Atlantic Shores Offshore Wind

Construction and Operations Plan

Lease Area OCS-A 0499: Atlantic Shores South

Cover art by Sandra Daly Art & Design

Volume II: Affected Environment

Submitted to:

BOEM
Bureau of Ocean Energy Management

Submitted by:

ATLANTIC SHORES offshore wind

Prepared by:

EDR
a better environment

Epsilon Associates Inc.

May 2024

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF APPENDICES

LIST OF APPENDICES (continued)

LIST OF APPENDICES (continued)

LIST OF APPENDICES (continued)

LIST OF APPENDICES (continued)

LIST OF APPENDICES (continued)

LIST OF ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
ACP	American Clean Power Association
ACE	Atlantic City Electric
ACPARS	Atlantic Coast Port Access Route Study
ADLS	Aircraft Detection Lighting System
AIS	Automatic Identification System
AMAPPS	Atlantic Marine Assessment Program for Protected Species
AMSL	Above Mean Sea Level
ANSI	American National Standards Institute
APE	Area of Potential Effect
API	American Petroleum Institute
AQRV	Air Quality Related Values
ASA	Applied Science Associates, Inc.
ATON	Aids to Navigation
AUV	Autonomous Underwater Vehicle
BACT	Best Available Control Technology
BFT	Blue Fin Tuna
BHMTC	Beach Haven Marlin and Tuna Club
BIA	biologically important area
BMP	Best Management Practice
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
BWEA	British Wind Energy Association
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CER	Certified Emission Reductions
CFR	Code of Federal Regulations
CO	Carbon Monoxide
COP	Construction and Operations Plan
COVID	Coronavirus
CMECS	Coastal and Marine Ecological Classifications Standards
CMS	Condition monitoring systems
CTV	Crew Transfer Vessels
DB	Disturbance
DAS	Distributed Acoustic Sensing
DC	Direct Current
DCR	Discharge Cleanup and Removal
DEC	Department of Environmental Conservation

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

DFO	Department of Fisheries and Oceans
DHS	Department of Homeland Security
DIN	dissolved inorganic nitrogen
DIP	dissolved inorganic phosphorus
DLRP	Division of Land Resource Protection
DMA	Dynamic Management Areas
DPCC	Discharge Prevention, Containment, and Countermeasure
DO	Dissolved Oxygen
DPS	distinct population segments
DSC	digital select calling
DSM	digital surface map
DTM	digital terrain model
ECC	Export Cable Corridors
EDR	Environmental Design & Research
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EHWL	extreme high-water level
ELWL	extreme low-water level
EJ	environmental justice
EMF	electromagnetic fields
ENOW	Economics National Ocean Watch
EPA	Environmental Protection Agency
EPM	Environmental Protection Measures
EPP	Environmental Protection Plan
ERP	Emergency Response Plan
ESA	Endangered Species Act
ESRI	Environmental Systems Research Institute
FAA	Federal Aviation Administration
FDR	Facility Design Report
FEMA	Federal Emergency Management Agency
FIR	Fishing Industry Representative
FLM	Federal Land Manager
FLO	Fisheries Liaison Officer
FPP	Fisheries Protection Plan
FTE	full time equivalent
FWRAM	Full Wave Range Dependent Acoustic Model
GARFO	Greater Atlantic Regional Fisheries Office
GBS	gravity-based structure

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

GCT	Global Container Terminals
GDP	Gross Domestic Product
GFEW	GROW Fine East Coast Model
GHG	Greenhouse gas
GIS	Geographic Information Systems
GNSS	Global Navigation Satellite System
GOANG	Go Air National Guard
GPR	Ground Penetrating Radar
GPS	Global Positioning Systems
GWP	Global Warming Potential
GWRA	Global Warming Response Act
HAB	Harmful Algal Bloom
HAP	hazardous air pollutants
HAPC	habitat areas of particular concern
HAT	Highest Astronomical Tide
HDD	horizontal directional drilling
HDPE	high-density polyethylene
HF	High frequency
HFNS	High-Frequency Natural Sound
HMS	Highly Migratory Species
HPO	Historic Preservation Office
HRG	High Resolution Geophysical
HRSA	Historic Resources Study Area
HRVEA	Historic Resource Visual Effects Assessment
HSSE	health, safety, security, and environmental
HVAC	high voltage alternating current
HVDC	high voltage direct current
IBEW	International Brotherhood of Electrical Workers
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IMPLAN	Impact analysis for planning
IPF	Impact producing factors
ISO	International Organization for Standardization
IUOE	International Union of Operating Engineers
IWC	International Whaling Commission
IWQAR	Integrated Water Quality Assessment Report
JCP&L	Jersey Central Power & Light

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

KOP(s)	key observation point(s)
LAER	Lowest Achievable Emission Rate
LF	low frequency
LGM	Last Glacial Maximum
LIUNA	Laborers International Union of North America
LNG	Liquified Natural Gas
LNM	Local Notice to Mariner
LUCY	Look Up Cultural Resources Yourself
MARIPARS	Massachusetts and Rhode Island Port Access Route Study
MARPOL	International Convention for the Prevention of Pollution from Ships
MBES	multibeam bathymetry echosounders
MBTA	Migratory Bird Treaty Act
MCS	multichannel high-resolution seismic system
MCHSI	Monmouth County Historic Sites Inventory
MCPS	Monmouth County Parks System
MDMR	Maine Department of Marine Resources
MEC	Munitions and Explosives of Concern
MF	Mid-frequency
MLLW	Mean Lower Low Water
MMPA	Marine Mammal Protection Act
MONM	Marine Operations Noise model
MOTBY	Military Ocean Terminal at Bayonne
MOU	Memorandum of Understanding
MP	monopile
MRASS	Mariner Radio Activated Sound Signals
MRI	magnetic resonance imaging
MRIP	Marine Recreational Information Program
MRMTC	Manasquan River Marlin Tuna Club
MTANJ	Marine Trades Association of New Jersey
MSFCMA	Magnuson–Stevens Fishery Conservation and Management Act
MSL	mean sea level
MW	megawatt
MWBE	minority and women-owned business enterprise
MWTS	Motus Wildlife Tracking System
NA	Not applicable
NAS	Noise Abatement Systems
NASCA	North American Submarine Cable Association

NAAQS	National Ambient Air Quality Standards
NAICS	North American Industry Classification System
NAROW	North Atlantic right whale
NCA	National Construction Alliance
NCCA	National Coastal Condition Assessment
NEAMAP	Northeast Area Monitoring and Assessment Program
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
NEQ	net explosive quantity
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NIESH	National Institutes of Environmental Health Sciences
nm	nautical miles
NGTC	National Guard Training Center
NHL	National Historic Landmarks
NHP	Natural Heritage Program
NHPA	National Historic Preservation Act
NJ	New Jersey
NJAC	New Jersey Administrative Code
NJBPU	New Jersey Board of Public Utilities
NJDEPE	New Jersey Department of Environmental Protection and Energy
NJDEP	New Jersey Department of Environmental Protection
NJDOT	New Jersey Department of Transportation
NJGWS	New Jersey Geological and Water Survey
NJHPO	New Jersey State Historic Preservation Office
NJPDES	New Jersey Pollutant Discharge Elimination System
NJWEA	New Jersey Wind Energy Area
NJWP	New Jersey Wind Port
NLEB	Northern long-eared bat
NMFS	National Marine Fisheries Service
NMS	Noise Mitigation System
NO_2	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
NORM	Navigational and Operational Risk Model
NO_X	Nitrogen Oxide
NPS	National Park Service
NRHP	National Register of Historic Places
NSPS	New Source Performance Standards
NSR	New Source Review

NSRA	Navigational Safety Risk Assessment
NSSP	National Shellfish Sanitation Program
NTM	Notices to Mariners
NVIC	Navigation and Vessel Inspection Circular
NWI	National Wetland Inventory
NYSDEC	New York State Department of Environmental Conservation
O&M	Operations and maintenance
OCS	Outer Continental Shelf
OPAREA	Operating Areas
OREC	Offshore Renewable Energy Credit
OREI	Offshore Renewable Energy Installation
OSRP	Oil Spill Response Plan
OSS	offshore substation
PAPE	Preliminary Area of Potential Effect
PARS	Port Access Route Study
PATON	Private Aid to Navigation
PDE	Project Design Envelope
PJM	Pennsylvania-New Jersey-Maryland Interconnection
PM	Protection Measures
POI	points of interconnection
PSD	Prevention of Significant Deterioration
PTE	Potential to Emit
PSMESP	Protected Species Management and Equipment Specifications Plan
RFC	Reliability First Corporation
ROSA	Responsible Offshore Science Alliance
ROV	Remotely Operated Vehicle
ROW	right-of-way
RSZ	Rotor swept zone
SAA	State Agreement Approach
SAR	search and rescue
SO_2	Sulfur Dioxide
SOTA	State of the Art
SOV	service operation vessel
SPCC	Spill Prevention Control and Countermeasure
SRHP	State Register of Historic Places
STEAM	Science, Technology, Engineering, the Arts, and Mathematics
SUA	special use airspace
SWPPP	Stormwater Pollution Prevention Plan

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

TACP	Tactical Air Control Party
TCP	Traditional Cultural Properties
THPO	Tribal Historic Preservation Officers
TMP	Traffic Management Plan
TP	transition piece
tpy	tons per year
TSS	total suspended solids
UAV	Unmanned aerial vehicle
UBCJA	United Brotherhood of Carpenters and Joiners of America
ULSD	Ultra Low Sulfur Diesel
US	United States
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
UXO	unexploded ordnance
VDH	Virginia Department of Health
VGP	Vessel General Permit
VHF	very high frequency
VI	Visual Impact
VIA	Visual Impact Assessment
VMS	vessel monitoring system
VOC	volatile organic compound
VRA	Visual Resource Assessment
VSA	visual study area
VTR	vessel trip report
WIND	Wind Innovation and New Development Institute
WMBE	Woman's Minority Business Enterprise
WSA	Water Supply Authority
WTA	Wind Turbine Area
WTGs	wind turbine generators
ZVI	zone of visual influence

1.0 INTRODUCTION

Atlantic Shores Offshore Wind, LLC (Atlantic Shores) is a 50/50 joint venture between EDF-RE Offshore Development, LLC (a wholly owned subsidiary of EDF Renewables, Inc. [EDF Renewables]) and Shell New Energies US, LLC (Shell). Atlantic Shores is submitting this Construction and Operations Plan (COP) to the Bureau of Ocean Energy Management (BOEM) for the development of two offshore wind energy generation projects (Projects 1 and 2, including an Overlap Area; also referred to as the Projects) within Lease Area OCS-A 0499 (the Lease Area).

Project 1 will be owned and operated by Atlantic Shores Offshore Wind Project 1, LLC (Atlantic Shores Project 1 Company). Project 2 will be owned and operated by Atlantic Shores Offshore Wind Project 2, LLC (Atlantic Shores Project 1 Company). Atlantic Shores is the owner and an affiliate of both the Atlantic Shores Project 1 Company and the Atlantic Shores Project 2 Company. Accordingly, for ease of reference, the term "Atlantic Shores" is used throughout the COP to refer interchangeably to the Project Companies. Further, at the time of this COP submission, in accordance with 30 CFR Parts 585.106, 585.107, and 585.409, Atlantic Shores has requested the assignment of the Project 1 and Project 2 development areas within the Lease Area to Atlantic Shores Project 1 Company and Project 2 Company jointly.

While this COP only describes the development of the southern portion of the Lease Area, as assigned to (or pending assignment to) Atlantic Shores Project 1 Company and Atlantic Shores Project 2 Company, Atlantic Shores maintains the right to develop the remainder of the Lease Area, which would be permitted under separate filings.

The purpose of the Projects is to develop offshore wind energy generation facilities in the Lease Area to provide clean, renewable energy to the northeastern United States by the mid-to-late 2020s. The Projects will help both the United States and New Jersey achieve their renewable energy goals, diversify New Jersey's electricity supply, increase electricity reliability, and reduce greenhouse gas emissions. The Projects will also provide numerous environmental, health, community, and economic benefits, including the creation of substantial new employment opportunities. This COP is organized into two volumes:

- Volume I provides detailed descriptions of the offshore and onshore facilities for the Projects and how Atlantic Shores plans to construct, operate, and decommission those facilities.

- Volume II provides a comprehensive assessment of the Projects' potential impact-producing factors (IPFs) to physical, biological, visual, cultural, and socioeconomic resources and describes the numerous environmental protection measures (EPMs) that Atlantic Shores will employ to avoid, minimize, and mitigate those potential effects. Volume II also characterizes the Projects' environmental setting.

The resources discussed in Volume II were identified through consultation and coordination with Federal and State agencies and tribes; desktop assessments; site-specific field studies; and stakeholder outreach. The site characterization and assessment is structured in accordance with 30 CFR Parts 585.626(a) and (b) and the BOEM guidelines on the information requirements for a COP for OCS renewable energy activities on a commercial lease (BOEM 2020). The approach also considers the additional detailed information and certifications, as specified under 30 CFR Part 585.627, which support BOEM's compliance with National Environmental Policy Act regulations as well as other applicable laws and regulations, including, but not limited to, the Endangered Species Act, Clean Air Act, and the Marine Mammal Protection Act. The information in Volume II also supports ongoing agency consultations and serves as the foundation and input for any Federal and State permits Atlantic Shores will be required to file.

Volume II is organized by resource area as follows:

- Environmental Setting
- Geology
- Physical Oceanography and Meteorology
- Physical Resources
- Air Quality
- Water Quality
- Biological Resources
- Wetlands and Waterbodies
- Coastal and Terrestrial Habitat and Fauna
- Birds
- Bats
- Benthic Resources
- Finfish, Invertebrates, and Essential Fish Habitat
- Marine Mammals
- Sea Turtles
- Visual Resources

- Cultural Resources
- Aboveground Historic Properties
- Terrestrial Archaeological Resources
- Marine Archaeological Resources
- Socioeconomic Resources
- Demographics, Employment, and Economics
- Environmental Justice
- Recreation and Tourism
- Commercial Fisheries and For-Hire Recreational Fishing
- Land Use and Coastal Infrastructure
- Navigation and Vessel Traffic
- Other Marine Uses and Military Activities
- Aviation and Radar
- Onshore Transportation and Traffic
- In-Air Noise and Hydroacoustics
- Public Health and Safety.

Within Volume II, the Atlantic Shores Project Area (Project Area) refers to the footprint of all offshore and onshore facilities for Projects 1 and 2, including areas affected by construction, operations and maintenance (O&M), and decommissioning. A detailed description of the Projects is provided in Volume I Project Information. Figure 1.0-1 provides an overview of the Projects. As applicable, the Project Area is defined in each resource section as the Offshore Project Area or Onshore Project Area as follows:

- Offshore Project Area – The Offshore Project Area includes the Federal and State waters and underlying seabed associated with the Wind Turbine Area (WTA, which includes Project 1, Project 2, and the Overlap Area) and the Atlantic and Monmouth Export Cable Corridors (ECCs). Offshore Project components include up to 200 wind turbine generators

(WTGs),[1] up to 10 offshore substations[2], and up to one permanent meteorological (met) tower. Up to eight total HVAC and/or HVDC export cables will be installed in two offshore ECCs. These offshore facilities are described in detail in Sections 4.1 through 4.6 of Volume I.

- Onshore Project Area[3] – The Onshore Project Area includes the area associated with onshore infrastructure that occurs from landfall sites to the points of interconnection (POIs). Onshore Project components include the Atlantic and Monmouth Landfall Sites, onshore interconnection cables, onshore substations and/or converter stations to be developed by Atlantic Shores, the O&M facility and potential adjacent parking structure, and the Cardiff and Larrabee POIs. These onshore facilities are described in detail in Sections 4.7 through 4.9 of Volume I.

The environmental setting for each resource (titled the "affected environment" in each section) is described based on available scientific literature, site-specific environmental survey data, ongoing Federal and State agency consultations, and public outreach. Results of these site surveys and assessments have been included as supporting technical appendices to this COP.

Atlantic Shores is requesting review and authorization of the Projects using a Project Design Envelope (PDE) approach as outlined in BOEM's 2018 draft PDE guidance. According to BOEM (2018), "A PDE approach is a permitting approach that allows a project proponent the option to submit a reasonable range of design parameters within its permit application, allows a permitting agency to then analyze the maximum impacts that could occur from the range of design parameters, and may result in the approval of a project that is constructed within that range." The PDE approach allows Atlantic Shores design flexibility and an ability to respond to advancements in industry technologies and techniques.

