forsythe National Wildlife Refuge (Brigantine), a PSD Class I area that ranges from approximately 27 km to 37 km northwest from the nearest edge of the proposed wind turbine array. Appendix A to this AQRV protocol is the proposed nearfield dispersion modeling protocol, with Figure 4-2 of that document showing the wind turbine array in comparison to the Brigantine Class I area receptors, which have been obtained from the standardized federal database on nationwide Class I area receptors.

This protocol briefly describes the modeling methodology proposed to analyze the impacts on Air Quality Related Values (AQRVs) in the Brigantine Class I area. The layout of emission sources to be modeled for the near-field analysis will be a starting point for the AQRV analysis, but those sources will be combined for some AQRV analyses as explained below. Please refer to the nearfield protocol for application of the Offshore and Coastal Dispersion Model (OCD), in Appendix A, for a description of the sources and emission locations to be used in the nearfield analyses.

2. Analysis Metrics and Models

There are three primary metrics for Class I area impacts on AQRVs that will be assessed with various modeling tools:

- plume blight, meaning a visible individual plume or collection of plumes due to emissions sources located in close proximity,
- regional haze, meaning a general reduction in visibility in the Class I area, due to project emissions sources that may be more widely dispersed in their emission locations, and
- deposition of nitrate and sulfate compounds that results from project-related emissions.

2.1 Plume Blight

Plume blight for this analysis will be assessed with the EPA screening model knows as VISCREEN (version 13190). Because preliminary VISCREEN runs have indicated that some of the conservative Level 1 screening criteria for plume blight would be exceeded at Brigantine, a more refined Level 2 analysis will be conducted. The Level 2 analysis quantifies the percent of the time that plumes could potentially be visible at the Class I area, accounting for actual meteorological data. The Level 1 and Level 2 VISCREEN analyses will follow the guidance provided in the “Workbook for Plume Visual Impact Screening and Analysis", EPA report # EPA-450/4-88-015.

VISCREEN will be applied separately to the 24-hour maximum emissions for three distinct emission activities that would occur in areas well separated from one another:

1) wind tower foundation installation of the monopile, at the NW corner of the wind tower array, which is the closest tower location to Brigantine,

2) horizontal directional drilling (HDD) for the southern export cable route, that would occur near the shoreline (approximately 500 meters offshore) of Ocean City, near the BL England substation, and
3) export cable installation for the northern export cable route (to Oyster Creek substation), with the vessel group for this activity modeled at a point closest to Brigantine.

A Level 1, and if needed, a Level 2 VISCREEN analysis will be applied to each of these three emission locations, with all vessels constituting the worst-case total 24-hour emissions in that location modeled as a single source for VISCREEN purposes.

2.2 Regional Haze

The analysis of regional haze will use the latest EPA-approved version of the California Puff Model (CALPUFF) model, version 5.8.5, level 151214, with EPA defaults for most inputs. CALPUFF will be executed separately for each of three years of meteorology (2018, 2019 and 2020), using a 12-kilometer spacing meteorological grid. The meteorological data will be Weather Research and Forecasting (WRF) data for the full modeling domain of data for the project region, as supplied for this project by the US Fish & Wildlife Service (FWS).

The main exceptions to default CALPUFF inputs will be with regard to background chemistry inputs as follows.

- A constant background ammonia (NH_3) concentration of 1.0 ppb is proposed for this analysis.
- Background ozone concentrations will be input to CALPUFF using the same hourly ozone data (for modeled years of 2018, 2019 and 2020) files used for the Ozone Limiting Method (OLM).

A discussion of the preparation of the hourly ozone files is provided in the nearfield dispersion modeling protocol for Ocean Wind, which is included in Appendix A.

The background ammonia value was chosen based on consideration of multiple references. The Interagency Workgroup on Air Quality Modeling (EPA 1998) recommended three ammonia background values for CALPUFF modeling:

- 0.5 ppb for forested lands
- 1.0 ppb for arid lands
- 10 ppb for grasslands

A second reference regarding NH_3 background is the Protocol for the Application of the CALPUFF Model for Analyses of Best Available Retrofit Technology (BART), December 22, 2005 (Revision 3.2 - 8/31/06), Visibility Improvement State and Tribal Association of the Southeast (VISTAS). Figure 3-3b of this document illustrates that for a semi-arid grassland area in western Wyoming, CALPUFF over-predicted the observed nitrate values by a factor of at least 2 for a constant 0.5 ppb NH_3 value, and up to a factor of 4 for a constant NH_3 value of 1.0 ppb.

Finally, a research summary by Fair and Yu (2020)[1] states that NH_3 concentrations over oceans are typically a few tens of parts per trillion (i.e., less than 0.1 ppb). Thus, there should not be a concern that during transport from the Ocean Wind emissions sources to the Brigantine receptors, NH_3 from natural ocean sources would cause higher background NH_3 concentrations. Over land vegetative decay and agricultural activities can generate significantly higher NH_3 concentrations, but these processes should have little time and distance over which to affect the air that is reaching Brigantine receptors from offshore emission locations.

[1] Nair, A.A., and Yu, F., 2020. Quantification of Atmospheric Ammonia Concentrations: A Review of Its Measurement and Modeling, *Atmosphere,* 2020, 11, 1092; Atmosphere | Free Full-Text | Quantification of Atmospheric Ammonia Concentrations: A Review of Its Measurement and Modeling (mdpi.com)

Given the information in the above references, it is expected that a constant NH_3 value of 1.0 ppb will provide quite conservative estimates of particulate nitrate and sulfate concentrations.

Finally, for the regional haze analysis, the conservative representation of all Ocean Wind sources that could be active during the construction phase in a single worse-case 24-hour period will be input to CALPUFF, with emission rates for NO_x, SO_2 and PM_{10}. This is the same worst-case set of emission sources to be used for short-term (24-hours and shorter) analysis of NAAQS, PSD Class II increments, and PSD Class I increments. The regional haze analysis will be based on worst-case 24-hour emissions for a somewhat limited group of vessels, which results in 215 emission points input to CALPUFF.

The regional haze modeling results will be compared against a threshold of 0.5 deciviews (dV), based on the average of the 8th high (98th percentile) 24-hour concentration across the 3 years of meteorology, as a measure of the potential significance of regional haze impacts.

2.3 Deposition Analysis

For the deposition analysis, CALPUFF will be executed using the annual average emission rates, given that deposition is primarily a long-term concern, rather than a short-term acute impact concern. For annual standards (NAAQS and PSD increments), the nearfield/OCD modeling will use a larger set of emission sources (288 points in total) that could emit over an annual period, but the annual average emission rates for these sources will be scaled appropriate to the annual averaging period for those analyses. Those same sources and emission rates will be used for the CALPUFF deposition analysis. The CALPUFF deposition results will be provided to FWS and EPA for review as part of the permit application modeling report.

3. CALPUFF Input Files

The proposed CALPUFF model input files for the regional haze (24-hour maximum emissions) and deposition (annual average emissions) analyses are attached (electronically) to this proposed AQRV protocol as Appendix B.

Appendix B includes four CALPUFF input files for one year of meteorology (2018), and the three hourly ozone input files. The four CALPUFF input files include two files for the 24-hour regional haze modeling (CALPUFF_A.INP and CALPUFF_B.INP), and two files for the annual deposition modeling (CALPUFF_2018A.INP and CALPUFF 2018B.INP) . Two files are needed for each averaging period, because CALPUFF has a limit of 200 sources, while there are 288 sources to be modeled for the annual (deposition) run, and 215 sources for the 24-hour (regional haze) run. Therefore, two CALPUFF runs will be done for each year of meteorology, for each of the regional haze and deposition runs, and the post-processor CALSUM will be used to add the results of the separate source group (A & B) runs together before further post-processing using the POSTUTIL and CALPOST programs. One representative input file is included in Appendix B for both POSTUTIL and CALPOST.

EJScreen Report (Version 2.0)

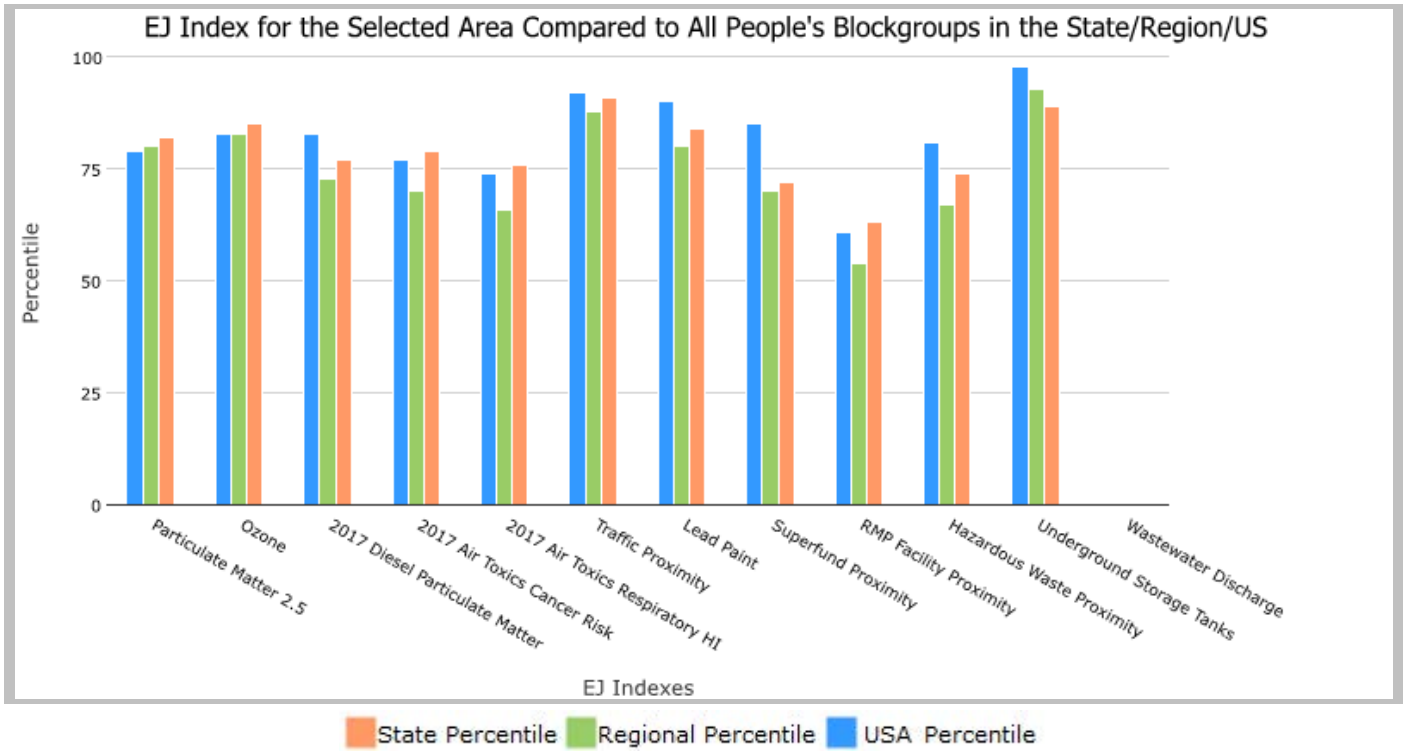
20 miles Ring Centered at 39.117946,-74.239474, NEW JERSEY, EPA Region 2

Approximate Population: 27,888

Input Area (sq. miles): 1256.38

OCW (The study area contains 1 blockgroup(s) with zero population.)