Impacts include both beneficial and detrimental effects that result from the interaction between a resource and an IPF. BOEM (2018) states, "IPFs identify the cause-and-effect relationships between actions (e.g., a wind energy project) and relevant physical, biological, economic, or cultural resources. They define the particular ways in which an action or activity affects a given resource. It is common that multiple IPFs affect the same resource."

---

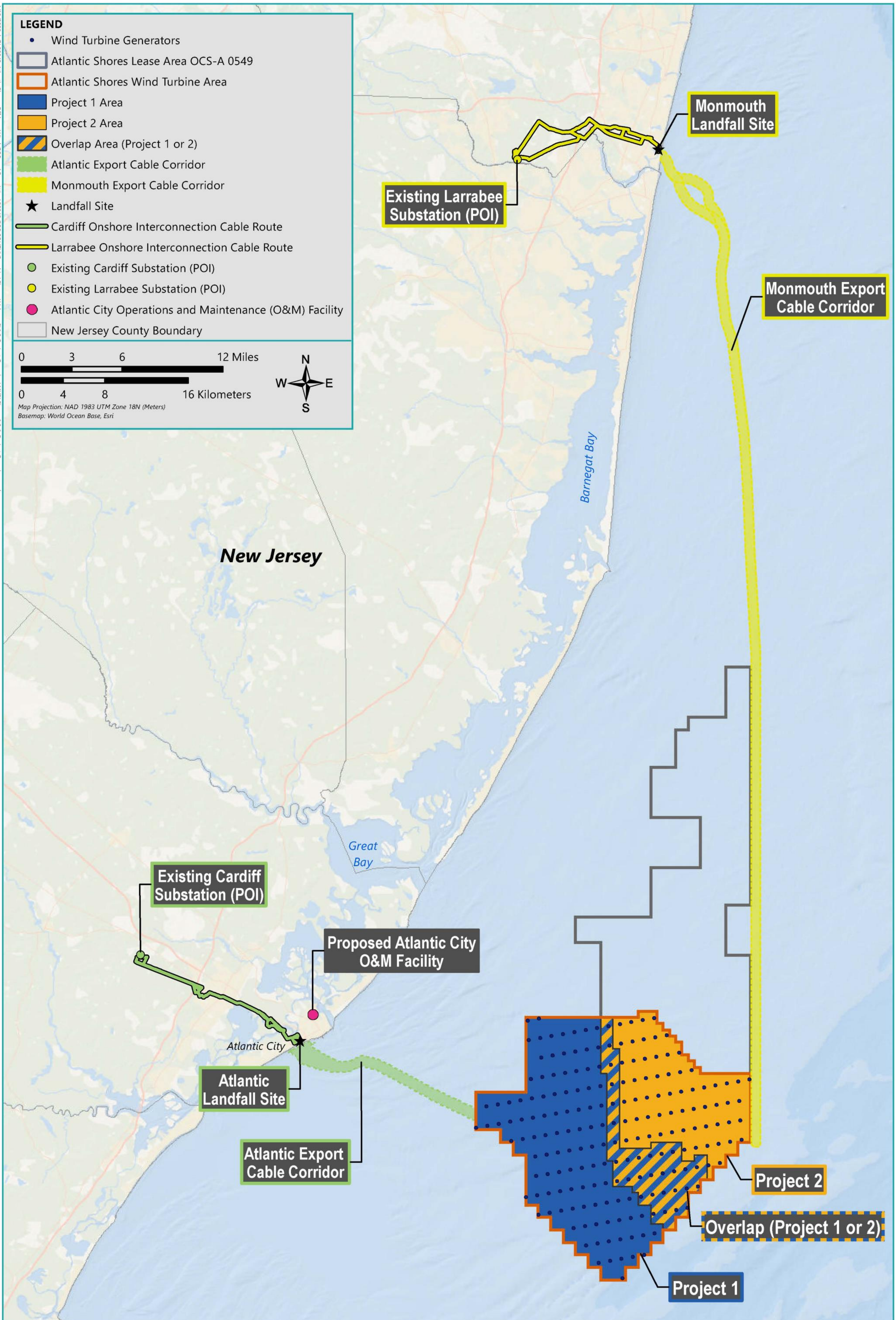
1 The number of WTGs in Project 1, Project 2, and the associated Overlap Area will not exceed 200 WTG locations. For example, if Project 1 includes 105 WTGs (the minimum), then the Overlap Area would be incorporated into Project 2, which would include the remaining 95 WTGs; conversely, if the Overlap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

2 Up to five substations for each Project.

3 As stated in Volume I, Section 4.9, Atlantic Shores could connect into the substation and/or converter station (referred to as the Brook Road Site). This site is to be developed as part of the State of New Jersey Board of Public Utility (BPU) State Agreement Approach (SAA) to support multiple offshore wind generation projects that the State will procure as part of New Jersey BPU's Third Offshore Wind Solicitation (Solicitation). Therefor this site has not been considered as part of the effects assessment.

In order to avoid, minimize, and/or mitigate the effects of IPFs on physical, biological, visual, cultural, and socioeconomic resources, each resource section also includes EPMs. EPMs are made up of studies, assessments, design elements, best management practices, and potential mitigations. Some EPMs have already been completed (i.e., project design considerations), while others will occur during and after construction. Similarly, some IPFs have been avoided and/or minimized due to factors such as Project siting decisions and execution strategies. A summary of the proposed EPMs is provided at the end of each section. The IPFs and the associated EPMs were developed based on the PDE and could be refined as the Projects evolve through ongoing consultation, stakeholder outreach, and final engineering design.

Atlantic Shores will continue to work with the appropriate agencies and stakeholders to identify practical EPMs that meet regulatory requirements and best industry standards. Final EPMs will be provided for review and approval prior to construction as part of Atlantic Shores' Facility Design Report and Fabrication and Installation Report as appropriate in accordance with 30 CFR Parts 585.701 and 702.



ATLANTIC SHORES offshore wind

Figure 1.0-1
Overview of the Projects

2.0 ENVIRONMENTAL SETTING

This section provides a detailed description of the general environmental setting including geologic, meteorologic and physical oceanic conditions within the Project Area.

2.1 Geology

This section provides an overview of the regional geologic setting and geologic conditions in the Onshore Project Area and Offshore Project Area (which includes Project 1, Project 2, and the Overlap Area), associated impact producing factors (IPFs), and measures to avoid, minimize, or mitigate potential effects during construction, operations and maintenance (O&M), and decommissioning. Geologic conditions in the Onshore and Offshore Project Area, including potential natural and anthropogenic (human-made) hazards, guide and inform the design, siting, and engineering of the Projects. Key geologic datasets are gathered during multi-season geophysical and geotechnical (G&G) survey programs between 2019 and 2021. Additional high resolution geophysical data was acquired in 2022 across small portions of the Lease Area OCS-A 0499 to expand inter array cable data coverage that did not exist in earlier data sets. Results of these investigations are utilized to ensure all aspects of the Projects are compatible with site-specific geologic conditions.

2.1.1 Affected Environment

The affected environment includes the existing geology within the Project Region and within the Offshore and Onshore Project Areas, including Monmouth and Atlantic counties. The geologic information in this section is based on published data as cited herein and the following site-specific offshore and onshore surveys and reports included in Appendices II-A1 through II-A7:

- The Marine Site Investigation Reports (MSIR) are provided in Appendix II-A1 and include four parts:
    - Appendix II-A1a provides the 2023 MSIR for the Wind Turbine Area (WTA). This MSIR was updated from the 2021 version previously submitted based on additional geophysical data acquired in 2022.
    - Appendix II-A1b provides the 2021 MSIR for the Atlantic Export Cable Corridor (ECC).
    - Appendix II-A1c provides the 2021 MSIR for the North Monmouth ECC.
    - Appendix II-A1d provides the 2021 MSIR for the South Monmouth ECC.
- The Geophysical Survey Factual Reports are provided in Appendix II-A2 and include four parts:

  - Appendix II-A2a provides the geophysical factual report for the WTA. This report was updated from the 2021 version previously submitted based on additional geophysical data acquired in 2022.

  - Appendix II-A2b provides the geophysical factual report for the Atlantic ECC.

  - Appendix II-A2c provides the geophysical factual report for the North Monmouth ECC.

  - Appendix II-A2d provides the geophysical factual report for the South Monmouth ECC.

- The 2020–2021 Geotechnical Factual Reports are provided in Appendix II-A3 and include six parts:

  - Appendix II-A3a provides the 2021 geotechnical parameters for soil boring locations within the WTA.

  - Appendix II-A3b provides the 2021 geotechnical parameters for vibracore and cone penetration test (CPT) locations within the WTA, Monmouth ECC, and Atlantic ECC.

  - Appendix II-A3c provides the 2020 geotechnical parameters for soil boring locations within Lease Area OCS-A 0499.

  - Appendix II-A3d provides the 2020 geotechnical parameters for vibracore locations within Lease Area OCS-A 0499.

  - Appendix II-A3e provides the 2020 geotechnical parameters for vibracore locations within the Monmouth ECC.

  - Appendix II-A3f provides the 2020 geotechnical parameters for vibracore locations within the Atlantic ECC.

- The 2021 Munitions and Explosives of Concern (MEC) Reports are provided in Appendix II-A4 and include two parts:

  - Appendix II-A4a identifies and assesses MEC hazards in and near the Projects' footprint.

  - Appendix II-A4b provides the risk assessment and mitigation strategies for MEC identified in Appendix II-A4a.

- The 2021 Cable Burial Risk Assessment (CBRA) Reports are provided in Appendix II-A5 and include three parts:

- Appendix II-A5a provides the CBRA for the Atlantic ECC.
- Appendix II-A5b provides the CBRA for the Monmouth ECC.
- Appendix II-A5c provides the CBRA for the WTA.

- The 2020 Atlantic Shores Geoscience-focused Desktop Study Report: Lease Area OCS-A 0499 (Appendix II-A6) was issued in March 2020. This report integrates and presents information from multiple geological and HRG data sources (including the 2019 reconnaissance survey data across the Lease Area), to describe the geologic conditions in the Offshore Project Area.
- The 2020 Natural Resources Conservation Service (NRCS) Mapped Soils Report is provided in Appendix II-A7 and include two parts:
  - Appendix II-A7a provides the report for the Cardiff onshore interconnection cable routes.
  - Appendix II-A7b provides the report for the Larrabee onshore interconnection cable routes.

2.1.1.1 Regional Geology Setting

The WTA is located a minimum of 8.7 miles (mi) (14 km) east of the New Jersey coast, on the western half of the submerged shallow portion of the Outer Continental Shelf (OCS) of the Western Atlantic continental margin. The continental shelf extends eastward from the New Jersey coast for about 87 mi (140 km) to the continental slope break (see Appendices II-A1 and II-A6). The offshore setting is known as the Mid-Atlantic Bight (also the New York Bight), due to its position within the open arc of the New Jersey-New York coastline.

The WTA is located along the Western Atlantic continental margin, which is known as a passive margin, as there is no nearby active tectonic plate boundary. Passive continental margins are considered zones of lower seismicity than active plate boundaries, such as along the California and southern Alaska coasts (USGS 2021a).

The geology of the region surrounding the WTA is comprised of a thick wedge of coastal plain sediments interbedded with marine sediments. The deepest sediments underlying the WTA region may date to the late Mesozoic Era (older than approximately 66 million years ago [mya]) (USGS 2021b). During the more recent Pleistocene Epoch (approximately 1.8 mya to 12 thousand years ago [kya]) to the Holocene Epoch (approximately 12 kya to the present), the Atlantic continental margin experienced multiple global glaciations, resulting in a series of sea level fluctuations caused by the southerly advance and northerly retreat of glacial ice. While past glacial maximums are not believed to have extended as far south as the WTA, the continental shelf was affected by these geologically recent glacial and post-glacial processes. During glacial maximums, when higher volumes of global water were contained in glacial ice, sea levels were lower exposing more of continental shelves to erosive processes than present.

During the most recent glacial advance in the Late Wisconsin period, the Last Glacial Maximum (LGM) occurred approximately 25 to 15.7 kya (see Appendices II-A1 and II-A6). At the LGM, the southerly position of the ice sheets was approximately 54 nm (100 km) north of the Projects Area (see Appendices II-A1 and II-A6), in the vicinity of Long Island and trending westerly through northern New Jersey. In the region surrounding the WTA, northwest to southeast oriented channels cut across the exposed continental shelf. These now buried paleo-channels in the shallow subsurface have been mapped from geophysical data and appear to emanate from the Great Egg River, the Mullica River, and other smaller drainages to the west (see Figure 2.1-1). The large paleo Hudson Shelf Valley, cut by the Hudson River, is well east and north of the Lease Area (see Figure 2.1-1). In places, first and second generations of overlapping paleo-channels appear to have formed as smaller drainage systems oscillated over the shelf.

As the climate warmed, sediments washed out of the melting glaciers and were transported south in pulses of meltwater, which resulted in lateral and vertical variations of depositional environments and sediment characteristics. As sea level rose, these sediments were winnowed and reworked by waves, tides, and storms, forming distinctive surficial bedforms such as ripples, megaripples, sandwaves, and less mobile features referred to as sand ridges, with ridge and swale topography, across the Mid-Atlantic continental shelf. Some of these subparallel seafloor features can be seen on Figure 2.1-1. Sea level rise over the last 20,000 years has elevated the New Jersey sea level an estimated 350 to 400 feet (ft) (107 to 122 meters [m]) vertically (Stockton Coastal Research Center c2020), resulting in the westerly migration of the shoreline to its present location. Marine processes on this open continental shelf continue to winnow and rework the unconsolidated surficial marine sediments.

2.1.1.2 Local Geology – Marine

Most of the Projects will be located offshore. Marine sediment types, seafloor sediments, and potential shallow hazards in the WTA and ECCs are described in the following subsections based upon the detailed studies referenced in Section 2.1.1.

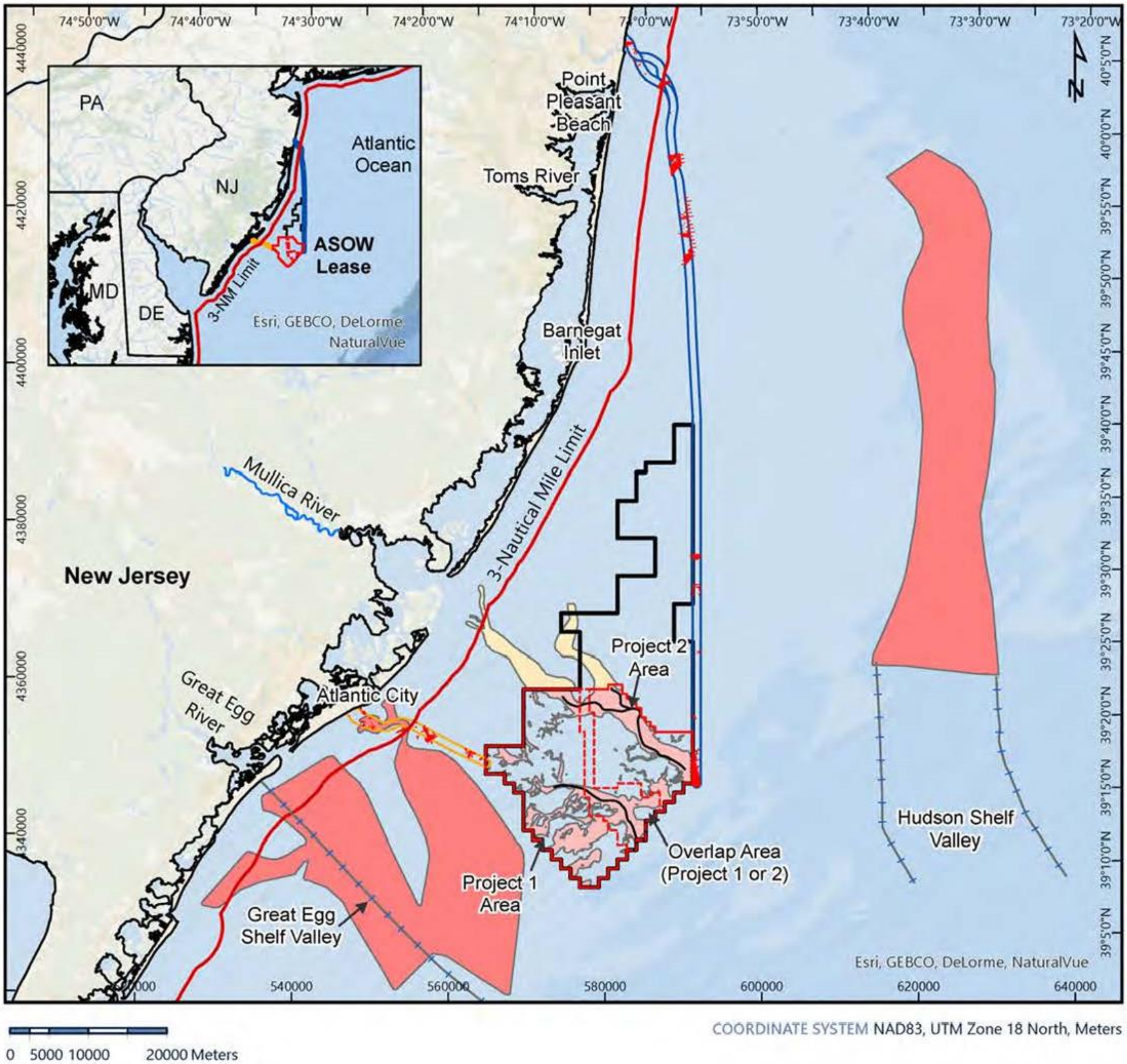
2.1.1.2.1 Sediment Types

The sediment types expected within the maximum horizontal and vertical footprints in the Offshore Project Area can be grouped into four key geological units (listed below from youngest to oldest). All offshore structures, including the offshore cables (export, inter-array, and inter-link cables), will be sited within the three youngest units. Only the foundations of the wind turbine generators (WTGs), the offshore substations (OSSs), and the met tower are expected to encounter the underlying Coastal Plain sediments:

- Holocene Marine Deposits: These unconsolidated deposits are composed of fine to coarse grained sand and cover the entire Offshore Project Area. The deposits comprise the bedforms which characterize the seafloor in the Offshore Project Area, including sandripples, megaripples, sandwaves, and sand ridges. They are thickest when associated with the sand ridges and are thin to absent within regional swales. The base of the Holocene Marine Deposits is generally a well-defined erosive boundary into the top of the underlying deposits.