Selected Variables	State Percentile	EPA Region Percentile	USA Percentile
Environmental Justice Indexes			
EJ Index for Particulate Matter 2.5	82	80	79
EJ Index for Ozone	85	83	83
EJ Index for 2017 Diesel Particulate Matter*	77	73	83
EJ Index for 2017 Air Toxics Cancer Risk*	79	70	77
EJ Index for 2017 Air Toxics Respiratory HI*	76	66	74
EJ Index for Traffic Proximity	91	88	92
EJ Index for Lead Paint	84	80	90
EJ Index for Superfund Proximity	72	70	85
EJ Index for RMP Facility Proximity	63	54	61
EJ Index for Hazardous Waste Proximity	74	67	81
EJ Index for Underground Storage Tanks	89	93	98
EJ Index for Wastewater Discharge	N/A	N/A	N/A



This report shows the values for environmental and demographic indicators and EJSCREEN indexes. It shows environmental and demographic raw data (e.g., the estimated concentration of ozone in the air), and also shows what percentile each raw data value represents. These percentiles provide perspective on how the selected block group or buffer area compares to the entire state, EPA region, or nation. For example, if a given location is at the 95th percentile nationwide, this means that only 5 percent of the US population has a higher block group value than the average person in the location being analyzed. The years for which the data are available, and the methods used, vary across these indicators. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJSCREEN documentation for discussion of these issues before using reports.

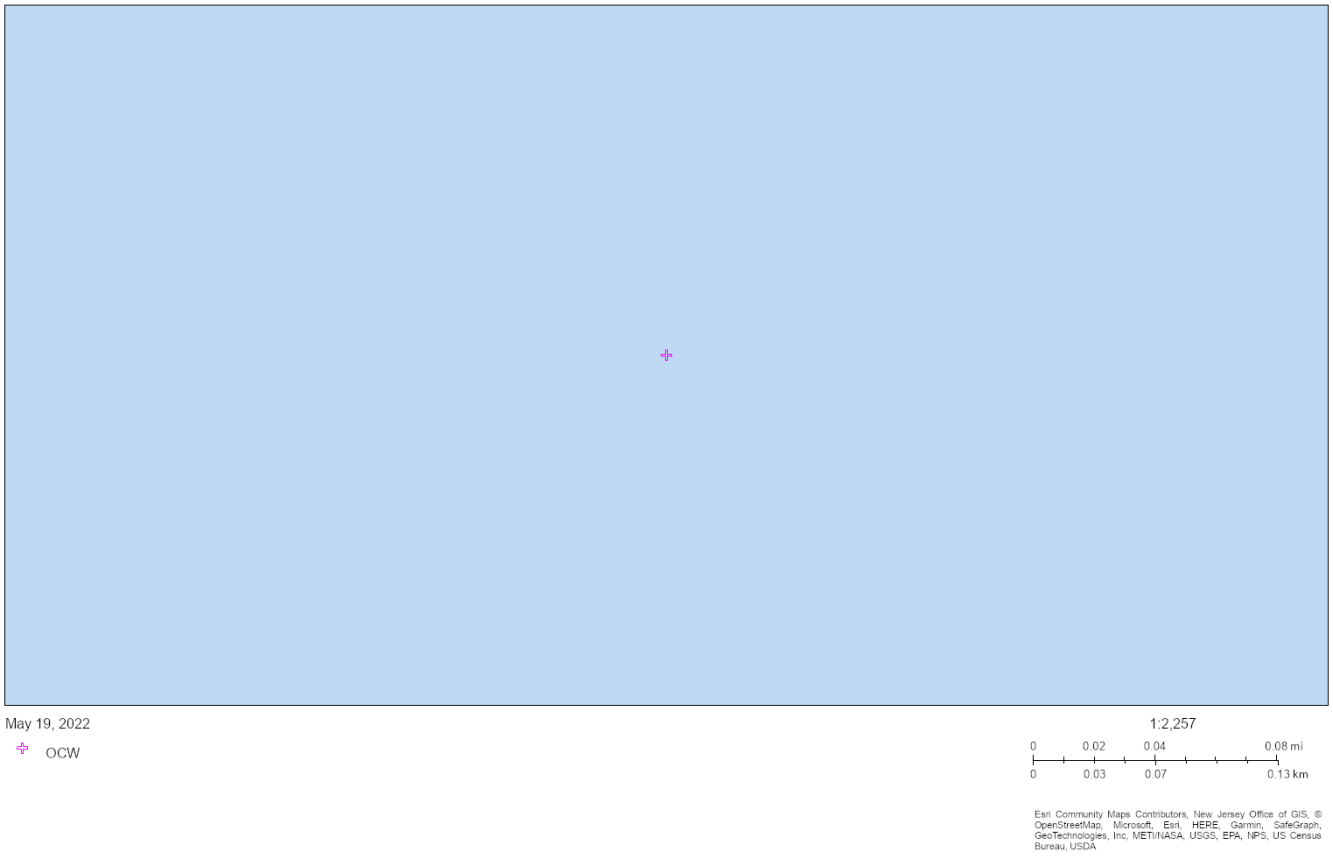
EJScreen Report (Version 2.0)

20 miles Ring Centered at 39.117946,-74.239474, NEW JERSEY, EPA Region 2

Approximate Population: 27,888

Input Area (sq. miles): 1256.38

OCW (The study area contains 1 blockgroup(s) with zero population.)



Sites reporting to EPA	
Superfund NPL	0
Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	1

EJScreen Report (Version 2.0)

20 miles Ring Centered at 39.117946,-74.239474, NEW JERSEY, EPA Region 2

Approximate Population: 27,888

Input Area (sq. miles): 1256.38

OCW (The study area contains 1 blockgroup(s) with zero population.)

Selected Variables	Value	State Avg.	%ile in State	EPA Region Avg.	%ile in EPA Region	USA Avg.	%ile in USA
Pollution and Sources							
Particulate Matter 2.5 (µg/m^3)	6.87	8.32	1	8.03	15	8.74	11
Ozone (ppb)	39.6	42.1	3	41.8	14	42.6	30
2017 Diesel Particulate Matter* (µg/m^3)	0.304	0.511	32	0.558	<50th	0.295	60-70th
2017 Air Toxics Cancer Risk* (lifetime risk per million)	20	29	19	29	<50th	29	<50th
2017 Air Toxics Respiratory HI*	0.21	0.38	8	0.37	<50th	0.36	<50th
Traffic Proximity (daily traffic count/distance to road)	1200	860	81	840	79	710	85
Lead Paint (% Pre-1960 Housing)	0.51	0.4	60	0.46	52	0.28	78
Superfund Proximity (site count/km distance)	0.1	0.44	15	0.28	34	0.13	67
RMP Facility Proximity (facility count/km distance)	0.02	0.76	0	0.62	0	0.75	0
Hazardous Waste Proximity (facility count/km distance)	1	3.3	43	4.9	35	2.2	57
Underground Storage Tanks (count/km^2)	27	15	80	9.3	89	3.9	97
Wastewater Discharge (toxicity-weighted concentration/m distance)	N/A	0.22	N/A	2.3	N/A	12	N/A
Socioeconomic Indicators							
Demographic Index	68%	34%	88	41%	78	36%	88
People of Color	78%	45%	79	49%	68	40%	82
Low Income	57%	23%	92	32%	82	31%	87
Unemployment Rate	10%	6%	86	6%	81	5%	85
Linguistically Isolated	16%	7%	85	14%	75	5%	90
Less Than High School Education	26%	10%	90	13%	84	12%	87
Under Age 5	6%	6%	54	6%	55	6%	49
Over Age 64	17%	16%	65	16%	60	16%	63

*Diesel particular matter, air toxics cancer risk, and air toxics respiratory hazard index are from the EPA's 2017 Air Toxics Data Update, which is the Agency's ongoing, comprehensive evaluation of air toxics in the United States. This effort aims to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that the air toxics data presented here provide broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. Cancer risks and hazard indices from the Air Toxics Data Update are reported to one significant figure and any additional significant figures here are due to rounding. More information on the Air Toxics Data Update can be found at: https://www.epa.gov/haps/air-toxics-data-update.

For additional information, see: www.epa.gov/environmentaljustice

EJScreen is a screening tool for pre-decisional use only. It can help identify areas that may warrant additional consideration, analysis, or outreach. It does not provide a basis for decision-making, but it may help identify potential areas of EJ concern. Users should keep in mind that screening tools are subject to substantial uncertainty in their demographic and environmental data, particularly when looking at small geographic areas. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJScreen documentation for discussion of these issues before using reports. This screening tool does not provide data on every environmental impact and demographic factor that may be relevant to a particular location. EJScreen outputs should be supplemented with additional information and local knowledge before taking any action to address potential EJ concerns.

Appendix K, Responses to EPA Comments Dated April 29, 2022 on March 2022 OCS Air Permit Application

Ocean Wind OCS Air Permit Application

1.0 EPA Comments – Attachment 1

1.1 Vessels Definitions and Other Clarifications

EPA Region 2 Comment a

To improve the clarity of the application, for each one of the vessel types included in Table 2-1 ("Vessel List - Construction and Commissioning Phase") on page 23 of the application, and Table 2-4 ("Marine Vessel List- O&M Phase") on page 26 of the application, please indicate to which of the following vessel categories listed at Section 6.2.1.5 ("LAER Determination") on pages 71-72 of the application it belongs: jack-up vessel, supply vessel, crew vessel, feeder jack-up vessel, primary crew transfer vessel, or secondary crew transfer vessel. If a vessel type included in Tables 2-1 and/or 2-4 does not belong to any of these vessel categories, please indicate this.

Ocean Wind Response a

Please see revised Tables 2-1 and 2-4 with an additional column indicating vessel category. Ocean Wind used the following vessel categories: Work Boat, Jack-up Vessel (Work Boat), Tugboat, Crew and Supply Vessel, and Primary Crew Transport Vessel. If a vessel does not meet any of the definitions provided in 17 CCR § 93118.5, the table indicates the vessel type is 'none'. See answer to comment 'b' below for an explanation of these categories.

EPA Region 2 Comment b

Please confirm whether the meaning of each of the following terms included in the application at pages 71-72 is identical to the definitions in the South Fork permit: jack-up vessel, supply vessel, crew vessel[5], feeder jack-up vessel, primary crew transfer vessel, and secondary crew transfer vessel. If not, please provide definitions for each of the above-listed terms. Should OW choose to provide definitions that differ from the ones in the South Fork permit, we recommend that OW propose in its application the same distinction made in the South Fork permit between "Primary Crew Transfer Vessel" and "Secondary Crew Transfer Vessel," or explain why such a distinction is not needed for its project. The definitions of the above-listed terms may be included as part of the OCS air permit, as needed.

Footnote 5: The definitions from the "CA SIP" that OW included in the application on pages 61-62 and 71-72, define only "crew and supply vessel" and do not separately define "crew vessel" and "supply vessel." Further, EPA notes that OW does not explain which regulations it is referring to using the abbreviation "CA SIP."

Ocean Wind Response b

Please see Ocean Wind's definitions below for the terms indicated by EPA in this comment. With respect to footnote 5 of the EPA comment document, the abbreviation "CA SIP" refers to 17 CCR § 93118.5, as described in Section 6.2.1.1. The application was edited to clarify this reference.

> Jack-up Vessel – Identical to South Fork permit definition: a vessel (whether self-propelled or not) that includes legs and a lifting system that enables the vessel to lower its legs into the seabed and elevate its hull to provide a stable work deck.
>
> Supply Vessel – Ocean Wind uses 'Crew and Supply Vessel' in lieu of 'Supply Vessel'

Crew Vessel – The South Fork permit does not contain a definition for 'Crew Vessel' (only for 'Primary Crew Transfer Vessel' and 'Secondary Crew Transfer Vessel'). Ocean Wind uses 'Crew and Supply Vessel' in lieu of 'Crew Vessel'.

Crew and Supply Vessel – Ocean Wind uses the following definition: a self-propelled vessel used for carrying personnel and/or supplies to and from off-shore and in-harbor locations (including, but not limited to, off-shore work platforms, construction sites, and other vessels). A crew and supply vessel does not include vessels that meet the definition of an Ocean-going Vessel.

Ocean-going Vessel – Identical to South Fork permit definition: a commercial, government, or military vessel meeting any one of the following criteria:

(A) A vessel greater than or equal to 400 feet in length overall as defined in 50 C.F.R. § 679.2, as adopted June 19, 1996;
(B) A vessel greater than or equal to 10,000 gross tons (GT ITC) per the convention measurement (international system) as defined in 46 C.F.R. 69.51-.61, as adopted September 12, 1989; or
(C) A vessel propelled by a marine compression-ignition engine with a per-cylinder displacement of greater than or equal to 30 liters.

Feeder Jack-up Vessel – Ocean Wind does not see the need to have a definition for 'feeder jack-up vessel' that is distinct from a 'jack-up vessel'.

Primary Crew Transport Vessel – At this point in time, Ocean Wind does not envisage the need to distinguish between 'Primary Crew Transport Vessels' and 'Secondary Crew Transport Vessels' as it is anticipated that all crew transport vessels associated with construction and with O&M will be needed on a frequent (e.g., daily). However, because the construction vessel spread and the O&M vessel spread could change in the future, Ocean Wind requests that the permit distinguish between 'Primary Crew Transport Vessel' and 'Secondary Crew Transport Vessel' similar to South Fork's permit. Ocean Wind's definition for 'Primary Crew Transport Vessel' is "any crew transport vessel that will be needed on an almost daily basis during both the construction and operational phases". Note that a Primary Crew Transport Vessel is a special category of 'Crew and Supply Vessel'.

Secondary Crew Transport Vessel – Ocean Wind's definition for 'Secondary Crew Transport Vessel' is identical to the definition in South Fork's air permit: all self-propelled vessels that are not Ocean-going Vessels and are used for carrying personnel to and from off-shore and in-harbor locations (including, but not limited to, off-shore work platforms, construction sites, and other vessels) from the staging area to the WTA and that are not the primary crew transfer vessel.

Work Boat – Ocean Wind's definition for 'Work Boat' is "a self-propelled vessel that is used to perform duties such as fire/rescue, law enforcement, hydrographic surveys, spill/response, research, training, and construction (including drilling)." A jack-up vessel is a type of work boat.

EPA Region 2 Comment c

Section 6.2.1.5 ("LAER Determination") on page 71 of the application summarizes what OW determined to be the lowest achievable emission rate ("LAER") for NO_x emissions. Specifically, OW proposes the use of vessels with certain "tiers" of marine engines but does not specify the federal standards that are the basis of those "tiers." The application further states that the use of vessels with the tier of marine engines identified as NO_x LAER will also serve as VOC LAER and best available control technology ("BACT") for NO_x, CO, PM, PM_{10}, $PM_{2.5}$ and GHG emissions. Please specify the federal standard(s) (e.g., 40 C.F.R. § 1042.101, etc.) corresponding to each "tier" of engine listed at section 6.2.1.5.[6]

Footnote 6: Please refer to the South Fork and Vineyard Wind OCS air permits as examples.

Ocean Wind Response c

Please see the revised LAER Determination in Section 6.2.1.5 addressing this request.

EPA Region 2 Comment d

Based on the application, OW has estimated the emissions from all diesel engines (main and auxiliary) on vessels that would be used for construction and commissioning ("construction") and operations and maintenance ("O&M") using "default emission factors," expressed as grams per kilowatt hour ("g/kW-hr"), obtained from BOEM's Offshore Wind Energy Facilities Emissions Estimating Tool – Version 2.0 (Wind Tool)[7]. See Section 3.1 ("Calculation Methodology") on page 28 of the application. Please describe how the default emission factors (g/kW-hr) for the diesel engines on vessels included in the table entitled "Project Information - BOEM Default Emission Factors" on page 3 of Appendix C to the application compare with the emission limits corresponding to Tier 1, 2, and 3 that are proposed as LAER for the diesel engines powering vessels which are OCS sources.

Footnote 7: BOEM developed the Offshore Wind Energy Facilities Emission Estimating Tool (Wind Tool) to help quantify emissions associated with proposed actions and assess the associated benefits of offshore wind energy facilities for purposes of NEPA analyses conducted for/by BOEM. A User's Guide for this Wind Tool is available at https://www.boem.gov/sites/default/files/documents/about-boem/BOEM-Wind-Power-User-Guide-V2.pdf.

Ocean Wind Response d

The specific emission standards corresponding to Tier 1, 2, 3, or 4 vary based on engine characteristics including engine category (Category 1, 2, 3), maximum in-use engine speed, model year, maximum engine power, and engine displacement. Therefore, there are multiple potential emission standards within each Tier category that may apply to the engines installed on vessels that are anticipated to meet the definition of an OCS source. Note that while the Project is not subject to NNSR for PM, a discussion on how the PM Tier standards compare to the BOEM default emission factors is included below because the $PM/PM_{10}/PM_{2.5}$ BACT analysis relies on the proposed LAER determination.

<u>NO_x</u>

The proposed LAER determination for Category 1 and 2 engines on jack-up vessels is to meet Tier 2 or better engine standards. The emission limits corresponding to Tier 2 through 4 engine standards range from 1.8 to 11.0 g/kw-hr for NOx, THC + NOx, or NMHC + NOx, as displayed in **Table 1.** The default BOEM emission factor for jack-up vessel main engines is 10.03 g/kW-hr and the default BOEM emission factor for jack-up vessel auxiliary engines is 11.55 g/kW-hr. If it is conservatively assumed that emission standards with the form THC + NOx and NMHC + NOx are 100% NOx, the BOEM default emission factor of 11.55 g/kW-hr is higher than the emission limits corresponding with all Tier 2 through 4 engine standards. The BOEM default emission factor of 10.03 g/kW-hr is higher than the emission limits corresponding with Tier 2 through 4 engine standards for all engine types except for the following (bolded items in Table 1):

- Category 2 engines certified to Tier 2 standards with a displacement greater than or equal to 25.0 and less than 30.0 liters per cylinder and a model year of 2007 or later.
- Category 2 engines certified to Tier 3 standards with a maximum rating of less than 2000 kW, a displacement greater than or equal to 25.0 and less than 30.0 liters per cylinder and a model year of 2014 or later.

However, note that the emission standard corresponding to these engine types (11.0 g/kW-hr) applies to THC + NOx. The NO_x portion of 11.0 g/kW-hr is less than 11.0 g/kW-hr.

Table 1. NO_x Emission Standards Corresponding to Tier 1, 2, 3 and 4 Engines

Tier	Engine Category	Maximum Engine Power (kW)	Displacement (L/cyl)	Model Year	Power Density kW/L	NOx Standard g/kW-hr	NOx + NMHC Standard g/kW-hr	THC + NOx Standard g/kW-hr
Tier 2	Category 1	≥ 37	< 0.9	2005+	NA	NA	NA	7.5 [a]
		All	0.9 ≤ D < 2.5	2004+	NA	NA	NA	7.2 [a]
		All	2.5 ≤ D < 5.0	2007+	NA	NA	NA	7.2 [a]
	Category 2	All	5.0 ≤ D < 15.0	2007+	NA	NA	NA	7.8 [a]
		< 3300	15.0 ≤ D < 20.0	2007+	NA	NA	NA	8.7 [a]
		≥ 3300	15.0 ≤ D < 20.0	2007+	NA	NA	NA	9.8 [a]
		All	20.0 ≤ D < 25.0	2007+	NA	NA	NA	9.8 [a]
		All	**25.0 ≤ D < 30.0**	**2007+**	**NA**	**NA**	**NA**	**11.0 [a]**
Tier 3	Category 1	<19	< 0.9	2009+	All	NA	7.5 [b]	NA
		19 ≤ P < 75	< 0.9	2009-2013	All	NA	7.5 [b]	NA
		19 ≤ P < 75	< 0.9	2014+	All	NA	4.7 [b]	NA
		≥ 75	< 0.9	2012+	≤ 35	NA	5.4 [b]	NA
		All	0.9 ≤ D < 1.2	2013+	≤ 35	NA	5.4 [b]	NA
		< 600	1.2 ≤ D < 2.5	2014-2017	≤ 35	NA	5.6 [b]	NA
		< 600	1.2 ≤ D < 2.5	2018+	≤ 35	NA	5.6 [b]	NA
		≥ 600	1.2 ≤ D < 2.5	2014+	≤ 35	NA	5.6 [b]	NA
		< 600	2.5 ≤ D < 3.5	2013-2017	≤ 35	NA	5.6 [b]	NA
		< 600	2.5 ≤ D < 3.5	2018+	≤ 35	NA	5.6 [b]	NA
		≥ 600	2.5 ≤ D < 3.5	2013+	≤ 35	NA	5.6 [b]	NA
		< 600	3.5 ≤ D < 7.0	2012-2017	≤ 35	NA	5.8 [b]	NA
		< 600	3.5 ≤ D < 7.0	2018+	≤ 35	NA	5.8 [b]	NA
		≥ 600	3.5 ≤ D < 7.0	2012+	≤ 35	NA	5.8 [b]	NA
		≥ 75	< 0.9	2012+	> 35	NA	5.8 [b]	NA
		All	0.9 ≤ D < 1.2	2013+	> 35	NA	5.8 [b]	NA
		All	1.2 ≤ D < 2.5	2014+	> 35	NA	5.8 [b]	NA
		All	2.5 ≤ D < 3.5	2013+	> 35	NA	5.8 [b]	NA
		All	3.5 ≤ D < 7.0	2012+	> 35	NA	5.8 [b]	NA
	Category 2	< 2000	7.0 ≤ D < 15.0	2013+	NA	NA	NA	6.2 [c]
		2000 ≤ P ≤ 3700	7.0 ≤ D < 15.0	2013+	NA	NA	NA	7.8 [c]
		< 2000	15.0 ≤ D < 20.0	2014+	NA	NA	NA	7.0 [c]
		< 2000	20.0 ≤ D < 25.0	2014+	NA	NA	NA	9.8 [c]
		< 2000	**25.0 ≤ D < 30.0**	**2014+**	**NA**	**NA**	**NA**	**11.0 [c]**
Tier 4	Category 2 and Commercial Category 1	600 ≤ P < 1400	All	2017+	NA	1.8 [d]	NA	NA
		1400 ≤ P < 2000	All	2016+	NA	1.8 [d]	NA	NA
		2000 ≤ P ≤ 3700	All	2014+	NA	1.8 [d]	NA	NA
		> 3700	< 15.0	2014-2015	NA	1.8 [d]	NA	NA
		> 3700	15.0 ≤ D < 30.0	2014-2015	NA	1.8 [d]	NA	NA
		> 3700	All	2016+	NA	1.8 [d]	NA	NA