- Late Pleistocene to Holocene Transgressive Channel Group (TCG) Deposits: These deposits are inferred to be of Late Pleistocene to Holocene age (28 kya to 7.4 kya) based on site specific radiocarbon dating and correlation with regional stratigraphy (see Appendix II-A1). The TCG deposits typically underlie the Holocene Marine deposits where they have not been exposed at the seafloor by erosion. The TCG deposits include substantial paleo-channel sequences of varying thickness that generally trend northwest to southeast across the Offshore Project Area (Figure 2.1-1). Several of the channels are aligned with present day river channels, such as the Mullica River, which indicates they are associated with the offshore extents of paleo-river channels. Recent site-specific geotechnical data show that the TCG deposits generally consist of interbedded sands and clays with pockets of organic material. The base of the channels is often associated with coarser grained gravel deposits which may represent fluival lag deposits that formed as the TCG channels initially incised deeply across the subaerially exposed shelf into the older sediments during the LGM.

- Late Pleistocene Deposits: The Pleistocene sequence underlying the Holocene Marine and Late Pleistocene to Holocene TCG deposits within the Offshore Project Area is comprised of sediments derived from at least three intervals of relative sea level high stand and low stands that occurred during the Wisconsin Glacial Stage. The age of these deposits is inferred to be between approximately 128 kya and 28 kya based on site-specific radiocarbon dating and correlation to regional stratigraphy. During sea level low stands, paleo-drainages crossed and carved channels into the shelf, deltas formed at river mouths, and estuary-lagoon-barrier island complexes formed near inlets. As the sea level rose and the shoreline transgressed westward, the channels began to flood, transition into estuaries, and infill with sediments. During transgressions and relative high stands, a range of environmental settings resulted in complex sedimentological packages. The recent G&G data acquired across the Offshore Project Area shows that these sediments display relatively high lateral and vertical variability across the area. The sediments are generally comprised of alternating medium dense to very dense, fine to medium grained sand, and stiff to very stiff clay with silt and shell fragments. The thickness of the Late Pleistocene Deposits varies across the Offshore Project Area, but in general increases to the south and southeast.



COORDINATE SYSTEM NAD83, UTM Zone 18 North, Meters

LEGEND

- 3-Nautical Mile Limit
- Lease Area OCS-A 0549
- Lease Area OCS-A 0499
- Wind Turbine Area (Overlap Area - Project 1 or 2)
- Atlantic Export Cable Corridor
- Monmouth Export Cable Corridor
- Regional Paleochannels
- ECC Interpreted Paleochannels (SBP & S-UHRS)
- TCG Generalized Thalweg
- TCG Extent (28 ka - 7.4 ka) / Possible Relict Mullica Paleochannel
- Possible Relict Mullica River Paleochannel (Paleochannels mapped by Fugro for the 2020 Desk Top Study using available seismic data near the lease area.)
- Large Regional Paleochannels (Paleochannels mapped by Fugro for the 2020 Desk Top Study using available seismic data near the lease area.)

Note: 1) The ECC and TCG paleochannel extents were mapped by Fugro based on the G&G data acquired for Atlantic Shores between 2020-2021.

ATLANTIC SHORES offshore wind

Figure 2.1-1
Interpreted Buried Paleochannels

- Coastal Plain Deposits: A regionally extensive, gently south-southeast dipping unconformity separates the late Pleistocene deposits in the Quaternary Period from the underlying pre-Quaternary age Coastal Plain Deposits. The site-specific geotechnical data in the Offshore Project Area show that the Coastal Plain deposits are generally of marine origin and comprised of dense to very dense, fine to coarse grained sand with interbedded silt layers, and very stiff to hard clay interbedded with sand. The depth below mudline to the top of the Coastal Plain Deposits within the WTA thickens to the south-southeast and ranges from approximately 32 to 157 ft (10 to 48 m) below the seafloor. The depth to the top of the Coastal Plain Deposits thins significantly to the north of the WTA and is close to or at the seafloor near the northern portion of the Monmouth ECC. The Pliocene-Miocene age Cohansey Formation and underlying Miocene age Kirkwood Formation are expected to be present in the deep stratigraphic section, which appears to be increasingly stratified with depth. Upgradient and onshore, these coastal plain formations comprise a large onshore and productive groundwater aquifer beneath eastern New Jersey (Section 2.1.1.3).

Due to the thickness of the coastal plain sediments, the Projects' foundations (to a maximum depth of approximately 272 ft [80 m]) (Tables 4.2-1 and 4.4-2 in Volume I) are not expected to encounter crystalline basement. The deepest soil borings acquired during the 2020 and 2021 geotechnical campaigns encountered Coastal Plain deposits. Appendices II-A3a and II-A3c contain the results of the soil borings within the WTA. In addition, the G&G data sets acquired between 2020 and 2021 2021 and additional geophysical data acquired in 2022 across the WTA and ECCs were fully interpreted and integrated in an iterative process to develop a robust ground model for the Projects. The final mapped horizons and interpretation define the stratigraphy that formed the basis for the overall ground model and are further described in the Marine Site Investigation Reports (Appendix II-A1). The geologic conditions in the Offshore Project Area are compatible with installation of the WTGs, OSSs, and the offshore cable system.

2.1.1.2.2 Seafloor Sediments

Interpretation of the seabed using multibeam echosounder (MBES) bathymetry and backscatter, and side scan sonar (SSS) data revealed a very gently to gently dipping seabed, typically between 1 and 3 degrees to the south-southeast, across the WTA and ECCs. Predominant seafloor features in the WTA and ECCs include sand bedforms of varying sizes, and swales (see Figures 2.1-1, 2.1-2, and 2.1-3; Appendices II-A1 and II-A6).

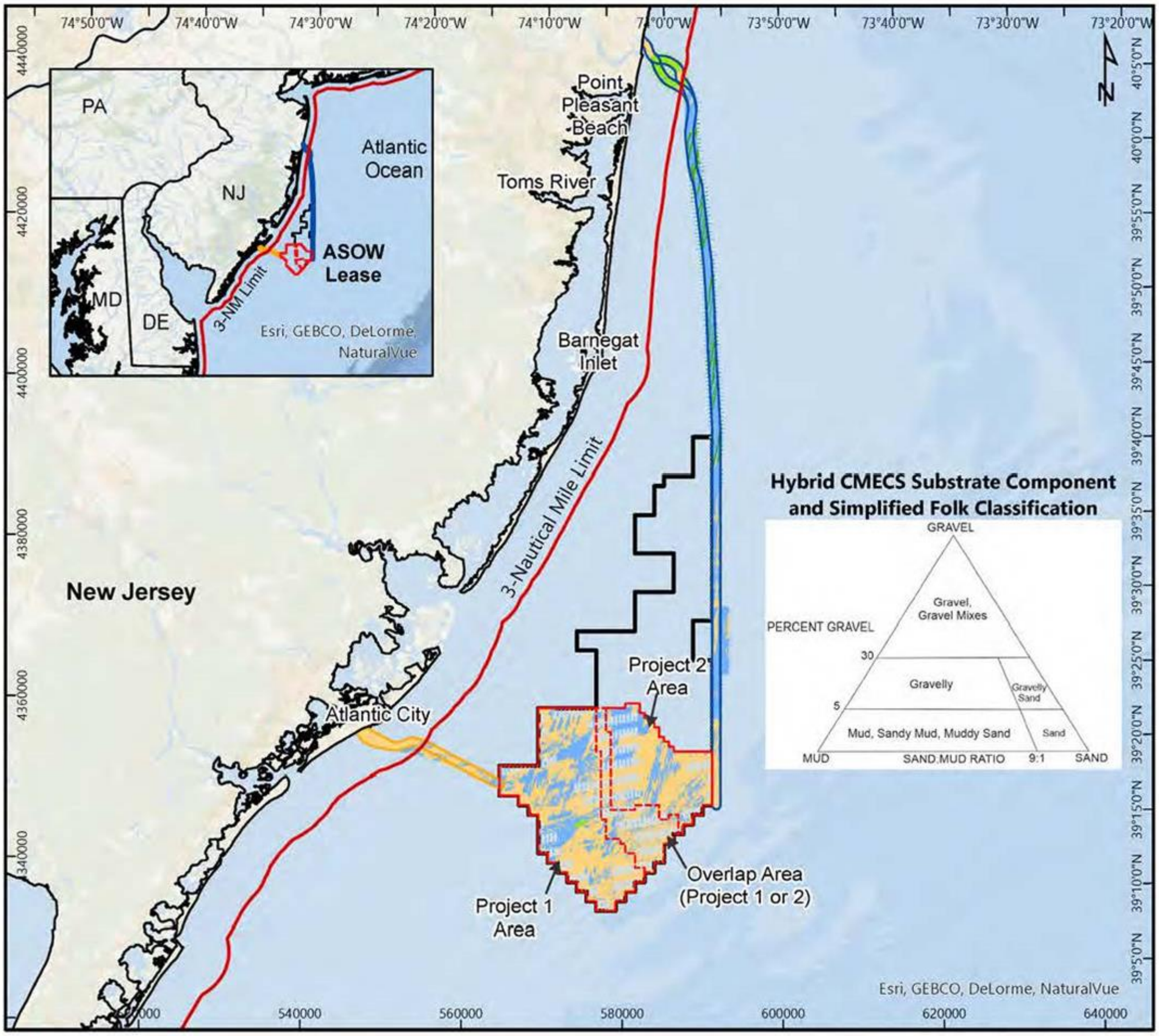
Regional surficial sediment mapping indicates a fining of mostly sandy surface sediments to the south across the Lease Area, with increased gravel and gravelly deposits present in the surface sediments in the north and western parts of the Lease Area (Mid-Atlantic Data Portal 2020). The site-specific G&G data and benthic habitat surveys acquired by Atlantic Shores aligns with the regional surficial sediment mapping and further details the surficial sediments in the Offshore Project Area. The G&G data were interpreted and integrated with the benthic habitat survey data that included numerous grab (surficial) sediment samples, sediment profile and plan view imagery (SPI-PV), video imagery from each grab sample location, and towed video and still imagery.

Figure 2.1-2 shows the type, extent, and trend of seafloor sediments derived from the G&G data. Gravel, gravel mixes, and gravelly sand are more predominant in the north and west parts of the Offshore Project Area. Sand, defined as less than 5% gravel, is more predominant in the south part of the Offshore Project Area and near the ECC landfall locations (Figure 2.1-2). The overall southwest to northeast trending patterns of sediment often line up well with the sand bedform features shown in Figure 2.1-3. In addition, some of the areas of coarser grained sediments are related to eroded exposures of underlying older sediments.

Sand is an important resource in nearshore areas off the New Jersey coast. Sand resources are used for coastal restoration, beach nourishment, and habitat restoration projects, under the jurisdiction of Federal and State agencies. The Projects' ECCs that were surveyed in 2020 were routed to avoid most Federal- and State-designated sand resource and sand borrow sites in the vicinity of the Offshore Project Area (see Figure 2.1-4). However, because small segments of both ECCs crossed designated sand borrow areas, Atlantic Shores actively coordinated with the Bureau of Ocean Energy Management (BOEM), the New Jersey Department of Environmental Protection (NJDEP), and the U.S. Army Corps of Engineers (USACE) Philadelphia District to reroute small portions of the ECCs in 2021, to avoid mapped sand resource areas, including leased sand borrow sites. Atlantic Shores collaboratively devised a cable layout strategy with these agencies that meets Federal and State requirements and industry best management practices (BMPs). Additional information is presented in Section 7.7, Other Marine Uses and Military Activities.

2.1.1.2.3 Potential Natural Hazards in Offshore Project Area

Natural surficial and shallow subsurface hazards are geologic features and conditions which can pose a risk to the Projects' activities. Natural hazards include but are not limited to mobile sediments, potentially unstable slopes, faults, and scour. The presence, absence, or status of natural hazards listed in 30 CFR Parts 585.626 and 585.627, based upon the existing studies listed in Section 2.1.1, are presented in Table 2.1-1.