[a] 40 CFR 1042 Appendix I Table 2 Primary Tier 2 Emission Standards for Commercial and Recreational Marine Engines at or Above 37 kW
[b] 40 CFR 1042.101 Table 1 Tier 3 Standards for Category 1 Engines Below 3700 kW
[c] 40 CFR 1042.101 Table 2 Tier 3 Standards for Category 2 Engines Below 3700 kW
[d] 40 CFR 1042.101 Table 3 Tier 4 Standards for Category 2 and Commercial Category 1 Engines At or Above 600 kW

The proposed LAER determination for Category 3 engines on jack-up vessels is to meet Tier 1 or better engine standards. The emission limits corresponding to Tier 1 through 3 engine standards range from 2.0 to 17.0 g/kw-hr for NOx, THC + NOx, or NMHC + NOx, as shown in **Table 2**. The default BOEM emission factor for jack-up vessel main engines is 10.03 g/kW-hr and the default BOEM emission factor for jack-up vessel auxiliary engines is 11.55 g/kW-hr. The BOEM default emission factor of 11.55 g/kW-hr is higher than the emission standards corresponding with Tier 1 for all Category of engines and Tier 2 for Category 3 engines except for the following:

- All engines with displacement of 2.5 or more liters per cylinder certified in accordance with 40 CFR 1042 Appendix I with a maximum rated test speed of less than 899 rpm.
- Category 3 engines certified to Tier 1 standards in accordance with 10 CFR 1042.104 with a model year between 2004 and 2010 and a maximum in-use engine speed of less than 889 rpm.
- Category 3 engines certified to Tier 2 standards in accordance with 10 CFR 1042.104 with a model year between 2011 and 2015 and a maximum in-use engine speed of less than 336 rpm.

The BOEM default emission factor of 10.03 g/kW-hr is higher than the emission standards for all Category 3 engines except for the following:

- Category 3 engines certified to Tier 1 standards in accordance with 10 CFR 1042.104 with a model year between 2004 and 2010 and a maximum in-use speed of less than 1819 rpm.
- Category 3 engines certified to Tier 2 standards in accordance with 10 CFR 1042.104 with a model year between 2011 and 2015 and a maximum in-use speed of less than 620 rpm.

Table 2. NO_x Emission Standards Corresponding to Tier 1, 2 and 3 for Category 3 Engines

Tier	Regulation	Engine Category	Engine Model Year	NO_x Limit g/kWh		
				n < 130	130 ≤ n < 2000	n ≥ 2000
1	40 CFR 1042 Appendix I	All	2004+	17.0	$45 * n^{-0.20}$	9.8
1	40 CFR 1042.104 Table 1	Category 3	2004-2010	17.0	$45 * n^{-0.20}$	9.8
2	40 CFR 1042.104 Table 1	Category 3	2011-2015	14.4	$44 * n^{-0.23}$	7.7
3	40 CFR 1042.104 Table 1	Category 3	2016+	3.4	$9.0 * n^{-0.20}$	2.0
n = engine's maximum in-use engine speed (revolutions per minute)						

PM

The proposed LAER determination for Category 1 and 2 engines on jack-up vessels is to meet Tier 2 or better engine standards. The PM emission limits corresponding to Tier 2 through 4 engine standards range from 0.04 to 0.5 g/kw-hr for PM, as displayed in **Table 3.** Note that the PM emission standard applies to only the filterable portion of the PM emissions, and does not apply to condensable PM.

The default BOEM $PM_{2.5}$ emission factor for jack-up vessel main engines is 0.30 g/kW-hr and the default BOEM emission factor for jack-up vessel auxiliary engines is 0.31 g/kW-hr. It is assumed that the BOEM default emission factor includes condensable PM. The BOEM emission factors in Wind Tool were based on EPA emission factors developed for national emission inventory purposes. While the national emission inventory documentation does not explicitly state that the marine vessel emission factors include the condensable fraction, the technical support document for the 2014 national emission inventory[1] explains that when EPA post-processed PM data to compute the condensable and filterable PM components for PM_{10} and $PM_{2.5}$, they found that the data reported by the state, local and tribal agencies for PM_{10} and $PM_{2.5}$ data to be comparable to the PM_{10} and $PM_{2.5}$ estimated by the EPA PM Augmentation Tool. Therefore, it is reasonable to assume that the national emission inventory data for PM_{10} and $PM_{2.5}$ includes the condensable fractions.

The condensable portion of PM_{10} and $PM_{2.5}$ emissions can be estimated using the AP-42 emission factor of 0.0077 lb/MMBtu from AP-42 Table 3.4-2 and converting to lb/hp-hr using the conversion factor of 7,000 Btu/hp-hr from footnote 'e' of AP-42 Table 3.4-1. The resulting condensable PM emission factor is 0.033 g/kW-

[1] See page 4-5 of EPA 2014 National Emissions Inventory, version 2 Technical Support Document (July 2018). Retrieved from: https://www.epa.gov/sites/default/files/2018-07/documents/nei2014v2_tsd_05jul2018.pdf.

hr. The BOEM default emission factor of 0.27 g/kW-hr (0.30 g/kW-hr minus the condensable portion of 0.033 g/kW-hr) is equal to or higher than the emission limits corresponding with Tier 2 through 4 engine standards for all engine types except for the following (bolded in Table 3 below):

- Category 1 engines certified to Tier 2 or Tier 3 standards with a displacement less than 0.9 liters per cylinder and a model year of 2005 or later.
- Category 1 engines certified to Tier 2 standards with a displacement greater than or equal to 0.9 and less than 1.2 liters per cylinder with a model year of 2004 or later.
- Category 1 engines certified to Tier 3 standards with a maximum power rating greater than or equal to 19 and less than 75 kW, a displacement less than 0.9 liters per cylinder, and a model year of 2009 or later.
- Category 2 engines certified to Tier 2 standards with a displacement greater than or equal to 15.0 liters per cylinder and a model year of 2007 or later.
- Category 2 engines rated less than 2,000 kW, certified to Tier 3 standards with a displacement greater than or equal to 15.0 and less than 20.0 liters per cylinder and a model year of 2014 or later.

Table 3. PM Emission Standards Corresponding to Tier 1, 2 and 3 for Category 3 Engines

Tier	Engine Category	Maximum Engine Power (kW)	Displacement (L/cyl)	Model Year	Power Density kW/L	PM Standard (Filterable Only) g/kW-hr
Tier 2	Category 1	**≥ 37**	**< 0.9**	**2005+**	**NA**	**0.4** [a]
		All	0.9 ≤ D < 1.2	2004+	NA	0.3 [a]
		All	1.2 ≤ D < 2.5	2004+	NA	0.2 [a]
		All	2.5 ≤ D < 5.0	2007+	NA	0.2 [a]
	Category 2	All	5.0 ≤ D < 15.0	2007+	NA	0.27 [a]
		< 3300	**15.0 ≤ D < 20.0**	**2007+**	**NA**	**0.5** [a]
		≥ 3300	**15.0 ≤ D < 20.0**	**2007+**	**NA**	**0.5** [a]
		All	**20.0 ≤ D < 25.0**	**2007+**	**NA**	**0.5** [a]
		All	**25.0 ≤ D < 30.0**	**2007+**	**NA**	**0.5** [a]
Tier 3	Category 1	**<19**	**< 0.9**	**2009+**	**All**	**0.4** [b]
		19 ≤ P < 75	< 0.9	2009-2013	All	0.3 [b]
		19 ≤ P < 75	< 0.9	2014+	All	0.3 [b]
		≥ 75	< 0.9	2012+	≤ 35	0.14 [b]
		All	0.9 ≤ D < 1.2	2013+	≤ 35	0.12 [b]
		< 600	1.2 ≤ D < 2.5	2014-2017	≤ 35	0.11 [b]
		< 600	1.2 ≤ D < 2.5	2018+	≤ 35	0.10 [b]
		≥ 600	1.2 ≤ D < 2.5	2014+	≤ 35	0.11 [b]
		< 600	2.5 ≤ D < 3.5	2013-2017	≤ 35	0.11 [b]
		< 600	2.5 ≤ D < 3.5	2018+	≤ 35	0.10 [b]
		≥ 600	2.5 ≤ D < 3.5	2013+	≤ 35	0.11 [b]
		< 600	3.5 ≤ D < 7.0	2012-2017	≤ 35	0.11 [b]
		< 600	3.5 ≤ D < 7.0	2018+	≤ 35	0.10 [b]
		≥ 600	3.5 ≤ D < 7.0	2012+	≤ 35	0.11 [b]
		≥ 75	< 0.9	2012+	> 35	0.15 [b]
		All	0.9 ≤ D < 1.2	2013+	> 35	0.14 [b]
		All	1.2 ≤ D < 2.5	2014+	> 35	0.12 [b]
		All	2.5 ≤ D < 3.5	2013+	> 35	0.12 [b]
		All	3.5 ≤ D < 7.0	2012+	> 35	0.11 [b]
	Category 2	< 2000	7.0 ≤ D < 15.0	2013+	NA	0.14 [c]
		2000 ≤ P ≤ 3700	7.0 ≤ D < 15.0	2013+	NA	0.14 [c]

Tier	Engine Category	Maximum Engine Power (kW)	Displacement (L/cyl)	Model Year	Power Density kW/L	PM Standard (Filterable Only) g/kW-hr
		< 2000	**15.0 ≤ D < 20.0**	**2014+**	**NA**	**0.34** [c]
		< 2000	20.0 ≤ D < 25.0	2014+	NA	0.27 [c]
		< 2000	25.0 ≤ D < 30.0	2014+	NA	0.27 [c]
Tier 4	Category 2 and Commercial Category 1	600 ≤ P < 1400	All	2017+	NA	0.04 [d]
		1400 ≤ P < 2000	All	2016+	NA	0.04 [d]
		2000 ≤ P ≤ 3700	All	2014+	NA	0.04 [d]
		> 3700	< 15.0	2014-2015	NA	0.12 [d]
		> 3700	15.0 ≤ D < 30.0	2014-2015	NA	0.25 [d]
		> 3700	All	2016+	NA	0.06 [d]

[a] 40 CFR 1042 Appendix I Table 2 Primary Tier 2 Emission Standards for Commercial and Recreational Marine Engines at or Above 37 kW
[b] 40 CFR 1042.101 Table 1 Tier 3 Standards for Category 1 Engines Below 3700 kW
[c] 40 CFR 1042.101 Table 2 Tier 3 Standards for Category 2 Engines Below 3700 kW
[d] 40 CFR 1042.101 Table 3 Tier 4 Standards for Category 2 and Commercial Category 1 Engines At or Above 600 kW

The proposed LAER determination for Category 3 engines on jack-up vessels is to meet Tier 1 or better engine standards. Note that there are no Tier 1 PM emission standards for engines rated above 37 kW so it is assumed that BOEM default emission factors are lower than PM emissions from Category 3 engines certified to Tier 1 standards.