0 5000 10000 20000 Meters

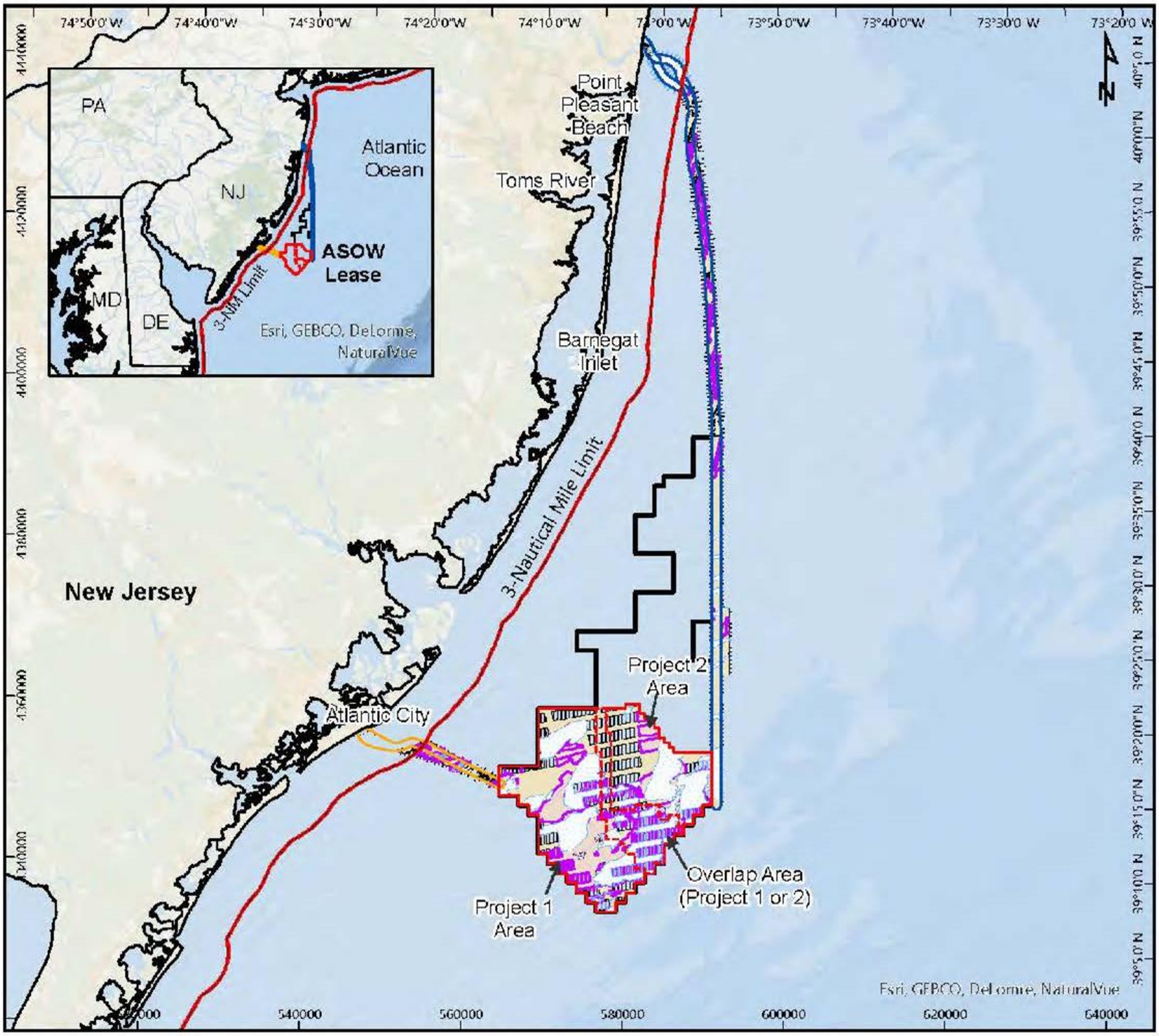
COORDINATE SYSTEM NAD83, UTM Zone 18 North, Meters

LEGEND

- 3-Nautical Mile Limit
- Lease Area OCS-A 0549
- Lease Area OCS-A 0499
- Wind Turbine Area (Overlap Area - Project 1 or 2)
- Atlantic Export Cable Corridor
- Monmouth Export Cable Corridor
- Gravel, Gravel Mixes (≥30% Gravel)
- Gravelly (5-<30% Gravel, <9:1 Sand:Mud Ratio)
- Gravelly Sand (5-<30% Gravel, ≥9:1 Sand:Mud Ratio)
- Sand (<5% Gravel, ≥9:1 Sand:Mud Ratio)

Notes: 1) A hybrid CMECS and simplified Folk classification was used in the seafloor mapping (see inset image). 2) Seafloor sediments were mapped from the 2020-2021 Geophysical and Geotechnical (G&G) data acquired by Fugro for Atlantic Shores.

Figure 2.1-2
Seafloor Sediments



0 5000 10000 20000 Meters

COORDINATE SYSTEM NAD83, UTM Zone 18 North, Meters

LEGEND

- 3-Nautical Mile Limit
- Lease Area OCS-A 0549
- Lease Area OCS-A 0499
- Wind Turbine Area (Overlap Area - Project 1 or 2)
- Atlantic Export Cable Corridor
- Monmouth Export Cable Corridor
- Sandwaves
- Megaripples
- Ripples

Notes: 1) Seafloor sand bedform interpretation used the BOEM 2020 bedform classification scheme. 2) Seafloor sand bedforms were mapped from the 2020-2021 Geophysical and Geotechnical (G&G) data acquired by Fugro for Atlantic Shores.

Figure 2.1-3
Seafloor Sand Bedform Morphology

Table 2.1-1 Potential Natural Hazards in the Offshore Project Area

Hazard	Definition	Description
Shallow faults; fault zones; fault attenuation 30 CFR Part 585.626(a)(1)(i) and (2)(ii) and (iv)	A fault is a planar or gently curved fracture in the earth's crust across which there has been relative displacement. Groups of related faults are termed fault zones. Fault attenuation refers to fault variation over distance.	The Offshore Project Area is located on the shallow OCS of the tectonically passive Western Mid-Atlantic continental margin (see Section 2.1.1.2). No evidence of faulting in the Offshore Project Area has been reported in the WTA and ECCs in the studies listed in Section 2.1.
Gas seeps or shallow gas; gas hydrates Parts 585.626(a)(1)(ii) and (iv)	Gas seeps or shallow gas refer to methane released into the water column from microbial decomposition of organic material in marine sediments. Gas seeps have been found along and near the Western Mid-Atlantic continental slope, well east and seaward of the Offshore Project Area (USGS 2021c). Gas hydrates are a crystalline solid formed of water and methane. Gas hydrates have also been found in the uppermost layers of deep-water continental slope sediments. Because gas hydrates act much like ice, they can affect the stability of shallow marine sediments (USGS 2021d).	Localized areas of possible shallow gas have been identified within the TCG channels in the north to east part of the WTA and locally within the north part of the Monmouth ECC. No evidence of gas seeps or fluid expulsion features at the seafloor have been identified within the WTA or ECCs studies listed in Section 2.1. No gas hydrates are expected within the Project Area because it is outside the zone of gas hydrate stability for the U.S. East Atlantic continental shelf.

Table 2.1-1 Potential Natural Hazards in the Offshore Project Area (Continued)

Hazard	Definition	Description
Slump blocks or slump sediments; instability of slopes at the facility location Part 585.626(a)(1)(iii); Part 585.626(a)(6)(iv)	Slump blocks or slump sediments refer to a block of unlithified sediments that collapse as a block or as a flow. Fine-grained slump sediments are often found on continental slopes, well east and seaward of the Offshore Project Area.	The seafloor displays a very gently to gently south to southeast dipping slope across the Offshore Project Area (see Section 2.1.1.2.2). No evidence of slump blocks or slump sediments has been reported in the WTA or ECCs in the studies listed in Section 2.1.
Ice scour of seabed sediments; effects of subsea permafrost Part 585.626(a)(1)(iii); Part 585.626(6)(vi)	Ice scour refers effects of ice movement across the land or seafloor, causing striations, gouges, or erosion. Permafrost is a subsurface layer of sediment that remains frozen throughout the year, chiefly in polar regions.	The seabed sediments in the Offshore Project Area are too far south to be affected by current seasonal ice scour, nor is permafrost present at this latitude. During the LGM, the Offshore Project Area was well south of the furthest extent of glacial ice (see Section 2.1.1.1).
Scour of seabed sediments Part 585.626(a)(2)(iii)	Seabed sediments can be scoured and eroded by tidal, wave, storm, or oceanic currents along the seafloor.	Bottom currents are expected to be low in the Offshore Project Area (see Section 2.2), given the unconstrained open ocean setting, the water depths, and the minimal topographic relief on the seabed in the WTA and along the ECCs. Localized currents can occur around introduced structures that can then scour and erode surrounding seabed sediments. Measures to reduce potential scour are described in Section 2.1.2.

Table 2.1-1 Potential Natural Hazards in the Offshore Project Area (Continued)

Hazard	Definition	Description
Assessment of seismic activity Part 585.626(a)(2)(i)	A probabilistic assessment of the future risk of seismic activity based upon historic regional seismic activity, the geologic setting, and other parameters.	The Projects are not located in an area considered tectonically activity. The Projects will be designed and constructed in accordance with applicable seismic standards.
Seabed subsidence Part 585.626(a)(2)(iii)	Seabed subsidence is the sinking of the seafloor and underlying sediments. It can be caused by several factors.	The potential for seabed subsidence due to compaction by Project structures will be fully analyzed and assessed once the complete geotechnical dataset has been processed and foundation type has been selected; methodology and results will be presented in final design and presented in Facility Design Report (FDR). The Projects will be designed and constructed to minimize potential seabed subsidence.
Occurrence of sand waves; sediment transport Part 585.626(a)(6)(iii); Part 585.627(a)(1)	Sand waves are mobile bedforms classified by the BOEM as having wavelengths of >204 ft (60 m) and heights >5.1 ft (1.5 m). Sediment transport is the movement of sediment particles either due to gravity or within a fluid.	Bedforms have been shown in the Offshore Project Area and have been characterized in the 2021 MSIRs (Appendix II-A1). Seafloor sediment will be disturbed primarily during the Projects' construction and some volume will be suspended into the water column and subject to transport. A Sediment Dispersion Modeling study assessing the extent and effects of sediment suspension, transport and re-deposition is provided in Appendix II-J3.

2.1.1.2.4 Potential Anthropogenic Hazards in Offshore Project Area

Anthropogenic hazards listed in 30 CFR Part 585.627(a)(1) that may affect Projects' design, siting, and construction include, but are not limited to, MEC, sediment contamination, shipwrecks with associated debris, and modern debris on the seafloor.

Munitions and Explosives of Concern (MEC)

MEC is a broad term that includes unexploded ordnance (UXO) and discarded military munitions or constituents that could pose an explosive hazard.

Atlantic Shores commissioned two site-specific studies to gain a more detailed understanding of potential MEC in the Offshore Project Area and potential mitigation measures:

- Munitions and Explosives of Concern (MEC) Hazard Assessment (Appendix II-A4a)
- Munitions and Explosives of Concern (MEC) Risk Assessment with Risk Mitigation Strategy (RARMS) (Appendix II-A4b).

The MEC Hazard Assessment report determined that the Offshore Project Area is within the low hazard zones (Zones 2 and 3). Atlantic Shores will follow recommendations in the above reports to reduce the risk to the industry standard of As Low as Reasonably Practicable (ALARP). Specifically, Appendix II-A4b states that "Except in areas which are classified as a significant hazard (Hazard Zone 1), Ordtek does not recommend that high-resolution magnetometry survey is necessary to detect buried items. The likelihood of encountering buried items that constitute a notable safety risk within the low hazard zones (Zones 2 and 3) is deemed to be below the ALARP threshold. Any additional high-density magnetometer survey would be disproportionate to the risk within these areas." Because the MEC hazard assessments define the Offshore Project Area as a low hazard zone for MEC, Atlantic Shores does not plan to conduct a site survey specifically for MEC. If any UXO/MEC are identified prior to construction, Atlantic Shores will mitigate through avoidance if possible. Should avoidance not be possible, Atlantic Shores will adhere to the U.S. Committee on the Marine Transportation System *Proposed National Guidance for Industry on responding to Munitions and Explosives of Concern in U.S. Federal Waters* (2023).

Potential Sediment Contamination

Data on sediment contaminant levels in the Offshore Project Area is limited. Three mapped ocean disposal sites are located proximal to the Offshore Project Area. These are listed in Table 2.1-2; locations are shown on Figure 2.1-4 (MARCO, C2020). Ocean disposal sites are designated, permitted, and managed by the U.S. Environmental Protection Agency (EPA) in coordination with the USACE for the dumping of permitted materials, including dredged material.

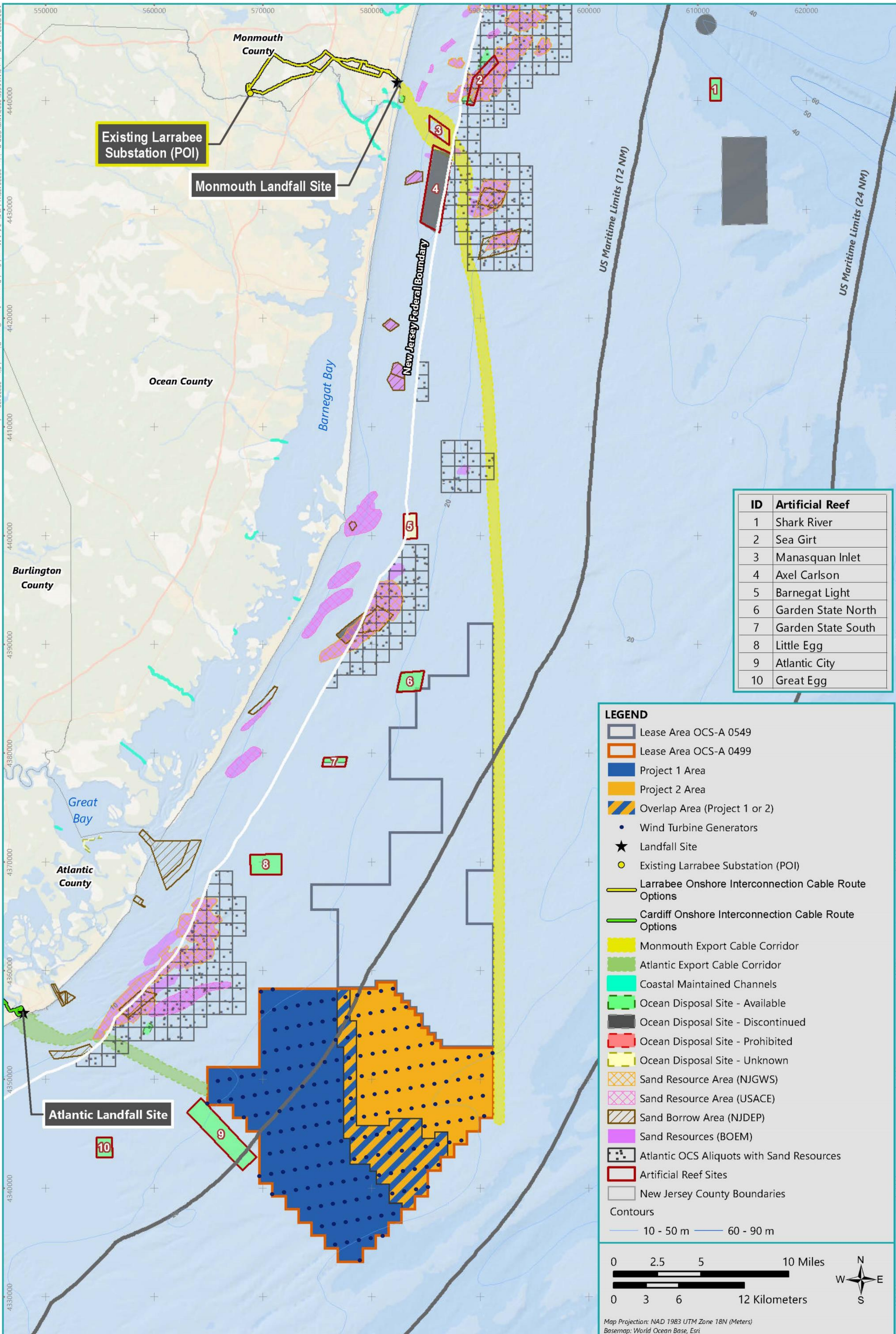
The rock dumping ground (Atlantic City Reef site), located proximal to the southwestern corner of the WTA, is unlikely to contain contaminants, as rocks are less likely to contain contaminants than dredge spoils or other types of debris. Two ocean disposal sites are located proximal the

Monmouth ECC. One is a discontinued dumping ground (Axel Carlson Reef site), and one is an active disposal site for dredged material (Manasquan site). The Axel Carlson Reef site is an artificial reef complex where many boats, military tanks, and construction materials have been disposed. The Manasquan site is a small dredge material disposal site that has received dredge spoils from local inlets. Atlantic Shores will avoid disposal sites designated as reefs.

Table 2.1-2 Mapped Ocean Disposal Sites Proximal to the Offshore Project Area

Site Name	Size (Square Nautical Miles [nm^2])	Depth (m)	Primary Use	Location in Relation to Atlantic Shores Project Area
Atlantic City Reef	6.37	Unknown	Rock dumping: available	Proximal to southwestern corner of WTA
Axel Carlson Reef	5.67	Unknown	Dumping ground: discontinued	Proximal to Monmouth ECC
Manasquan	0.11	18	Dredged material disposal: available	Proximal to Monmouth ECC

Given the types of materials that may have been disposed at Axel Carlson Reef and Manasquan, these areas may contain contaminated sediments. Atlantic Shores intends to avoid these mapped disposal sites. Other ocean disposal sites are located outside the Offshore Project Area, but due to the nature of the activities conducted at these disposal sites, any contaminated sediments at those sites would be unlikely to migrate to the Offshore Project Area at concentrations that would affect marine sediment quality. Additional Information is presented in Figure 7.7-2 in Section 7.7 Other Marine Uses and Military Activities.



ATLANTIC SHORES offshore wind

Figure 2.1-4

Mapped Sand Resource Areas and Ocean Disposal Sites in Vicinity of Offshore Project Area

Shipwrecks and Debris Fields

Shipwrecks and associated debris fields can pose a hazard to' construction of the Projects, particularly cable installation activities. Research has been conducted by a Qualified Marine Archaeologists (QMAs) to locate wrecks that have been reported in or near the Offshore Project Area. Project archaeologists are also evaluating the Projects' survey data to identify known and potential shipwrecks and associated debris fields, and to determine cultural significance (Section 6.3, Marine Archaeological Resources). Efforts will be made to avoid impacts to any shipwreck sites or debris fields that are listed or eligible for listing on the National Register of Historic Places and, for State waters, the New Jersey Register of Historic Places, as described in Section 6.3 Marine Archaeological Resources.

Modern Debris

Modern debris on the seafloor, such as fishing debris or materials discarded by ships, can pose a potential risk to offshore cable installation equipment, anchored or jack-up vessels, or other construction activities. These features are detected and mapped during the HRG surveys.

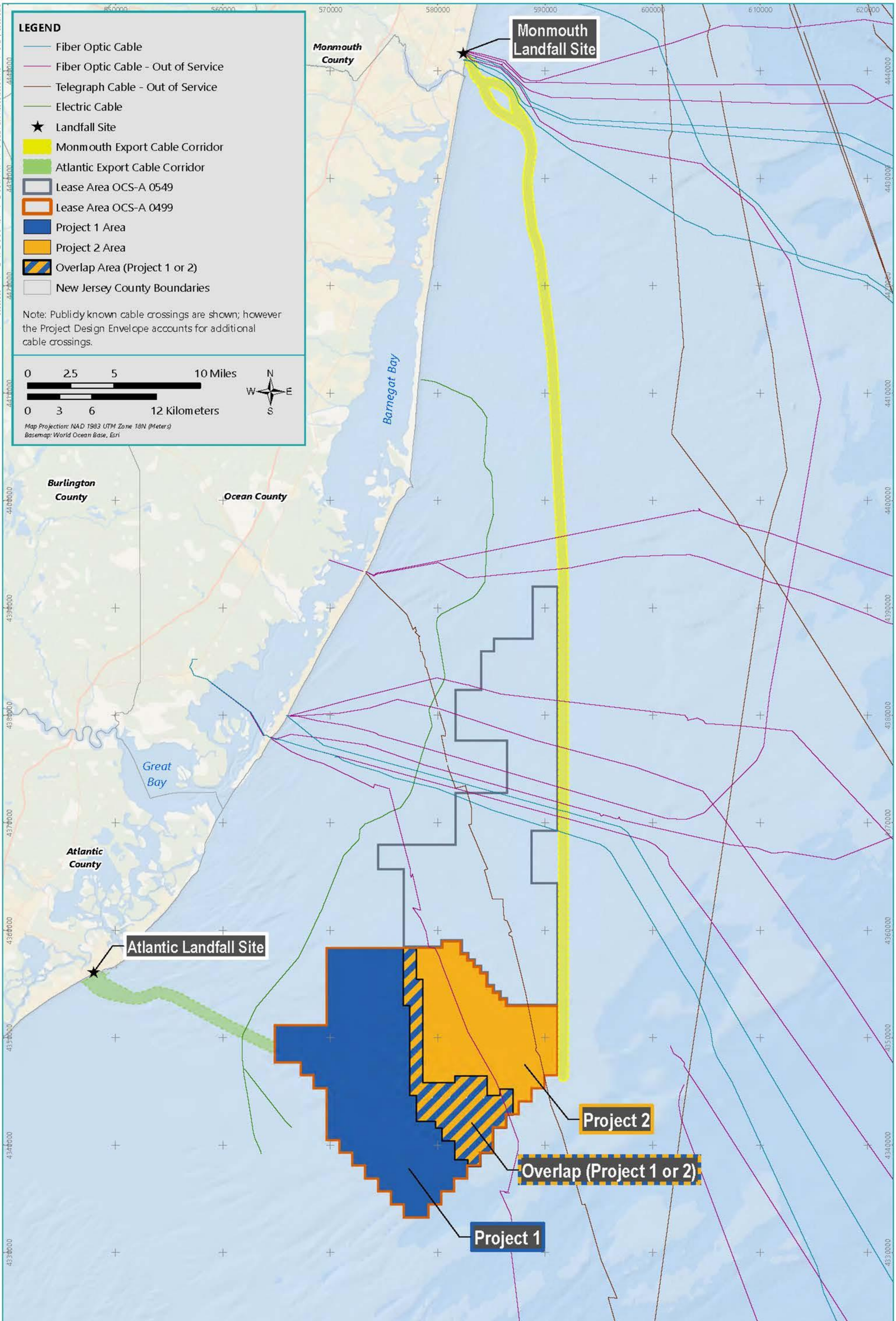
Cable Crossings

As described in Section 4.5.8 of Volume I, the ECCs will cross existing marine infrastructure, including submarine cables (see Figure 2.1-5). The Monmouth ECC could have up to 15 crossings that each export cable will need to complete, while the Atlantic ECC could have up to four crossings for each export cable.[4] It is also estimated that up to 10 inter-array cable crossings and up to two inter-link cable crossings may be required.

Any cable crossing will be surveyed in accordance with applicable industry standards and practices and, if the cable is still active, Atlantic Shores will seek to enter into a crossing agreement with its owner. The crossing agreement will address crossing methods, setback requirements, and other parameters. Atlantic Shores has identified all cable owners and has initiated discussions regarding crossing methods and/or setbacks.

At each crossing, before installing the Atlantic Shores cable, the area around the crossing will be cleared of any marine debris. Depending on the status of the existing cable and its location, such as burial depth and substrate characteristics, cable protection may be placed between the existing cable and the Atlantic Shores overlying cable. However, if sufficient vertical distance exists, such protection may be avoided. The presence of an existing cable likely would prevent the Atlantic Shores cable from being buried to its target burial depth of 5 to 6.6 ft (1.5 to 2 m). In this case, cable protection may be required at the crossing location to cover the new cable. Following installation of the new cables, the cable crossing will be surveyed again.

4 The maximum number of cable crossings for each ECC accounts for the possibility that other offshore cables may be installed prior to the start of Projects construction.



ATLANTIC SHORES offshore wind

Figure 2.1-5
Cable Crossings

2.1.1.3 Local Geology – Terrestrial

This section describes the terrestrial geology and soils within the Onshore Project Area (i.e., at the landfall sites, along the two proposed onshore cable interconnection routes, and at the proposed onshore substation and/or converter station sites) from review of published information and Project-specific soils reports (see Appendix II-A7a and A7b). The Onshore Project Area is located within the Coastal Plain physiographic province of New Jersey.

Atlantic Shores has identified two counties in New Jersey where onshore facilities for the Projects may be located:

- **Monmouth County**: onshore Project components in Monmouth County include the Monmouth Landfall Site and the Larrabee Onshore Interconnection Cable Route. The Larrabee Onshore Interconnection Cable route will include a new substation and/or converter station at the Lanes Pond Road Site or the Randolph Road Site or the interconnection to a substation and/or converter station at the Brook Road Site developed under the NJBPU's State Agreement Approach (SAA)[5].

- **Atlantic County**: onshore Project components in Atlantic County include the Atlantic Landfall Site and Cardiff Onshore Interconnection Cable Route. The Cardiff Onshore Interconnection Cable route includes a substation and/or converter station at the Fire Road Site.

For onshore Project facilities located in both Monmouth and Atlantic counties, shallow bedrock is not expected during underground installation of the onshore interconnection cables due to the thickness of coastal plain sediments below coastal New Jersey. Subsurface conditions within the Projects' vertical and lateral footprints will be confirmed during geotechnical surveys planned within the Onshore Project Area. This section describes the local geology and soils present in each county.

2.1.1.3.1 Monmouth County

The offshore export cables within the Monmouth ECC will transition onshore at the Monmouth Landfall Site in Sea Girt Borough. As described in Section 4.8.2 of Volume I, the Larrabee underground onshore interconnection cable route will then utilize existing roadway and utility rights-of-way (ROWs) and a paved bikeway to interconnect to the proposed Project substation and/or converter station, which is located on a previously disturbed land parcel (see Figure 4.8-2 in Volume I). The underground cable route will then continue to the Point of Interconnection (POI) at the nearby existing Larrabee Substation.

The Monmouth Landfall Site will be in the southeast corner of a previously disturbed area at the Army National Guard Training Center (NGTC) in Sea Girt Borough. The offshore to onshore cable

[5] https://www.nj.gov/bpu/about/divisions/ferc/saa.html

transition will be accomplished using horizontal directional drilling (HDD), to avoid nearshore and beach effects (see Section 4.8 of Volume I). The HDD will penetrate subsurface nearshore unconsolidated sands, silts, and clays. The HDD will be installed at depths designed to prevent exposure of the cable at the landfall site from beach and nearshore erosion.

The onshore interconnection cable route will largely be constructed within previously developed and disturbed areas. Undisturbed soil units mapped by the NRCS within approximately 100 ft (30.5 m) of the centerline of Larrabee onshore interconnection cable route and associated substation and/or converter station locations are shown and described in Appendix II-A7a. In summary, a total of 27 soil units are mapped within the Onshore Project Area. The most common soil series are the Klej loamy sand, the well-drained Downer sandy loam, and the Downer-Urban land complex, located in knolls and hills. Additional physical characteristics of the soils are described in Appendix II-A7a, including inclusions, hydric status, acidity, drainage characteristics and other conditions relevant to suitable onshore design of the Projects.

A Phase I Environmental Site Assessment will be conducted prior to ground disturbing activities in the Onshore Project Area to confirm the site conditions present within the Projects' construction footprint. If potentially impacted soils are encountered during construction, Atlantic Shores will address this issue in accordance with applicable Federal, State, and local laws and regulations.

2.1.1.3.2 Atlantic County

As described in Section 4.7 of Volume I, the offshore export cables within the Atlantic ECC will transition onshore at the Atlantic Landfall Site in Atlantic City. The Atlantic Landfall Site will be located on a parcel of land that is currently used as a public parking lot bounded by Pacific, South Belmont, and South California Avenues and California Avenue within Atlantic City in Atlantic County, New Jersey (see Figure 4.8-1 of Volume I). This landfall site will include underground transition vaults associated with the Atlantic export cables (one per export cable).

The Cardiff Onshore Interconnection Cable Route will then run underground within existing roadway, utility ROWs and a paved bike path to connect to the local electrical grid at the existing Cardiff Substation POI. Between the landfall and the POI, the onshore interconnection cables will also connect to a proposed Project substation and/or converter station along the route (see Figure 4.8-1 of Volume I).

Atlantic City, including the Atlantic Landfall Site and the first portion of the Cardiff Onshore Interconnection Cable Route, is located on Absecon Island, a highly developed low, sandy barrier island separated from the mainland by Absecon Bay and adjacent tidal marshes. Absecon Island is one of the current systems of northeast to southwest oriented geologically recent barrier islands along the southern New Jersey coast. Landward of the islands are large tidal lagoons, estuaries, and marshlands such as Absecon Bay.

The offshore to onshore export cable transition at the Atlantic Landfall Site will be initiated from a paved parking lot or in-street landfall located landward of the beach, dunes, and adjacent roadway, to minimize effects to the beach and nearshore environments. The transition will be accomplished using HDD (see Section 4.8 of Volume 1). The HDD will penetrate subsurface nearshore unconsolidated sands, silts, and clays. The HDD will be installed at depths designed to prevent exposure of the cable at the landfall site due to beach and nearshore erosion.

The onshore cable route will be constructed largely within previously developed and disturbed areas. Undisturbed soil units mapped by the NRCS within approximately 100 ft (30.5 m) of the centerline of the Cardiff Onshore Interconnection Cable Route and proposed substation and/or converter station locations are shown and described in Appendix II-A7b. In summary, a total of 18 soil units are mapped within the Onshore Project Area. The most common soil series are the well-drained Downer loamy sand, sandy hydric Psammaquents often found in flat areas, and the well-drained Psamments found in flat areas. Additional physical characteristics of the soils are described in Appendix II-A7b, including inclusions, hydric status, acidity, drainage characteristics and other conditions relevant to suitable onshore design of the Projects.

As noted for Monmouth County, a Phase 1 Environmental Site Assessment will be conducted prior to ground disturbing activities in the Onshore Project Area to confirm the site conditions present within the Projects' construction footprint. If potentially impacted soils are encountered during construction, Atlantic Shores will address this issue in accordance with applicable Federal, State, and local laws and regulations.

2.1.2 Potential Impacts and Proposed Environmental Protection Measures

Geological conditions influence Project siting and design. Geological conditions may also be disturbed by Project construction, O&M, or decommissioning. Project facilities and activities which may be affected by geological conditions, or which may disturb geologic conditions, are presented in Table 2.1-3.

Table 2.1-3 Impact Producing Factors for Geology

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Influence of Site Geology on Project Design	●	●	●
Natural and Anthropogenic Hazards	●	●	●
Installation and Maintenance of New Structures and Cables	●	●	●
Presence of Structures and Cables		●	●

The maximum Project Design Envelope (PDE) analyzed for the purpose of this section is the maximum onshore and offshore build-out of the Projects (as defined in Section 4.11 of Volume I).

2.1.2.1 Influence of Site Geology on Design of the Projects'

Offshore

Atlantic Shores has conducted HRG and geotechnical surveys of the WTA and/or ECCs in 2019, 2020, 2021, and 2022. All survey data are being carefully evaluated to guide the siting, design, and engineering of offshore components, including WTG and OSS foundations and offshore cables (export, inter-array, and inter-link cables).

As described in Section 3.4 of Volume I, Atlantic Shores performed an extensive evaluation of all viable WTG and OSS foundation types that may be suitable for the geological conditions in the WTA. Following this detailed analysis, which included an assessment of preliminary sediment profiles, Atlantic Shores determined that piled, suction bucket, and gravity foundations are all suitable to include in the PDE (see Sections 3.4, 4.2, and 4.4 of Volume I). Subsequent to additional review and consultation with multiple federal agencies, Atlantic Shores has committed to using monopiles for all WTGs associated with Project 1. WTG foundations for Project 2 will be either monopiles or piled jackets. Only one WTG foundation type (monopile or piled jackets) will be utilized for all WTG positions in Project 2. OSS and met tower foundations will consist of either piled, suction bucket, or gravity foundations. Only one OSS foundation type (piled, suction bucket, or gravity) will be utilized for all OSSs in Project 2. As additional geophysical and geotechnical data are evaluated, Atlantic Shores will continue to refine the design of the foundation types specific to geological conditions. Atlantic Shores is also continuing to evaluate geophysical and geotechnical data to inform the siting and design of the inter-array cables within the WTA.

Atlantic Shores is also evaluating geological conditions within the ECCs using data from the marine field investigations. As described in Section 3.3 of Volume I, Atlantic Shores considered geological conditions when siting the ECCs. Mapped surficial and shallow geological characteristics were used to confirm technical feasibility for cable installation tools. The presence of mobile sediments was also assessed (see Section 2.1.2.2). Mobile sediments may pose a risk of over-burial or exposure of the cable (see Section 3.3 of Volume I). Bathymetry maps were also used during siting of the ECCs to identify any areas of steep slopes, which are not preferred due to expected installation constraints (see Section 3.3 of Volume I).

During siting of the ECCs, sandy sediments were preferred over rocky, stiff, or very fine sediments to ensure cable burial to a sufficient depth (see Section 3.3 of Volume I). The Projects' ECCs were routed to avoid most Federal- and State-designated sand resource areas and sand borrow sites in the vicinity of the Offshore Project Area (see Section 2.1.1.2.2). For the small segments of both of the ECC 2020 survey routes which cross designated sand resource areas and sand borrow sites, Atlantic Shores actively coordinated with the relevant regulatory agencies to reroute small portions of the ECCs in 2021 to avoid mapped sand resource areas in accordance with Federal and State requirements and industry BMPs (see Section 7.7 Other Marine Uses and Military Activities).

Onshore

Atlantic Shores considered site geology when developing the onshore interconnection cable routes. The selected onshore interconnection cable routes each provide shorter, more direct routes than other alternatives considered to minimize the area disturbed (see Section 3.2.4 of Volume I). Additionally, the onshore interconnection cable routes will largely be constructed within previously developed and disturbed areas such as existing roadways, utility ROWs, and/or bike paths to minimize effects to undisturbed land areas. Atlantic Shores will also use trenchless techniques (e.g., HDD, pipe jacking, and jack-and-bore) to minimize soil disturbance in select locations such as wetlands, waterbodies, or busy roadways.