1.2 Wind Turbines – Backup Power Systems During O&M

EPA Region 2 Comment

Please update Section 2 ("Project Description") of your application to include a description of (1) the backup system for powering the wind turbines that OW plans to use during O&M (since the application indicates no emergency diesel generators will be located on the wind turbines ("WTs") during O&M); (2) instances when the backup power system will be needed; and (3) instances when it may become necessary to install and operate diesel generators at or for use by the wind turbines.

Ocean Wind Response

Please note that a summary of this information was provided in Appendix A of the March 2022 permit application. The information has been added to Section 2.3.2, as requested, as well as expanded with additional information to help clarify.

1.3 NO_x, VOC, PM_{10}, and $PM_{2.5}$ Emissions and 40 C.F.R. § 1039.101(b) Emission Standards

EPA Region 2 Comment a.i.

Please revise the following tables of Appendix C of the application: 1) "Construction Emissions from Auxiliary Equipment Engines Onboard Vessels" on page 12 of Appendix C; 2) "Construction Emissions from Offshore Generator Engines" on page 13 of Appendix C; and 3) "Operations and Maintenance Emissions from Offshore Emergency Generator Engines" on page 16 of Appendix C to address the following:

Include the emissions factors in g/kW-hr for NO_x, VOC, PM_{10} and $PM_{2.5}$. Please provide all relevant assumptions and calculations supporting the selection of each emission factor.[8]

Footnote 8: The calculations and assumptions used to derive the NO_x and VOC emission factors (in g/kW-hr) are important because, many times, the tier standard(s) that applies to a given engine are presented as NO_x +

NMHC or NMHC. Also, the tier standard(s) contain emission standards for PM emissions, and not for PM_{10} and $PM_{2.5}$ emissions.

Ocean Wind Response a.i.

For each table indicated, the footnotes were revised to clarify the assumptions and calculations supporting the selection of each emission factor. Please note that the PTE for NO_x, CO, and PM, PM_{10}, and $PM_{2.5}$ was estimated based on the applicable emission standard from 40 CFR § 1039.101 Table 1. The PTE for PM_{10} and $PM_{2.5}$ was estimated based on the applicable emission standard from 40 CFR § 1039.101 Table 1 plus condensable PM estimated using an AP-42 emission factor from Table 3.4-2. The PTE for all other pollutants (CO_2, CH_4, N_2O, SO_2, and VOC) were estimated using AP-42 emission factors from Tables 3.4-1 and 3.3-1. The revised footnotes explain the assumptions used to derive NO_x, PM_{10}, $PM_{2.5}$ emission factors from Tier 4 standards.

EPA Region 2 Comment a.ii.

The column headers titled "NO_x + HC" that appear in tables on pages 12 and 13 of Appendix C should be revised to read "NO_x + NMHC," consistent with "Table 1 of 40 C.F.R. § 1039.101 - Tier 4 Exhaust Emission Standards After the 2014 model year g/kW-hr" found in 40 C.F.R. § 1039.101(b).

Ocean Wind Response a.ii.

Ocean Wind concurs. The change has been made to both tables.

EPA Region 2 Comment a.iii.

Add a "NMHC" column header for each of the three above-mentioned Appendix C tables, consistent with Table 1 of 40 C.F.R. § 1039.101(b).

Ocean Wind Response a.iii.

A column for NMHC was not added to each table as requested because Ocean Wind elected to conservatively estimate VOC emissions using AP-42 emission factors and not emission standards corresponding with Tier 4.

EPA Region 2 Comment a.iv.

We note several inconsistencies between the Tier 4 emissions standards (in g/kW-hr) of Table 1 in 40 C.F.R. § 1039.101(b), which appear to apply to the various size engines listed in the above-mentioned tables, and the 40 C.F.R. § 1039.101(b) emission standards that appear in the three above-mentioned Appendix C tables.[9] Please review the three Appendix C tables and update them with the correct emission standards that apply to each engine. Also, please update, as necessary, the tons per year ("tpy") emissions that correspond to the corrected and/or updated "g/kW-hr."

Footnote 9: For the Appendix C "Construction Emissions from Auxiliary Equipment Engines Onboard Vessels" table, the NMHC (g/kW-hr) emission standards are missing for the 760 HP, 500 HP, 480 HP, 250 HP, 150 HP and 90 HP engines; and the CO emissions standard for the 60.5 HP engines is 5 g/kW-hr. For the Appendix C "Construction Emissions from Offshore Generator Engines" table, the NMHC (g/kW-hr) emission standards are missing for the 600 kW, 156 kW and 76 kW engines, and, for the 37 kW engines, the applicable emission standard is NOx + NMHC and not NOx + HC. For the Appendix C "Operations and Maintenance Emissions from Offshore Emergency Generator Engines" table, the NMHC (g/kW-hr) emission standard is missing for the 600 kW engines.

Ocean Wind Response a.iv.

As noted in the above response, Ocean Wind elected not to include the applicable NMHC emission standard on any of the three tables because Ocean Wind is conservatively estimating VOC emissions using AP-42 emission factors. Ocean Wind updated the CO emission standard for the 60.5 HP (45 kW) engine from 5.5 g/kW-hr to 5.0 g/kW-hr on the table "Construction Emissions from Auxiliary Equipment Engines Onboard Vessels". The column header for table "Construction Emissions from Offshore Generator Engines" has been updated from NOx + HC to NOx + NMHC. Ocean Wind reviewed the Tier 4 emission standards from Table 1 in 40 CFR § 1039.101 and confirmed that the listed emission standards are correct for each engine in the tables.

EPA Region 2 Comment b.i.

Please make the following changes regarding the "Operations and Maintenance Emissions from Auxiliary Equipment Onboard Vessels" table included on page 15 of Appendix C to the application:

Please update the "Operations and Maintenance Emissions from Auxiliary Equipment Onboard Vessels" table on page 15 of Appendix C to the application, to include, for each engine listed in the table, the corresponding Tier 4 emission standards (g/kW-hr) from Table 1 in 40 C.F.R. § 1039.101(b). Please make sure that this Appendix C table includes the NO_x, VOC, PM_{10}, and $PM_{2.5}$ (g/kW-hr) emissions, as well as all related calculations and assumptions.

Ocean Wind Response b.i.

Ocean Wind used AP-42 emission factors to estimate PTE for the equipment listed in "Operations and Maintenance Emissions from Auxiliary Equipment Onboard Vessels" because Ocean Wind believes that the PTE of O&M should be considered separately from the PTE of the construction and commissioning phase when determining whether equipment in the O&M phase is subject to NNSR or PSD programs. The O&M PTE is below NNSR and PSD thresholds when O&M is considered separately from the construction and commissioning phase PTE and when the WTGs are not included in the OCS source in O&M. Because the PTE is below NNSR thresholds, LAER does not apply, and the engines do not have to meet Tier 4 emission standards. Therefore, AP-42 emission factors were used to estimate emissions from this equipment.

Because EPA HQ has not yet resolved these two issues (whether the PTE of O&M should be considered separately from the PTE of the construction and commissioning phase and whether the WTGs should be included in the OCS source in O&M), Ocean Wind is providing the requested information to prevent a potential delay in permit issuance. The O&M PTE provided with Appendix B of the revised Application includes Tier 4 standards for the equipment listed in "Operations and Maintenance Emissions from Auxiliary Equipment Onboard Vessels", as requested in this comment.

EPA Region 2 Comment b.ii.

Please explain whether the tpy emissions from the engines that power the equipment onboard vessels during O&M were calculated based on the Tier 4 emission standards in 40 C.F.R. § 1039.101(b), consistent with the way the tpy emissions were calculated for similar engines used during construction.

Ocean Wind Response b.ii.

The emissions from equipment listed in "Operations and Maintenance Emissions from Auxiliary Equipment Onboard Vessels" were not calculated based on Tier 4 emission standards in 40 CFR § 1039.101. Please see response to previous comment (EPA Comment b.i.) for an explanation.

The O&M PTE provided with Appendix B of the revised Application uses Tier 4 emission standards in 40 CFR § 1039.101 to estimate PTE.

1.4 Potential to Emit Clarifications

EPA Region 2 Comment a.

It appears that there are inconsistencies between the tpy values for some pollutants, as they appear in Table 3-3 ("Emission Estimates – Construction and Commissioning Phase") on page 33 of the application; in Table 4-2 ("WTA Potential-to-Emit During Construction and Commissioning and PSD SER Thresholds") on page 36 of the application; and in the "Project Emission Summary" table for "Construction" on page 22 of Appendix C to the application. Please review and update these three tables as necessary to ensure consistency. Also, please clarify whether the potential to emit ("PTE") of PM_{10} and $PM_{2.5}$ emissions in tpy included in the application account for both filterable and condensable fractions. If not, the application should be revised accordingly.

Ocean Wind Response a.

Ocean Wind updated the PTE tables to ensure consistency across the permit application. As noted in the cover letter to this revised application, Ocean Wind revised the vessel spread information since the submittal of the March 2022 application. The PTE submitted with this revised application reflects the resulting revised PTE estimates.

The PM_{10} and $PM_{2.5}$ PTE for equipment that estimated PTE based on Tier 4 emission standards from 40 CFR § 1039.101 (auxiliary equipment onboard vessels and generators) has been updated to include condensable fractions. It is assumed that the BOEM emission factors for PM_{10} and $PM_{2.5}$ include the condensable fraction. See the explanation above in response to Comment 1.1(d).