Atlantic Shores will conduct geotechnical borings as necessary to confirm geological subsurface conditions prior to onshore interconnection cable installation. Atlantic Shores is also evaluating sediment profiles at the landfall sites and in the nearshore area to engineer the HDD bore paths. Use of HDD will avoid effects to the beaches at the landfall locations.

Onshore substation and/or converter station sites were selected to avoid disturbance to undeveloped land areas and resources such as wetlands and floodplains (see Section 4.9.1 of Volume I).

2.1.2.2 Natural and Anthropogenic Hazards

The Projects will avoid natural and anthropogenic hazards to the maximum extent practicable.

Offshore

The Offshore Project Area has been sited and designed to avoid natural hazards to the maximum extent practicable. The Projects will be sited on a largely level submerged continental shelf in interbedded coastal plain and marine sediments. Project structures are not expected to encounter bedrock. The passive margin setting is comparatively inactive and stable tectonically. Faults have not been identified in the Offshore Project Area, based upon the studies in Section 2.1.1.

Sandy sediments are predominant on the seafloor in the Offshore Project Area. Project components have been sited within sandy sediments, which are preferred over rocky, stiff, or very fine sediments to ensure cable burial to a sufficient depth. Mobile sand bedforms (i.e., ripples, megaripples, and sandwaves) were mapped from the site-specific G&G data within the WTA and ECCs. The presence of these features may necessitate the removal of the tops of some sand bedforms prior to offshore cable installation to ensure the cables can be installed within stable seabed. Sand bedform removal will be limited only to the extent required to achieve adequate cable burial depth. Additionally, foundations, particularly gravity foundations, may require some seabed preparation. Seabed preparation involves removing the uppermost sediment layer to establish a level surface, remove any surficial sediments that are too weak to support the planned structure, and enable full contact between the foundation's base and the seafloor.

Atlantic Shores considered natural and anthropogenic hazards to develop the target burial depth for the offshore cables. All offshore cables will have a target minimum burial depth of 5 to 6.6 ft (1.5 to 2 m). The cable burial depth is based upon a cable burial risk assessment that considers activities such as anchor use and commercial fishing practices to develop a safe target burial depth for the cables (Appendix II-A5). Cable surveys will be performed at regular intervals to identify any issues associated with potential scour and depth of burial (see Section 5.4.4 of Volume I). Atlantic Shores is continuing to investigate the potential presence of anthropogenic hazards. The Projects have been designed to avoid three mapped ocean disposal sites located proximal to the Offshore Project Area. Atlantic Shores also plans to avoid shipwrecks and MEC. If any anthropogenic hazards cannot be avoided, appropriate mitigation measures will be developed in consultation with BOEM and other appropriate resource agencies. Mitigation strategies for MEC are presented in Section 2.1.1.2.4 and Appendix II-A4b.

Existing cables cross both ECCs. Atlantic Shores has identified all cable owners and has initiated discussions regarding crossing methods and/or setbacks.

The Projects will also be managed by a comprehensive Oil Spill Response Plan (OSRP) to minimize risk of sediment contamination (see Volume I, Appendix I-D).

Onshore

Atlantic Shores is proposing to accomplish the offshore-to-onshore transition at each landfall site using HDD. The HDD will be installed at depths designed to prevent exposure of the cable at the landfall sites due to beach and nearshore erosion.

The onshore interconnection cable route will largely be constructed within previously developed and disturbed areas. A Phase 1 Environmental Site Assessment will be conducted prior to ground disturbing activities in the Onshore Project Area. Any potentially impacted soils will be addressed in accordance with applicable Federal, State, and local laws and regulations. Atlantic Shores will also develop and maintain a Spill Prevention, Control, and Countermeasure (SPCC) Plan for the life of the Projects.

During installation of the onshore interconnection cable, existing underground utilities along the onshore interconnection route could constitute an anthropogenic hazard. Atlantic Shores has confirmed utility locations using available as-built plans, survey pits, and/or Ground Penetrating Radar (GPR) of the existing infrastructure and is consulting with the New Jersey Department of Transportation (NJDOT), involved municipalities, and utility representatives to ensure appropriate siting and placement of the Projects' infrastructure.

2.1.2.3 Installation and Maintenance of New Structures and Cables

The installation of new structures and cables may result in the following:

- temporary disturbance to marine sediments and terrestrial soils during construction and decommissioning

- temporary effects to water quality from suspension and transport of disturbed marine sediments or erosion and sedimentation of terrestrial soils.

Offshore

The installation of new WTG and OSS foundation structures and offshore cables will temporarily disturb marine sediments. As described in Section 4.0 of Volume I, seafloor-disturbing activities include seabed preparation, placement of scour protection, installation of WTG and OSS foundations, limited dredging of the tops of mobile bedforms, cable installation activities, HDD operations at the landfall sites, anchoring of support vessels, and use jack-up vessels. A summary of the seafloor disturbance under the maximum design scenario is presented in Section 4.11 of Volume I.

Seafloor disturbance will mobilize and temporarily suspend some shallow sediments into the water column, where they may be transported and re-deposited onto the seafloor. Sediment disturbance resulting from installation of new structures and cables is expected to result in a short-term increase in suspended sediment concentrations at the seafloor, limited to areas immediately adjacent the specific construction activity. Effects to water quality will be temporary and localized, and no long-term effects to water quality conditions are anticipated (see Section 3.2 Water Quality). Atlantic Shores will use the shortest feasible offshore cable route to minimize seafloor disturbance and will select cable installation techniques (e.g., jet plow embedment) that minimize sediment suspension to the maximum extent practicable. Atlantic Shores will also use anchor midline buoys and dynamically positioned vessels as practicable to minimize seafloor disturbance. Sediments disturbed during construction activities are not expected to contain contaminants given that sediments are predominantly sandy and known sources of anthropogenic contaminants (i.e., the mapped ocean disposal sites described in Table 2.1-2) will be avoided.

During O&M, the degree of suspended sediment will be significantly lower than during construction because any needed maintenance activities will be limited to discrete portions of offshore cables or structures. Any effects during O&M are expected to be short-term and temporary due to the sandy seafloor in the Offshore Project Area. Decommissioning of structures and cables is expected to have similar short-term and localized effects as those described for construction.

Onshore

Atlantic Shores has minimized potential disturbance of terrestrial soils by siting the onshore interconnection cables primarily along existing roadways, utility ROWs, and/or along bike paths. Atlantic Shores is also proposing to use HDD to accomplish the offshore-to-onshore transition, which will minimize the amount of soil disturbance at the landfall sites. Atlantic Shores will also use trenchless techniques to minimize soil disturbance in select locations such as wetlands, waterbodies, or busy roadways.

BMPs will be employed to properly contain excavated soils and sediments and stabilize disturbed soil areas, to avoid erosion and sediment runoff into waterbodies. These will include, but are not limited to, the following:

- pre-construction installation of appropriate erosion and siltation control measures, such as siltation fencing, near water bodies, around catch basins, and around temporary stockpiles
- regular monitoring of disturbed areas and existing drainage areas, and monitoring of these areas immediately after precipitation events and adjustment of measures as needed
- development of a dust control plan to control dust during construction, in compliance with applicable dust control standards in NJDOT's Soil Erosion and Sedimentation Control Standards
- stabilization, through seeding or re-paving of disturbed areas as appropriate, as soon as possible following installation activities
- development of a Stormwater Management Plan, including erosion and sedimentation control measures.

2.1.2.4 Presence of Structures and Cables

Offshore Project structures such as WTG and OSS foundations will occupy areas of the seabed over the operational life of the Projects. The presence of these structures may result in localized changes to the seafloor.

During O&M, localized bottom currents can develop around Project structures at the seabed that can then scour and erode sediments surrounding foundations. To minimize these effects and maintain the structural integrity of the foundation, scour protection may be installed on the seafloor at the base of each foundation. Types of scour protection that may be utilized around WTG and OSS foundations include rock placement, rock bags, grout- or sand-filled bags, concrete mattresses, ballast-filled mattresses, or frond mattresses described in Sections 4.2.5 and 4.4.3 of Volume I, respectively. Alternately, for monopile foundations, scour protection may not be used; if scour protection is not used, the depth of penetration will be increased to account for the expected scour (see Table 4.2-1 in Volume I).

Offshore cable surveys will be performed at regular intervals to identify any issues associated with potential scour and depth of burial (see Section 5.4.4 of Volume I). If needed, cable protection, as described in Section 4.5.7 of Volume I, will be installed.

2.1.2.5 Summary of Proposed Environmental Protection Measures

The Projects will be designed to be compatible with geologic conditions in the Project Area.

Offshore

- HRG and geotechnical surveys of the WTA and/or ECCs were conducted in 2019, 2020, 2021, and 2022 to provide detailed site data for Project siting and design.
- The shortest feasible offshore cable route will be used to minimize seafloor disturbance. Additionally, dynamic positioning vessels and jet plow embedment will be used to the maximum extent practicable to minimize sediment disturbance and alteration during the offshore cable installation process. Atlantic Shores will also use anchor midline buoys on anchored construction vessels, where feasible, to minimize disturbance to the seafloor and sediments.
- The Projects will be designed to avoid known natural and anthropogenic hazards to the maximum extent practicable. This includes avoidance of three proximal mapped ocean disposal areas, shipwrecks, and MEC.
- The ECCs were routed to avoid most Federal- and State-designated sand resource areas and sand borrow sites.
- Existing cables cross both ECCs. Any cable crossing will be surveyed in accordance with applicable industry standards and practices both before and after each cable crossing. Atlantic Shores has identified all cable owners and has initiated discussions regarding crossing methods and/or setbacks.
- All offshore cables will be buried to a target depth of 5 to 6.6 ft (1.5 to 2 m) to avoid interference with existing marine uses (e.g., anchoring and commercial fishing) and protect the cable.
- The Projects will also be managed by a comprehensive OSRP, to minimize risk of sediment contamination.
- Cable surveys will be performed at regular intervals to identify any issues associated with potential scour and depth of burial.

Onshore

- A Phase 1 Environmental Site Assessment will be conducted prior to ground-disturbing activities to assess the presence or absence of pre-existing contamination in the construction footprint.
- Onshore geotechnical borings will be conducted as needed.
- Onshore interconnection cable routes have been sited to travel primarily along previously disturbed areas such as existing roadways, utility ROWs, and/or bike paths.
- HDD will be used at the landfall sites. The HDD will be installed at depths designed to prevent exposure of the cable due to beach and nearshore erosion.
- A dust control plan will be prepared to control fugitive dust during construction, in compliance with applicable dust control standards in NJDOT's Soil Erosion and Sedimentation Control Standards.
- Trenchless techniques will be used to minimize soil disturbance in select locations such as wetlands, waterbodies, or busy roadways.
- An SPCC Plan will be developed and maintained for the life of the Projects.
- BMPs will be employed to properly contain excavated soils and sediments and stabilize disturbed land areas, to avoid erosion and sediment runoff into nearby resource areas. These will include, but are not limited to:
    - pre-construction installation of appropriate erosion and siltation control measures, such as siltation fencing, near water bodies, around catch basins, and around temporary stockpiles
    - regular monitoring of disturbed areas and existing drainage areas, and monitoring of these areas immediately after precipitation events and adjustment of measures as needed
    - stabilization, through seeding or re-paving of disturbed areas as appropriate, as soon as possible following installation activities
    - development of a Stormwater Management Plan, including erosion and sedimentation control measures.

2.2 Physical Oceanography and Meteorology

This section describes the oceanographic and meteorological (metocean) conditions affecting the Onshore and Offshore Project Areas, including a discussion of physical characteristics of currents, regional circulation, and winds, and how the proposed facilities, construction, operation, and maintenance (O&M), and decommissioning may affect or be affected by the metocean conditions within the Project Areas.

2.2.1 Affected Environment

The information in this section used to characterize the affected environment is based on published data as cited herein and the following site-specific surveys and reports:

- **Volume I Metocean Analysis** (Appendix II-B1) was conducted in 2020 and evaluated long-term hindcast modelized timeseries, dating back to 1979, at four representative locations (one in the northern portion of the Lease Area OCS-A 0499 [Lease Area], one in the southern portion of the Lease Area, and one at each landfall location) describing the wind, wave, current, and atmospheric conditions. The study addressed both normal and extreme conditions and was used for preliminary design work, namely for foundations and wind turbine selection.

- **Volume II Metocean Design Basis** (Appendix II-B2) was conducted in 2020 and presents the background data and full data sets and methodologies used to develop Volume I Metocean Analysis Report.

Although high fidelity modelized data are useful to describe site conditions, Atlantic Shores (in collaboration with Rutgers University and MARACOOS) deployed its first floating light detection and ranging (lidar) system outside of the Lease Area on December 29, 2019, to further enhance its understanding of metocean conditions. The system consists of a buoy with various instruments measuring wind, wave, water level, currents, as well as parameters such as air and water temperature, air pressure, and conductivity. The key measuring system of the system is the lidar profiler that measures wind speed and directions above the buoy at various heights up to 820 feet (ft) (250 meters [m]) above sea level. All data collected by this first deployment are made public through the MARACOOS ERDDAP server.

Atlantic Shores also initiated a multi-year site-specific metocean campaign in the Lease Area, which begins with approval of the Site Assessment Plan (SAP) in April 2021. This campaign will further refine the understanding of conditions (including the extremes of those conditions) and validate modeling data within the Offshore Project Areas. A detailed report pertaining to this campaign will be provided to BOEM as part of the design basis in the Facility Design Report (FDR).

These collective metocean studies are key inputs into the Project design basis. The results of these multi-year studies will be provided with the FDR and Fabrication and Installation Report (FIR) prior to Project construction.

The Atlantic Shores Offshore Project Area includes the Wind Turbine Area (WTA), which is comprised of Project 1, Project 2 and the Overlap Area. The WTA is located in the Mid-Atlantic Bight region which extends from Cape Hatteras, North Carolina, to Cape Cod, Massachusetts. The larger Atlantic Shores Project Region can be divided into two parts: the Atlantic Shores Offshore

Project Region, which extends from North Carolina to Massachusetts encompassing the Mid-Atlantic Bight, and the Atlantic Shores Onshore Project Area, which ranges from Atlantic City, New Jersey, to Sea Girt, New Jersey. The Offshore Project Region is affected by the circulation features of the Mid-Atlantic Bight coastal area, as well as the Gulf Stream current and eddies, while the Onshore Project Area experiences the humid subtropical climate of the Mid-Atlantic region. Based on a scientific literature review and metocean studies conducted for Atlantic Shores (see Appendix II-B1 and Appendix II-B2), the major oceanographic and meteorological processes that are expected to influence the Offshore Project Area are wind, waves, currents, tides, tidal currents, and hurricanes and strong storms.

The following sections discuss the primary metocean conditions affecting the Offshore Project Area.

2.2.1.1 Currents

The offshore waters near the Mid-Atlantic Bight are influenced by two main current systems: the southward flowing cool water (temperatures less than 46 degrees Fahrenheit/8 degrees Celsius [46 °F/8 °C]) coming from New England and the warm water of the Gulf Stream, which flows northward along the coast from Florida to North Carolina and then migrates northeastward into deeper water after reaching Cape Hatteras at 35°N (see Figure 2.2-1). The Gulf Stream can have significant effects on the ecosystems of the Mid-Atlantic Bight.

The currents near the Offshore Project Area in the coastal Mid-Atlantic Bight are separated and flow in opposite directions at a point which varies over a distance of 54 nautical miles (nm) (100 kilometers [km]) along the New Jersey coastline (Ashley et al. 1986). This bifurcation phenomenon is likely caused by the combination of several mechanisms including wave refraction, residual drift of ocean currents over the continental shelf, and swell processes. The currents near the bifurcation point show spatial variation, especially regarding the short-term regional current pattern (Buteux 1982). However, variability is less pronounced over the long term (Bumpus 1965).

In combination with this regional scale pattern, small scale circulation patterns are also present near the coast. These currents are caused by wave refraction around ebb tidal deltas and rip current circulation. However, the smaller scale current reversals do not show significant spatial variation and can cause erosion in the Offshore Project Area.

Beardsley and Winant (1978) discussed two possible mechanisms that can drive the alongshelf flow in the Mid-Atlantic Bight region: river runoff and the physical mechanism which creates alongshelf pressure gradient. The study found that river runoff cannot solely drive the alongshelf flow. Rather, in addition to the runoff, large scale wind stress and heat flux distribution are necessary.

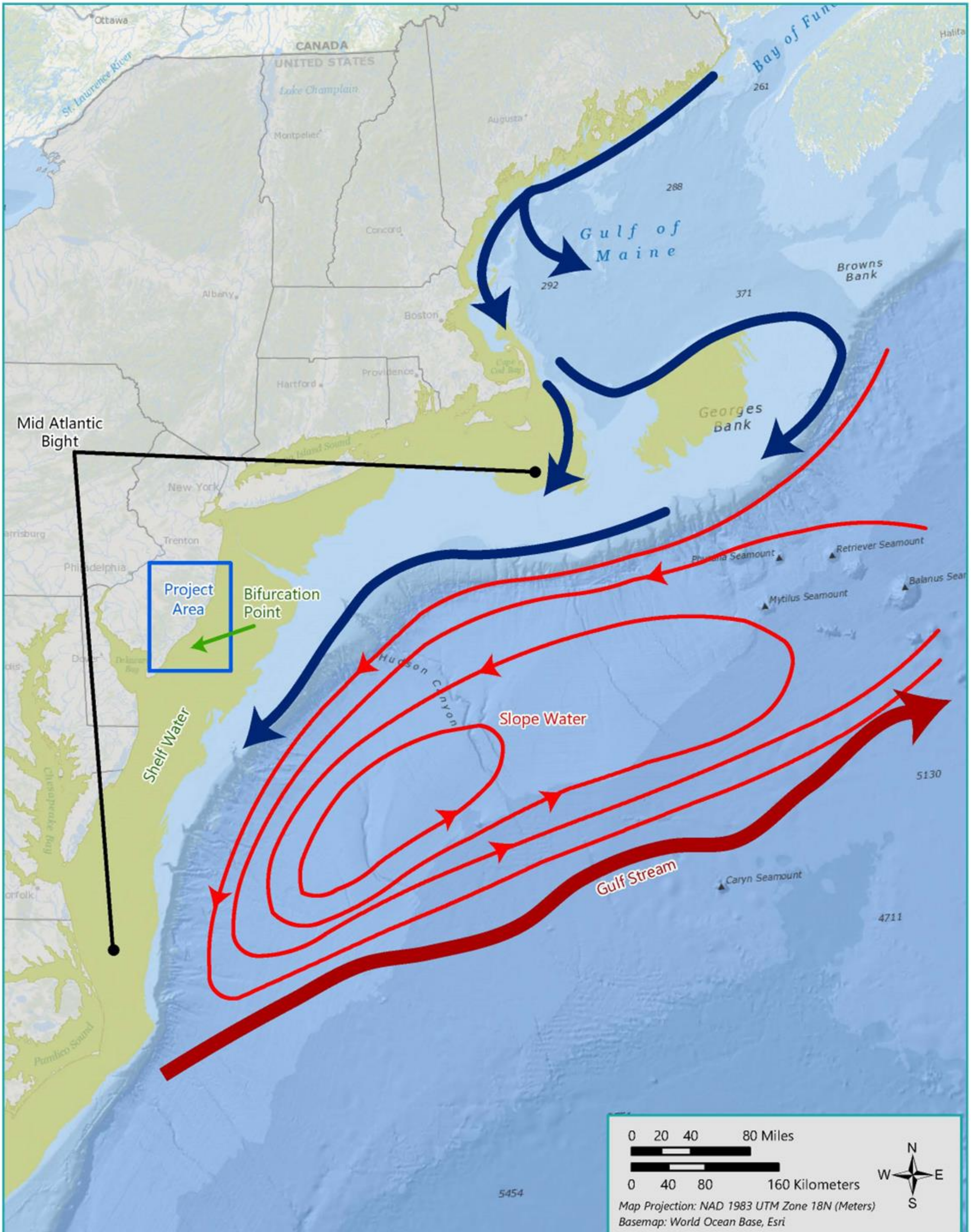
Based on High Frequency (HF) Radar data collected in the New Jersey Shelf, Kohut et al. (2004) found that the annual mean current measured between May 1999 and May 2000 showed a weak southwestward flow along the shore as presented in Figure 2.2-2. This study discussed the seasonal variation of the New Jersey Shelf current, where stratification caused by freshwater runoff and warmer temperatures can be seen during the summer season. However, during the winter season, current is more variable and shows relatively less correlation with the wind and is strongly correlated with the topography.

Gong et al. (2010) also characterized the spatial structure of the mean current and seasonal surface circulation in the New Jersey Shelf, using long-range HF radar data from 2002 to 2007. The mean surface flow over New Jersey Shelf is between 1 and 5 inches per second (in/s) (2 and 12 centimeters per second [cm/s]) down shelf and towards the south. The study also suggested that the surface flow in the New Jersey Shelf is a function of topography, seasonal stratification, and wind forcing. The current is in the same direction of the wind during the unstratified/mixed (winter) season, as dominant northwest winds drive cross-shelf offshore flows. However, during the stratified season (summer), the flow direction is to the right of the wind due to Ekman forcing, as dominant southwest wind drives cross-shelf offshore flow. During the transition seasons (spring and autumn), northeast winds drive energetic along-shelf flows.

An extremal analysis of current speed for different return periods and different depth levels from all directions is presented in Table 2.2-1 based on the hindcast period 1924–2018 of GROW-FINE East Coast Model (GFEC) model (see also Appendix II-B2). Based on this analysis, the maximum current speed can reach 1.21 feet per second (ft/s) (0.37 meters per second [m/s]) at the surface layer for a 1-year return period, which is close to the annual maximum of the shelf break jet of the Mid-Atlantic Bight (Chen and He 2010).

Table 2.2-1 Extreme Current Speeds (as ft/s and m/s) for Different Return Periods from a location in the Wind Turbine Area (WTA)

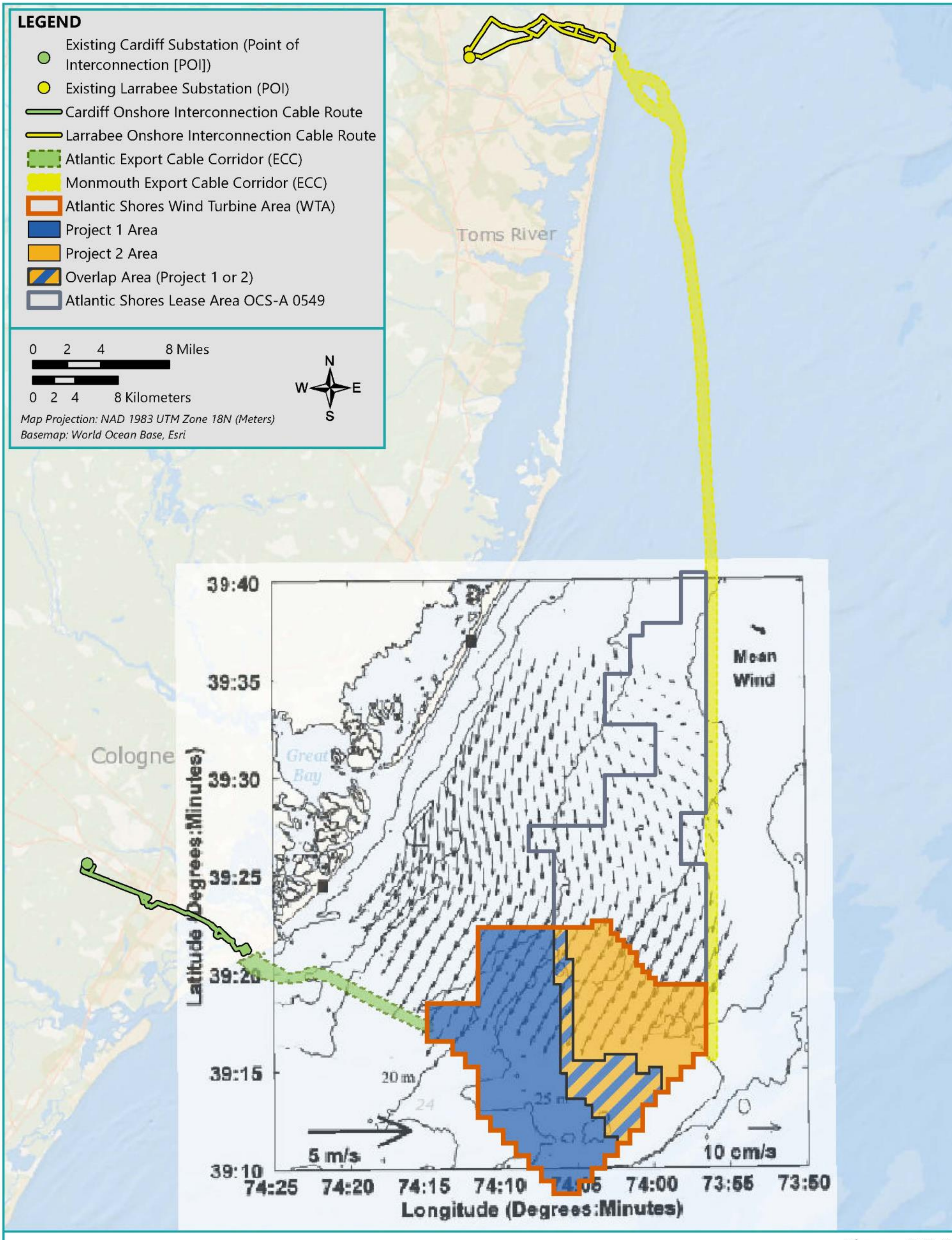
Depth Level	Current Speed for Return Period							
	1 Year		10 Year		50 Year		100 Year	
	ft/s	m/s	ft/s	m/s	ft/s	m/s	ft/s	m/s
Surface	1.21	0.37	2.72	0.83	3.70	1.13	4.10	1.25
Depth Average	1.08	0.33	2.36	0.72	3.11	0.95	3.41	1.04
Near-Bottom	0.89	0.27	2.00	0.61	2.72	0.83	3.02	0.92



ATLANTIC SHORES offshore wind

Figure 2.2-1

Currents in the Mid-Atlantic Bight, as Modified from Mid-Atlantic Regional Ocean Assessment (MAROA 2020), Offshore New Jersey



ATLANTIC SHORES offshore wind

Figure 2.2-2

Annual Mean Surface Current near the Lease Area Measured by HF Radar Offshore New Jersey

2.2.1.2 Tides

The nature of tides on the Mid-Atlantic Bight shelf is semi-diurnal (i.e., changes direction twice a day) and rotary. In offshore regions, tidal currents are weak (less than 0.2 ft/s [0.05 m/s]); however, nearshore tidal currents could reach velocities of 5 ft/s (1.5 m/s) (USDOI 1982).

Tidal levels relative to lowest astronomical tide are extracted from the closest National Oceanic and Atmospheric Administration tide station (Station ID: 8534720) to the Offshore Project Area and presented in Table 2.2-2. The Highest Astronomical Tide recorded at the station is 7.05 ft (2.15 m) while the Mean Tide Level is 3.38 ft (1.03 m) above Lowest Astronomical Tide.

Table 2.2-2 Tidal Levels Relative to Lowest Astronomical Tide at Atlantic City, New Jersey

Tide Levels	Feet	Meters
Highest Astronomical Tide	7.05	2.15
Mean Higher High Water	5.81	1.77
Mean High Water	5.31	1.65
North American Vertical Datum (NAVD88)	3.84	1.17
Mean Sea Level	3.44	1.05
Mean Tide Level	3.38	1.03
Mean Low Water	1.38	0.42
Mean Lower Low Water	1.21	0.37
Lowest Astronomical Tide	0.00	0.00

The monthly average, maximum, and minimum water levels near the landfall sites is presented in Table 2.2-3, based on the observation data from Atlantic City Steel Pier (Buoy 8534720), and tidal elevation record from Sandy Hook, New Jersey (Buoy 8531680) in 2019. The data show the maximum water level of 5.16 ft (1.57 m) in October; however, as discussed in Appendix II-B1, the absolute extreme maximum water level of this station is 6 ft (1.83 m) above mean sea level (AMSL) as recorded on September 14, 1944. The absolute extreme minimum is 7.45 ft (2.27 m) below mean sea level (BMSL) as recorded on January 10, 1978 (Tides and Currents 2020a).

Tidal elevation record at Sandy Hook, New Jersey, shows the maximum water level of 5.16 ft (1.572 m) in January 2019. The absolute extreme maximum and minimum water level of this station is 9.45 ft (2.881 m) AMSL and 6.95 ft (2.118 m) BMSL as recorded on October 26, 2012, and on January 10, 1978, respectively (see Appendix II-B1; Tides and Currents 2020b).

Table 2.2-3 Tidal Elevation (Relative to Mean Sea Level) Measurement in Atlantic City and Sandy Hook, New Jersey Buoys

Month	Unit	Atlantic City Steel Pier			Sandy Hook, New Jersey		
		Mean	Max	Min	Mean	Max	Min
January	ft	0.21	0.46	-4.66	0.23	5.16	-5.22
	m	0.06	0.14	-1.42	0.07	1.57	-1.59
February	ft	-0.05	0.40	-3.68	0.02	4.66	-4.07
	m	-0.01	0.12	-1.12	0.01	1.42	-1.24
March	ft	0.21	4.01	-3.65	0.24	4.94	-4.45
	m	0.07	1.22	-1.11	0.07	1.51	-1.36
April	ft	0.41	3.78	-3.11	0.37	4.50	-3.53
	m	0.13	1.15	-0.95	0.11	1.37	-1.08
May	ft	0.68	4.21	-2.29	0.77	4.44	-2.42
	m	0.21	1.28	-0.70	0.24	1.35	-0.74
June	ft	0.61	3.92	-2.42	0.71	4.37	-2.65
	m	0.19	1.20	-0.74	0.22	1.33	-0.81
July	ft	0.59	4.03	-2.33	0.70	4.39	-2.56
	m	0.18	1.23	-0.71	0.21	1.34	-0.78
August	ft	0.78	4.06	-2.76	0.77	4.32	-3.22
	m	0.24	1.24	-0.84	0.24	1.32	-0.98
September	ft	0.87	4.19	-2.45	0.79	4.52	-2.94
	m	0.27	1.28	-0.75	0.24	1.38	-0.90
October	ft	1.11	5.16	-2.90	1.02	5.07	-3.80
	m	0.34	1.57	-0.89	0.31	1.54	-1.16
November	ft	0.62	4.41	-3.28	0.56	4.52	-3.73
	m	0.19	1.34	-1.00	0.17	1.38	-1.14
December	ft	0.38	4.17	-3.48	0.41	4.49	-4.20
	m	0.12	1.270	-1.06	0.12	1.37	-1.28

2.2.1.3 Water Temperature, Salinity, and Density

There are three main water masses present in the Mid-Atlantic Bight: the relatively fresh Shelf Water with salinity less than 35 parts per thousand (ppt); the more saline slope water (35 ppt < salinity < 36 ppt); and the warm and salty Gulf Stream (temperature >64 °F [18 °C], salinity >36 ppt) (Miller et al. 2014).

Using satellite-derived velocity and temperature data, Connolly and Lentz (2014) showed that interannual variability in wintertime temperature in the Mid-Atlantic Bight is partially controlled by alongshore advection of warmer water. The study also demonstrated that surface heat flux is controlled by the difference of air-sea temperature.

Based on data collected at the New Jersey Wind Energy Area (NJ WEA) for 2003–2016, the median salinity of the water in the Offshore Project Area is 32.2 ppt and ranges from 29.4 to 34.4 ppt. Temperature in the Offshore Project Area shows higher seasonal variability (BOEM 2017), with variation of temperature as high as 68 °F (20 °C) at the surface and 59 °F (15 °C) at the seabed (BOEM 2017). During spring and summer, the water in the Mid-Atlantic Bight experiences a strong stratification caused by increased freshwater runoff and warmer temperatures. During this time, the warm fresh water creates a layer over the cooler and saltier layer; thus, preventing the water from mixing. This creates a bottom-trapped, cold, nutrient-rich pool, referred to as the Mid-Atlantic Cold Pool that extends from Georges Bank, Maine to Cape Hatteras, North Carolina and is located over the mid- and outer-shelf of the Mid-Atlantic Bight (NEIEA n.d.; Chen et al. 2018).