EPA Region 2 Comment b.

OW indicates at Section 6.3 ("BACT Determination") on page 100 of the application that this project is subject to BACT for particulate matter ("PM") emissions. Thus, the application should be updated to include PM emissions in all tables containing project emissions, either as tpy, g/kW-hr, or other units, as applicable.

Ocean Wind Response b.

Ocean Wind updated the application to display PM in all tables that display project PTE. Ocean Wind also updated the PTE estimates to include PM emissions separately from PM_{10} and $PM_{2.5}$.

1.5 Generator Set Engines on Offshore Substations

EPA Region 2 Comment a.

Potential to Emit - Based on the application, there will be three (3) identical generator set engines ("engines"), each rated at 600 kW, installed permanently on the three offshore substations ("OSS") (one on each OSS). These engines will be operated as non-emergency engines during the commissioning of the project. The engines are described as EPA Tier 4 certified engines as defined by 40 C.F.R. § 1039.101(b), and the PTE of these 3 engines was calculated based on the Tier 4 emissions standards. OW plans to continue to use the 3 engines during O&M, but as emergency engines. As stated on page 26 of the application, OW anticipates using the 3 engines during O&M for the following purposes: (1) power outage in the entire windfarm; (2) failure in both primary sources of power (auxiliary transformers) supplying low voltage and utility systems; and (3) normal testing and maintenance. However, based on the application, the PTE of each of the 3 engines during O&M was calculated based on 100 hr/yr/engine for "routine testing and maintenance non-emergency operation." Both the federal and New Jersey regulations define the PTE to be the maximum capacity of a stationary source to emit under its physical and operational design, and provide that any physical or operational limitation on the capacity of the source to emit a pollutant shall be treated as part of its design if the limitation or the effect it would have on emissions is federally enforceable.[10] As described above, the PTE for each of the 3 engines does not assume the maximum capacity, or worst-case scenario, because it only accounts for routine testing

and maintenance operation, and not for the engines' other types of operation. The calculation of PTE for the 3 engines in the application is not consistent with the applicable definition of PTE. The PTE should be determined based upon an estimate of the maximum number of hours the engine could operate, taking into account all of the scenarios under which OW anticipates using the engines. In the event that OW determines that 100 hr/yr/each engine (as included in the application) is a reasonable and realistic worst-case scenario that would cover all of the engines' expected operating scenarios, OW should update its application by clearly indicating that is the case. OW should also be aware that any estimates of annual hours of operation OW uses in its calculation may provide the basis for permit conditions (e.g., an annual tpy emissions cap on these engines) to ensure that the source's operations are consistent with the information presented in the application.

Footnote 10: For complete definitions, see, e.g., 40 C.F.R. § 55.2 (definition of "potential emissions"); 40 C.F.R. § 52.21 (definition of "potential to emit"); N.J.A.C. 7:27-8.1 (definition of "potential to emit"); and N.J.A.C. 7:27-22.1 (definition of "potential to emit").

Ocean Wind Response a.

Although the engines described by EPA will be used for emergency purposes during O&M, Ocean Wind revised the permit application to reflect that Ocean Wind will purchase generator engines that will be certified by the manufacturer to meet Tier 4 standards in 40 CFR § 1039.101(b) for non-emergency engines. Ocean Wind is requesting a 1,000 hour per year limit per engine on the hours of operation that will cover all operating scenarios, such as emergency use, readiness testing, and maintenance. See revised PTE estimates and revised description of the engines in Section 2.3.2, Section 2.5.2, and Section 3.1.3.

EPA Region 2 Comment b.

EPA Certificate of Conformity to Tier 4 – Once it becomes available, please provide a copy of the EPA certificate of conformity showing the 3 generator set engines rated at 600 kW are certified to the Tier 4 standards in 40 C.F.R. § 1039.101(b). Note that the EPA certificate of conformity must be included in the permitting record before commencing the public notice and comment period for the draft permit.

Ocean Wind Response b.

Ocean Wind disagrees that a certificate of conformity must be included in the permitting record before commencing the public notice and comment period for the draft permit. Ocean Wind requests a permit condition requiring Ocean Wind to purchase generator engines certified to Tier 4 standards in 40 CFR § 1039.101(b). Ocean Wind suggests this permit condition should be sufficient evidence for the public notice documentation that the generator engines will comply with 40 CFR § 1039.101(b).

However, because Ocean Wind wishes to avoid any delay in the processing of the air permit application, Ocean Wind will supply the EPA Certificate(s) of Conformity from the generator contractor before the commencement of public notice and comment period for the draft permit if available at that time.

1.6 BACT and LAER – All Emission Sources Included in the OCW OCS Air Application

EPA Region 2 Comment

OW has submitted an OCS air permit application for the construction and O&M of its project. EPA's view is that the construction and O&M of a wind development area (including all offshore substations and wind turbine generators located within it) are part of a single OCS source. The OCS air permit that would eventually be issued to OW would thus authorize the construction and O&M of all of the emission sources included in the application. Based on our review of the information submitted thus far, it appears the OW project is subject to PSD[11] and nonattainment new source review ("NNSR")[12] requirements, which among other things require the application of BACT and LAER for certain pollutants emitted by the emission sources that constitute the OCS

source. Thus, the application should be updated to include BACT and LAER analyses for the following emission sources during O&M:

(1) for engines powering vessels that would meet the definition of OCS source, engines powering electric auxiliary equipment onboard such vessels, and engines powering electric generator sets on any OSS, OW should conduct a BACT analysis addressing NO_x, CO, PM, PM_{10}, $PM_{2.5}$ and GHG, and LAER for NO_x and VOC; and

(2) for switchgears[13] on WTs and OSS during O&M, OW should conduct a BACT analysis that addresses sulfur hexafluoride (SF_6)[14] fugitive emissions.[15] We recommend that OW, as part of the BACT analysis for SF_6 emissions, consider the option of using SF_6-free switchgears.

Footnote 11: See 40 C.F.R. § 52.21 ("Prevention of Significant Deterioration of Air Quality").

Footnote 12: See N.J.A.C. 7:27-18 ("Control and Prohibition of Air Pollution from New or Altered Sources Affecting Ambient Air Quality).

Footnote 13: Based on the OW application, there will 103 switchgears that will contain a total mass of SF_6 of 24,226 lbs and will annually emit 121.16 lbs of SF6 (or 1,380 tons of CO2e).

Footnote 14: SF_6 is used as an electrical and thermal insulator in electrical equipment, but it is also a powerful greenhouse gas, having a global warming potential (GWP) of 23,500 times that of carbon dioxide (CO_2). SF_6 has the highest GWP of all greenhouse gases addressed by the Intergovernmental Panel on Climate Change (IPCC) inventory protocols.

Footnote 15: BACT applies to the fugitive emissions for a non-category PSD source, such as OW (see 40 C.F.R. § 52.21(b)(1)(iii) for a list with source categories), once it is determined that the source is subject to PSD without taking into account the fugitive emissions.

Ocean Wind Response

As Ocean Wind describes in Appendix B of the revised Application, Ocean Wind does not agree that the O&M phase should be subject to PSD and NNSR because the construction and commissioning phase is over the PSD and NNSR thresholds.Additionally, as Ocean describes in Appendix A of the revised Application, WTGs should not be considered part of the OCS source in O&M. When excluding WTGs from the OCS source, the O&M PTE does not exceed PSD or NNSR thresholds and, therefore, the Project is not subject to the requirement to submit any BACT or LAER analyses for emission sources in the O&M phase.

Because EPA HQ has not yet resolved the two policy issues described above, Ocean Wind is providing the requested information to prevent a potential delay in permit issuance. Please see Appendix B of the revised Application with the requested information.

1.7 BACT and LAER Analysis – Engines Powering Vessels that Would be OCS Sources

EPA Region 2 Comment

OW's application proposes that, for the engines powering vessels that would be OCS sources during construction, BACT for NO_x, CO, PM, PM_{10}, $PM_{2.5}$, and GHG emissions and LAER for NO_x and VOC emissions would be the use of vessels with lower tier (more polluting) engines (Tier 1 and Tier 2), and only switching to the use of vessels with higher tier/less polluting engines if those vessels will be available.

OW's justification for the BACT and LAER emission limits it selected can be summarized as follows:

(1) vessels used for the construction and O&M of the OW project will be third-party vessels not owned by OW; (2) there is a limited supply of vessels worldwide that are capable of constructing offshore wind projects; (3) there are several other offshore wind projects scheduled to be constructed at the same time as OW, both in the US and abroad, and all of these projects will use vessels from the same limited pool of available vessels; (4) OW cannot wait for the vessels that have less polluting engines to be available because this would delay its construction and O&M schedule(s); and (5) it is not feasible for OW to require third-party vessel contractor owners to replace or retrofit their vessels' engines to minimize pollution because doing so would constrain OW's ability to substitute vessels on short notice due to schedule changes, the third-party vessel contractor would not be able to recover the high cost of retrofit or replacement, and the costs of replacing and/or retrofitting would be so great that they would prevent offshore wind farms from being built.

The OW project is covered under Title 41 of the Fixing America's Surface Transportation Act (FAST- 41), with an already-established final permit decision date, and an already-estimated construction and operation schedule in place (at the earliest, construction would commence over 1 year from now and operations would commence over 3 years from now). Thus, we would like to understand the specific facts that would prevent OW from securing contracts for low-polluting vessels. We believe the public would benefit from such information and clarification, in the context of a future public review of a draft OCS air permit for the OW project. Thus, EPA recommends that OW include in its BACT and LAER analysis information explaining the rationale behind OW's overall approach to securing contracts for the vessels needed for construction and O&M. We also recommend updating the application with information supporting the statement that the costs of replacing and/or retrofitting high-polluting vessels engines would be prohibitive for the development of the offshore wind industry in the US.

Further, based on our brief review of several technical articles,[16] Orsted, the owner of OW and a company that also has several other planned wind projects offshore the United States and abroad, is engaged in chartering and constructing installation/construction vessels and support/service vessels that it plans to use for the construction and O&M of its other US projects. Based on these articles, it appears that these vessels will use very low polluting engines. We recommend updating the application with information relevant to the new vessels referenced in those articles and explaining why Orsted does not plan to use those new vessels for its OW project, if that is the case.

Footnote 16: See technical articles available at https://us.orsted.com/news-archive/2021/06/contract-to-charter-offshore-wind-turbine-installation-vessel, https://us.orsted.com/news-archive/2022/01/rhode-island-shipyards-to-build-five-new-offshore-wind-crew-vessels, and https://us.orsted.com/news-archive/2022/03/construction-begins-on-chouest-vessel.

Ocean Wind Response

EPA has requested Ocean Wind provide additional information regarding Ocean Wind's approach to securing vessels needed for construction and O&M. The offshore wind industry is in its infancy in the United States. No large offshore wind projects (>500 MW) have been built yet in the United States. The contracting process to secure the vessels needed to build offshore wind projects of a large scale is dynamic and complex and this contracting process has only been conducted for a handful of projects in the United States.

Only the vessels that will be used by Ocean Wind and that are part of the OCS source must comply with BACT and LAER emission limits. As such, Ocean Wind is focusing its response on those vessels Ocean Wind reasonably anticipates will be part of the OCS source: jack-up vessels (a type of work boat) and crew transport vessels in the construction phase and jack-up vessels (a type of work boat) in the O&M phase.

Ocean Wind's approach to securing contracts for jack-up vessels for the monopile foundation installation and the WTG topside installation is to contract out the construction activity, not the individual jack-up vessel. Orsted procurement documents do not require that third party contracts for the jack-up vessel(s) meet the highest

available Tier standard (such as Tier 4 for Category 1 and 2 engines with maximum ratings of greater than 600 kW). If Orsted were to include such requirements, Orsted would be required to bear the cost of both the cost of the engine replacement or retrofit as well as the cost of all lost vessel days while the vessel is out of commission due to the required upgrades. Including such requirements would also significantly prolong the time to secure contracts because vessel owners would have to evaluate the feasibility, time, and cost of vessel engine upgrades, as well as determine yard availability.

Additionally, the selection of contractors for a large offshore wind construction project is itself an extremely complex, years-long, multi-faceted process. As described in supporting documentation for the Vineyard Wind air permit application and considered in the EPA's issuance of the associated construction permit,

> "Primary contractor selection must take into account: technical feasibility of the contractor's methodology, impact of the contractor's methodology on numerous resources, proposed schedule, past experience, history of injuries or fatalities, quality of the health, safety and environmental documentation, ability to comply with permits/permit applications, component delivery risk, ability to provide a Jones Act-compliant vessel spread, ability to accommodate design, permit, or schedule changes; ability to provide local content, cost, and more."

The delay in contracting a jack-up vessel would put the project at substantial risk due to the tight jack-up vessel market. The cost of engine upgrades would also put the project at substantial risk, independent from the contracting delay. While LAER cannot consider cost for a single project, the New Source Review Workshop Manual[2] states that:

> "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 brief internet search reveals how constrained the wind turbine installation vessel market is today, and how even more constrained it is poised to become in the near future. According to an article[3] written in February 2021,

> "There were only 32 wind turbine installation vessels in the world in 2020, according to a recent analysis by Norwegian firm Rystad Energy. Even though more are being built, the global fleet won't be enough to meet offshore demand beyond 2025, according to Rystad… What's more, some of the vessels in the existing fleet are becoming obsolete because turbines are growing increasingly gigantic. At 351 feet long, a single turbine blade for the Haliade X is already longer than the tower height of one of GE's older turbines. Longer blades can generate more power, and taller turbines can reach stronger winds at higher altitudes. So companies are competing with each other by building bigger turbines. "You see this race," Fløtre says.
>
> That makes the shortage of ships a bigger problem. So far, there are only 12 vessels in the world capable of installing next-generation wind turbines like the Haliade X, according to ACP.
>
> There's yet another challenge that's specific to the US: none of the existing global fleet complies with America's Jones Act. The 1920 act requires vessels moving between two points in the US to be built, owned, crewed, and registered in the US. That also applies to a vessel transporting turbine parts from a US port to a project site that's within federal waters."

---

[2] US Environmental Protection Agency (EPA). 1990, October. *New Source Review Workshop Manual. Prevention of Significant Deterioration and Nonattainment Area Permitting.* Retrieved from https://www.epa.gov/nsr/nsr-workshop-manual-draft-october-1990.

[3] Retried from https://www.theverge.com/22296979/us-offshore-ships-wind-boom-installation-vessels.

Note that Ocean Wind is installing the Haliade X turbines so there are, at most, only twelve vessels available worldwide capable of constructing the WTGs. The offshore wind market is growing at a fast rate, not only in the United States, but worldwide, so the likelihood that a majority of the twelve vessels are available in the time frame needed to construct Ocean Wind is slim. Additionally, there may be other constraining factors that limit the suitability of any particular jack-up vessel to the construction needs of the Project, including the design of the crane and lift systems needed to handle components. It is likely that if Ocean Wind were to include requirements that the jack-up vessel(s) meet the highest available Tier standard, Ocean Wind would not receive competitive bids for the construction of the Project due to the global constraint of the jack-up vessel market, in general, and specifically for jack-up vessels with Tier 4 (or Tier 3) compliant engines.

Due to the complexity of the contracting process, Orsted is unable to fully quantify the cost of including requirements that jack-up vessel(s) meet the highest available Tier standard, both for Ocean Wind and for the industry in general. The costs to offshore wind projects would be incurred due to schedule delays could include the following:

[redacted]	[redacted]	[redacted]

In summary, there are only twelve jack-up vessels worldwide capable of installing 12-MW WTGs, such as those being installed with Ocean Wind. Most of these existing jack-up vessels have engines that are Tier 1 or Tier 2. Requiring vessel owners to upgrade or replace vessel engines to be certified to higher emission standards is cost-prohibitive not just to Ocean Wind, but to the domestic offshore wind industry due to the risks such requirements would impose on the competitive bidding process, the costs of the upgrades (including the costs of renting the vessels while work is being performed), and the costs of schedule impacts due to both the extended bidding process and the vessel upgrades. Similarly, projects cannot wait for lower-polluting vessels to become available because of the existing and future constrained global availability of jack-up vessels exacerbated by the significant projected growth of the global offshore wind industry, including domestically.

While there are some jack-up vessels currently under construction, or slated to be under construction soon, with lower-emitting engines, these vessels will either not be ready in time for the construction schedule of Ocean Wind or the vessels are already committed to other projects. The Charybdis, chartered by Dominion Energy, Orsted, and Eversource, will be the first domestic wind turbine installation vessel. It will be a jack-up vessel and is scheduled to be sea-ready by late 2023. The Charybdis is already contracted to support Revolution Wind and Sunrise Wind, under joint development by Orsted and Eversource. These projects are scheduled to be constructed at the same time as Ocean Wind, so the Charybdis cannot be used for Ocean Wind. Eneti has contracted the construction of a newbuild WTIV with Daewoo Shipbuilding and Marine Engineering[4]. The WTIV is scheduled to be delivered second quarter 2025, which is too late to be used for Ocean Wind, based on Ocean Wind's construction schedule.

It is likely that crew transport vessels will be part of the OCS source during construction by being attached to an OCS source. In the revised permit application, Ocean Wind is clarifying that proposed LAER for primary crew transport vessels is to meet the highest Tier standard for marine engines in 40 CFR § 1042.101. Tier 4 emission standards apply to engine(s) at or above 600 kW and Tier 3 emission standards apply to engine(s)

[4] Retrieved from https://www.rigzone.com/news/eneti_drops_plans_to_build_jones_actcompliant_wtiv-03-feb-2022-167796-article/

below 600 kW (see revised Section 6.2.1.5). At this point, Ocean Wind has determined that all of its crew transport vessels in both construction and O&M will meet the definition of a primary crew transport vessel and will therefore meet the highest Tier standard for marine engines in 40 CFR § 1042.101.

Note that one of the vessels described by EPA in footnote 16, the ECO Edison, is a service operation vessel (SOV) designed to provide support during O&M and scheduled to be delivered in 2024. Ocean Wind does not plan to utilize an SOV during O&M because the O&M logistical plan is shore-based whereas other projects may employ an offshore-based logistical plan that would include the use of an SOV. Ocean Wind's construction and commissioning vessel spread includes an SOV in the construction support vessel package. However, it is not anticipated that this vessel will meet the definition of an OCS source, so it would not be required to comply with LAER or BACT.

Ocean Wind disagrees that the O&M phase should be subject to PSD and NNSR because the construction and commissioning phase is over the PSD and NNSR thresholds. See response to Comment 1.6 above. However, to avoid a delay in permitting, the discussion provided above for jack-up vessels in the construction and commissioning phase applies to jack-up vessels in the O&M phase. Although there is a longer lead-time to secure contracts for the O&M activities, the only activities that Orsted is able to schedule far in advance are the planned maintenance activities. The only activities that require the use of a jack-up vessel are unplanned events that require the exchange of a major component of a WTG or OSS.

Additionally, the global constraint of the jack-up vessel market is predicted to become worse over the next ten years, especially for jack-up vessels capable of installing turbines larger than 9 MW. As noted in an article dated February 2, 2022[5], "Turbines larger than 8 MW accounted for just three per cent of global installations between 2010 and 2021, but that percentage is forecast to surge to 53 per cent by 2030. As the energy transition accelerates, demand for offshore wind turbine installation vessels worldwide, excluding China, will rocket from 11 vessel years in 2021 to almost 79 vessel years by 2030. The need for installation vessels for turbines larger than 9 MW, which was nonexistent in 2019, will grow significantly by the end of the decade and reach 62 vessel years in 2030...". Although the article is describing the installation of turbines, the same vessel technology required to install new turbines of a certain size and type are needed to replace components on existing turbines of the same size and type.

Therefore, the reasoning provided above relevant to the construction and commissioning phase also applies to the O&M phase, both because of the unpredictable nature of events which would require the use of a jack-up vessel in O&M and due to the predicted future constraints of the global jack-up vessel market.

1.8 Emission Offsets

EPA Region 2 Comment

EPA considers all offshore substations and wind turbine generators associated with a particular wind development area to be part of a single OCS facility. Accordingly, the permit application should quantify, as part of the OCS source's PTE, all air pollutant emissions from vessels servicing or associated with the OCS facility, including emissions from vessels servicing or associated with the WTs and occurring within 25 miles of the OCS facility, during construction and O&M.[17] Based on the application, the OW project will be subject to the requirements of N.J.A.C. 7:27-18 ("Control and Prohibition of Air Pollution from New or Altered Sources Affecting Ambient Air Quality (Emission Offset Rule)"), including the requirement to obtain emission reductions or offsets to offset the PTE of NO_x during O&M consistent with N.J.A.C. 7:27-18.3(c)(1). See also N.J.A.C. 7:27-18.5. The application should be updated to include an emission offset demonstration consistent with N.J.A.C. 7:27-18.3(e).

[5] Retrieved from https://www.offshorewind.biz/2022/02/02/bottlenecks-loom-unless-installation-vessels-keep-pace-with-super-sized-wind-turbines-report/.

Footnote 17: The permit application should take into account similar considerations in its Title V analysis.

Ocean Wind Response

N.J.A.C. 7:27-18.3(h) specifies that emissions resulting from temporary emission increased directly from the construction of a project are not subject to offset requirements. As such, offsets are not required for the construction and commissioning phase of the Project. Ocean Wind disagrees that the O&M phase should be subject to PSD and NNSR because the construction and commissioning phase is over the PSD and NNSR thresholds. See response to Comment 1.6 above.

As Ocean Wind describes in Appendix A of the revised Application, Ocean Wind does not agree that WTGs should be considered part of the OCS source in O&M. When excluding WTGs from the OCS source, the O&M PTE does not exceed PSD or NNSR thresholds and, therefore, the Project would not need to obtain emission offsets for emissions in the O&M phase (and would not be required to obtain a Title V permit).

Because EPA HQ has not yet resolved the two policy issues described above, Ocean Wind is providing the requested information to prevent a potential delay in permit issuance. Please see revised Appendix B of the revised Application with the requested information.

1.9 Emissions From Vessels Within 25 miles of the OCS Source

EPA Region 2 Comment

The application references emissions that occur “within 25 nautical miles of the Lease Area’s centroid.” EPA’s regulations in 40 CFR part 55 do not define emissions from OCS sources based on the centroid of the lease area, although EPA has allowed the use of a centroid approach to emissions calculations on a case-by-case basis in other OCS permitting actions. If OW elects to use a centroid approach to the calculation of to-and-fro vessel emissions for PTE purposes, the application should provide a rationale for use of this approach that is consistent with the definition of “OCS source” in CAA section 328(a)(4)(C) and EPA’s regulatory definition of “potential emissions” in 40 CFR § 55.2. If, for example, using the centroid approach would result in a calculation of vessel emissions approximately equivalent to the calculation resulting from assessment of each vessel’s emissions whenever it is located within 25 miles of the lease area boundary, EPA may take this information into account in determining whether the calculation of the OCS source’s “potential emissions” is consistent with CAA and part 55 requirements.

Ocean Wind Response

When estimating emissions using the boundary of the lease area, the overall Project emissions are less than if estimating emissions using the centroid of the lease area. There are two categories of vessel emissions: transit and on-site maneuvering. On-site maneuvering emissions are unchanged regardless of how “within 25 miles of the OCS source” is defined because on-site maneuvering emissions are based on the total duration of vessel use, minus time spent in transit, maneuvering at port, and hoteling at port. The on-site maneuvering duration is blind to whether vessel transit is occurring within or outside of 25 miles of the OCS source. Transit emissions depend on which port a vessel travels to/from and number of trips to/from that port, as well as how within 25 miles of the OCS source is defined. Changing from the centroid of the array to the boundary of the lease area would increase emissions from all transit routes except for Atlantic City. Atlantic City is approximately 21 nautical miles from the centroid of the lease area and approximately 14 nautical miles from the lease area boundary. There are enough vessels traveling to and from Atlantic City in construction and commissioning that the total transit emissions from all vessels decreases when using the boundary of the lease area compared to the centroid of the array. The total number of hours vessels spend in transit within 25 miles of the OCS source during construction and commissioning when using the boundary of the lease area is approximately 4% lower than the total number of hours vessels spend in transit when using the centroid of the array. Therefore, it is

consistent with the definition of PTE in 40 CFR § 55.2 to utilize the centroid of the array area because this results in a conservatively high calculation of PTE.

1.10 Coastal Zone Management Act Requirements

EPA Region 2 Comment

Please provide the following related to the CZMA requirements: (1) a copy of the OW consistency certification[18] that the proposed offshore wind energy project complies with the enforceable policies of NJ's NOAA-approved coastal program and that such activities will be conducted in a manner consistent with that program[19]; and (2) evidence that the certification of compliance has been submitted to NJDEP. Note that EPA will need to receive a copy of the NJDEP concurrence and/or consistency decision prior to commencing public notice and comment for any draft OCS air permit.

Footnote 18: The consistency certification is required to be submitted under section 307(c)(3)(B) of the CZMA, 16 U.S.C. § 1456(c)(3)(B), and 15 C.F.R. § 930.76 or section 307(c)(3)(A) of the CZMA, 16 U.S.C. § 1456(c)(3)(A), and 15 C.F.R. § 930.57.

Footnote 19: All OCS air permit applicants for OCS projects offshore NJ, that are also applicants as defined under the CZMA at 15 C.F.R. § 930.52, are required to provide NJ with a consistency certification because NJ has identified, "[a]ny Federally licensed or permitted activity described in any OCS plan for all lease sales on the Outer Continental Shelf of the [United] States under which New Jersey is identified as an 'affected state'" as subject to federal consistency review in its federally approved coastal management program. See https://coast.noaa.gov/data/czm/consistency/media/nj.pdf.

Ocean Wind Response

Ocean Wind has included a discussion of the Coastal Zone Management Act requirements in the revised permit application in Section 4.1.6 and has included a copy of the Coastal Zone Consistency Assessment in Appendix F to the OCS permit application. Appendix F also includes documentation that the Coastal Zone Consistency Assessment was provided to NJDEP on March 30, 2021.

Ocean Wind anticipates receipt of NJDEP concurrence and/or consistency decision no later than October 28, 2022. Per 15 CFR § 930.96 and 16 CFR § 1456, it is Ocean Wind's understanding that EPA is required to receive a copy of the NJDEP concurrence and/or consistency decision prior to issuing the OCS air permit but not prior to commencing public notice.

2.0 EPA Comments – Attachment 2

2.1 Prior Communication Between OCW and EPA Region 2

Email Message from Suilin Chan (EPA Region 2) on April 7, 2022 to Katharine Perry (Ocean Wind)

Subject: RE: Ocean Wind 1 OCW Air Permit Application

Katharine,

Regarding your question below on environmental justice (EJ), we do see it in the application but we recommend that it should also reference and respond to the new Environmental Justice Executive Orders, namely,

- Executive Order 13985, Advancing Racial Equity and Support for Underserved Communities Through the Federal Government, January 20, 2021:
    - https://www.federalregister.gov/documents/2021/01/25/2021-01753/advancing-racial-equity-and-support-for-underserved-communities-through-the-federal-government

- Executive Order 14008, Tackling the Climate Crisis at Home and Abroad, January 27, 2021:
    - https://www.federalregister.gov/documents/2021/02/01/2021-02177/tackling-the-climate-crisis-at-home-and-abroad
- Executive Order 13990, Protecting Public Health and the Environment and Restoring Science To Tackle the Climate Crisis, January 20, 2021:
    - https://www.federalregister.gov/documents/2021/01/25/2021-01765/protecting-public- health-and-the-environment-and-restoring-science-to-tackle-the-climate-crisis

As you see there is also an overlap with EJ and climate change under EO 14008. It should be noted that in February 2022, EPA released EJSCREEN 2.0 which includes new layers for climate change. This tool should assist you in preparing the EJ analysis for this project. There is no concrete guidance to approach the EJ/climate change analysis. It is a case-by-case analysis that should address EPA's goal to reduce climate pollution, increase resilience to the impacts of climate change, protects public health, delivers environmental justice, and deployment of clean energy technology initiatives.

We note that you have conducted public outreach. Enhanced public outreach is an important part of addressing environmental justice concerns. In that regard, please be sure to include references to outreach that considered linguistic isolation as well as the other demographics found under EJSCREEN 2.0. We also recommend a discussion of how and where the administrative record will available electronically for easy public access and translation of key documents.

EPA will also coordinate with NJDEP to ensure that their Environmental Justice law is addressed appropriately. Please contact Annamaria Colecchia if you have additional questions on this subject matter.

Sincerely, Suilin

Ocean Wind Response

Please see the updated Environmental Justice section of the revised air permit application (Section 12).

Email Message from Suilin Chan (EPA Region 2) on March 30, 2022 to Katharine Perry (Ocean Wind)

Subject: FW: Ocean Wind 1 OCW Air Permit Application

Dear Ms. Perry,

Thank you for your initial March 29, 2022, submittal of Ocean Wind's OCS air permit application. EPA is now in the process of reviewing your submittal. We initially note that the submitted permit application is incomplete because, as your email indicates, it does not include the necessary air quality modeling analyses to demonstrate compliance with the NAAQS, PSD increments, the air quality related values (AQRVs), and the additional impact analyses. It also lacks an environmental justice analysis and the MMIF meteorological data evaluation with respect to your project. As EPA continues its review of the submitted application, EPA may identify additional inadequacies, which it will also convey to Ocean Wind.

The submitted permit application does not include a revised air modeling protocol. The protocol included in the application appears to be the same as the draft air modeling protocol Ocean Wind previously submitted to EPA on November 12, 2021, which EPA found inadequate. EPA provided written comments on that draft protocol on February 16, 2022 and discussed its comments with you during meetings on December 15, 2021, January 31 and March 10, 2022. We were surprised that our comments were not addressed in the OCS air permit application notwithstanding Ocean Wind's representation to EPA during the March 10, 2022, meeting that it planned to submit a revised protocol by mid-April.

Your OCS air permit application submittal email indicated that, "Ocean Wind anticipates submitting the final application including modeling analysis by June 29, 2022." As you know, the FAST-41 dashboard established

for the Ocean Wind project includes as a milestone Ocean Wind's submittal of a complete OCS air permit application by June 29, 2022. However, in order to meet that milestone, it is imperative that EPA receive the updated modeling protocol as soon as possible, and the air modeling analysis at least 45 days in advance of the June 29 milestone, as EPA's review of the air modeling analysis can take at least a month. If EPA's review determines that corrections or revisions to the air quality analysis are needed, Ocean Wind would need time to make those changes before the application can be deemed complete. If Ocean Wind initially submits its air modeling analysis to EPA too close to June 29, and revisions to that analysis are necessary, Ocean Wind may be unable to meet the June 29 milestone. Please let us know as soon as possible if you have any questions.

Sincerely, Suilin Chan

Ocean Wind Response via Email on March 31, 2022:

Good afternoon,

Thank you for your initial review of Ocean Wind 1's OCS air permit application. We understand that the application cannot be considered complete until the requisite air quality modeling analyses are submitted. With respect to the environmental justice analysis, could you please confirm the environmental justice discussion that was included in Section 12 of the permit application is adequate for the initial completeness review?

Ocean Wind appreciates EPA's request that a revised modeling protocol be submitted to allow EPA sufficient review time. Ocean Wind anticipates submitting a revised modeling protocol in mid-April which will address EPA's comments on the initial modeling protocol.

Barring any unforeseen circumstances in the modeling analyses, Ocean Wind anticipates submitting the modeling analyses to demonstrate compliance with the NAAQS and PSD increments by 45 days in advance of the June 29 milestone, or mid-May. The MMIF meteorological data evaluation for the two (offshore and onshore) node point data sets received from EPA will also be submitted with the final modeling analyses in mid-May.

We anticipate submitting the modeling analyses to demonstrate impacts with respect to Class I AQRVs (plume visibility, regional haze and deposition) June 1, 2022 as we are currently waiting on the data needed to allow us to complete this modeling. Our understanding is EPA will rely on Tim Allen of the USFWS to conduct the completeness review of the AQRV analysis and we are working closely with him during the preparation of the analyses to minimize review time upon submittal.

Ocean Wind looks forward to continuing to work with EPA during your review of our application and supporting materials.

Please reach out if you have any additional questions or concerns.

Thank you!

Katharine