The formation of the Cold Pool is driven by seasonal patterns in solar heating and wind (Ganim 2019) and is not spatially uniform (Lentz 2017). It forms at the start of spring, when wind mixing is reduced and surface heat fluxes increase, causing the water column to become stratified (Ganim 2019; Lentz 2017). Freshwater runoff in the spring can further intensify stratification (Castelao et al. 2010). The Cold Pool, located along the seafloor, is isolated from warming surface waters by the seasonal thermocline and creates habitat conditions that provide thermal refuge to colder water species in the Mid-Atlantic Bight ecosystem (Lentz 2017). Cold Pool waters are nutrient-enriched and, when upwelled toward the surface, can drive phytoplankton growth and high concentrations of particulate organic matter in the water column (Voynova et al. 2013). The timing of the formation and breakdown of the Cold Pool, as well as its spatial extent, varies significantly each year but generally develops annually between spring and fall (Chen and Curchitser 2020). The Cold Pool dissipates in the fall due to enhanced vertical mixing from an increase in the frequency of strong wind events and the cooling of surface temperatures (Ganim 2019). Despite a growing body of scientific literature on the Cold Pool, the mechanisms of its formation, evolution, and long-term fluctuations remain poorly understood (Chen et al. 2018), and multi-year observations show continued warming and a diminishment in size (NOAA 2020).

Considering the environmental, economic (with respect to fishing), and scientific significance of the Cold Pool, and the necessity of collecting more information at both the water surface and the ocean floor (Goldsmith et al. 2019) to help understand this environmental phenomenon, Atlantic Shores deployed a buoy outside of the Lease Area with additional bottom sensors. This buoy has captured and will continue to record weather events, which are crucial to analyzing the Cold Pool development life cycle (Chen et al. 2018).

A longer-term dataset obtained from the World Ocean Atlas climatology information (Zweng et al. 2018; Locarnini et al. 2018) for the WTA indicates the monthly sea surface water temperature typically varies from 41 to 73 °F (5 to 23 °C), and sea surface salinity ranges from 30.5 to 32.5 ppt (see Figure 2.2-3). This seasonality of salinity and temperature is consistent with observations recorded in the northern Mid-Atlantic Bight, indicating larger temperature variation and smaller salinity variation (Castelao et al. 2010). Based on salinity and temperature values from the World Ocean Atlas climatology dataset, the density of the seawater at the surface from a location in the WTA ranges from 63.74 to 64.05 pounds per cubic foot (lb/ft^3; 1,021 to 1,026 kilograms per cubic meter [kg/m^3]).

2.2.1.4 Winds, Air Temperature, and Density

The wind record was obtained from the GFEC continuous timeseries provided by Oceanweather, Inc. (1979–2018). Based on this dataset, winds at this location predominantly come from the south-southwest, with a significant number of high-speed winds (greater than 33 ft/s [10 m/s]) coming from the northwest as presented in Figure 2.2-4 (see Figure 2-1 in Appendix II-B2).

Extreme event analyses of wind speed at 33 ft (10 m) AMSL for different return periods and for several averaging periods are presented in Table 2.2-4. The analysis was done combining all the timeseries available from GFEC in all directions. Based on this analysis, the annual maximum wind speed (10-minute average) is 50.3 miles per hour (mph) (22.5 m/s), and the maximum wind speed is 70.7 mph (31.6 m/s) for a 50-year return period and 74.5 mph (33.3 m/s) for a 100-year return period. Further extreme event analysis will be performed during detailed design and will be presented with the FDR and FIR.

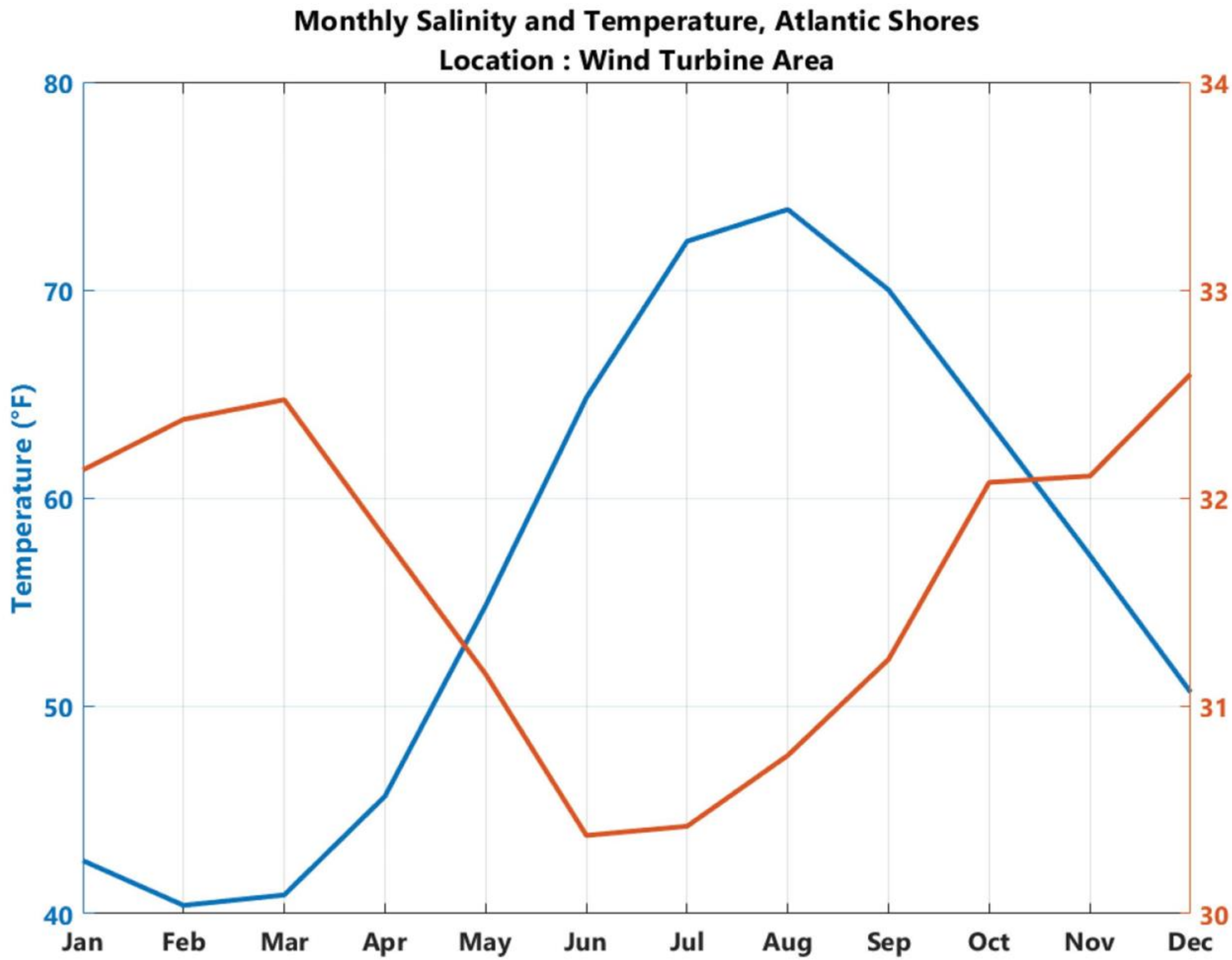


Figure 2.2-3

Monthly Sea Surface Temperature (°F) in Blue and Salinity (ppt) in Orange from within the WTA

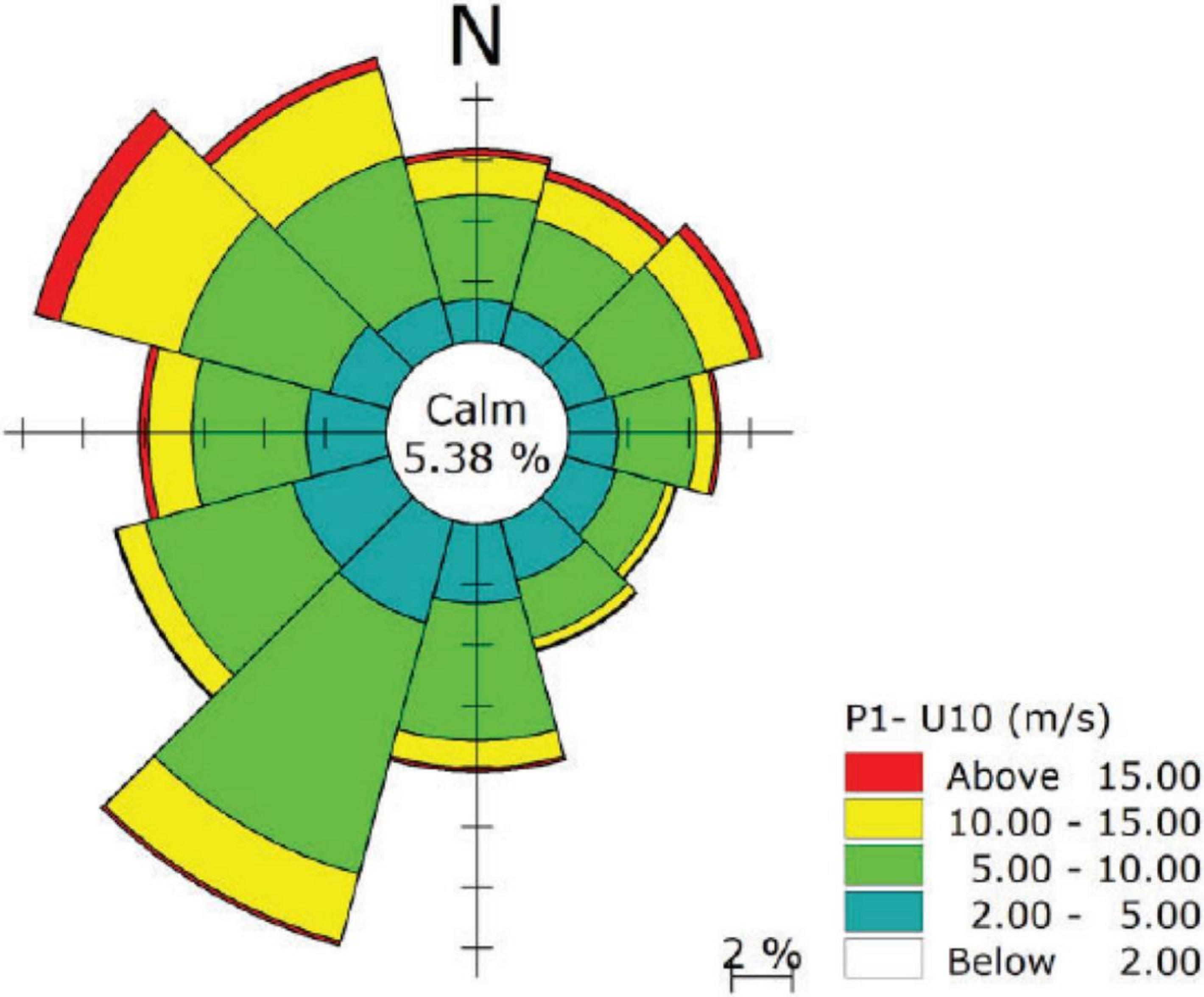


Figure 2.2-4
Windrose from within the WTA for 1979-2018

Table 2.2-4 Extreme Wind Speeds within the WTA (Elevation: 33 ft [10 m AMSL])

Averaging Time	Unit	Return Period (Years)					
		1	10	50	100	500	1,000
1 hour	ft/s	70.2	86.6	98.8	103.7	123.4	131.6
	m/s	21.4	26.4	30.1	31.6	37.6	40.1
10 minutes	ft/s	73.8	91.2	103.7	109.3	129.9	138.5
	m/s	22.5	27.8	31.6	33.3	39.6	42.2
1 minute	ft/s	81.4	100.4	114.2	120.1	143.0	152.2
	m/s	24.8	30.6	34.8	36.6	43.6	46.4
3 seconds	ft/s	92.2	114.2	129.9	136.5	162.4	173.2
	m/s	28.1	34.8	39.6	41.6	49.5	52.8

Monthly and annual values of air temperature and density at this location were analyzed at 443 ft (135 m) AMSL, using the model output for continuous period (1979–2018). In January, air temperature is minimum, and density is maximum; while in August, air temperature reaches the highest value while density drops to its minimum. The average air temperature at this offshore location is 53.8 °F (12.1 °C) and average air density is 0.05 lb/ft^3 (0.87 kg/m^3). The highest monthly average temperature at this location is 72.7 °F (22.6 °C) (in August) and lowest monthly average temperature is 36.3 °F (2.4 °C) (in February) as presented in Table 2.2-5.

Table 2.2-5 Monthly Statistics of Air Temperature and Air Density within the WTA for 1979-2018

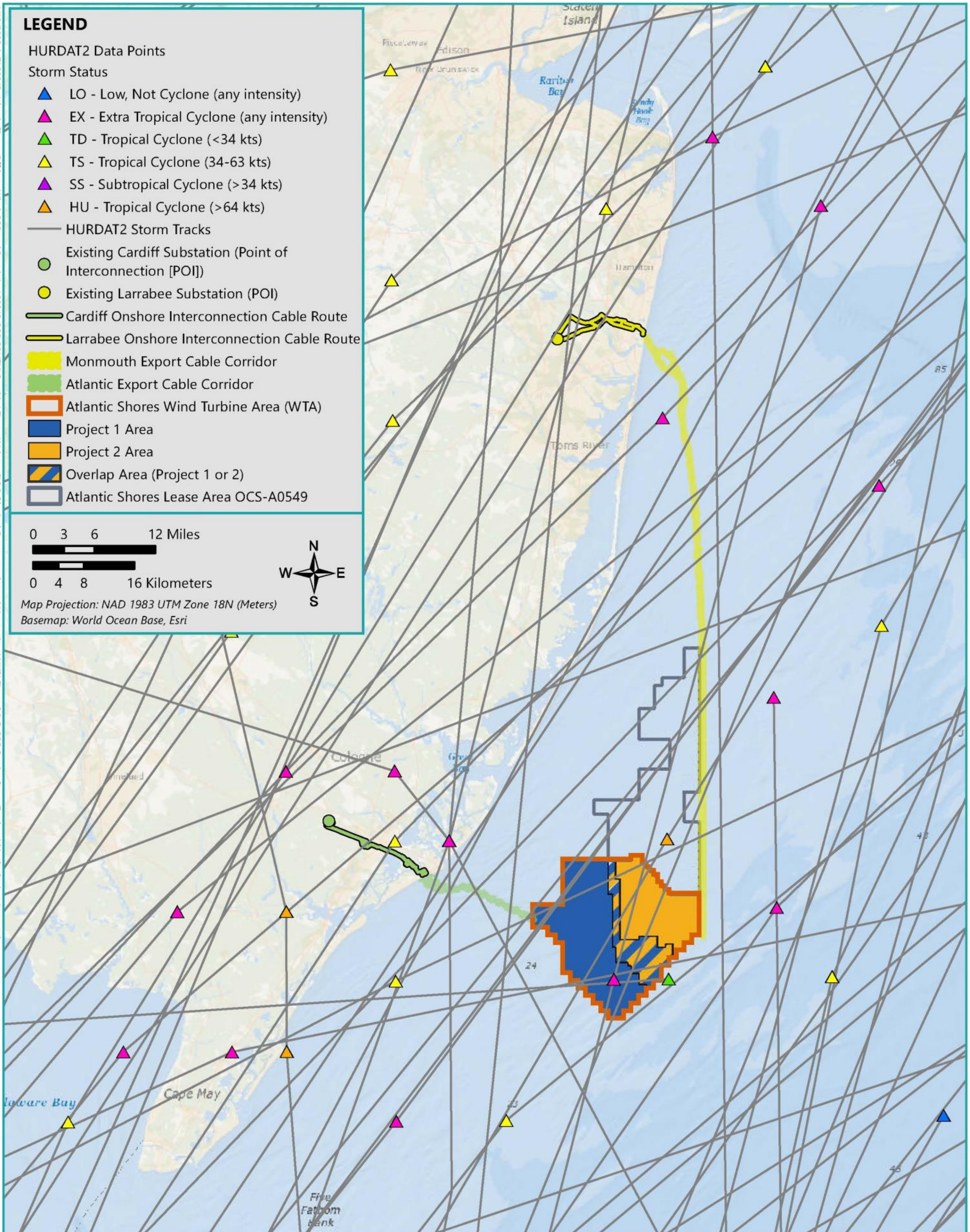
Month	Unit	Air Temperature			Unit	Air Density		
		Mean	Avg	Max		Min	Avg	Max
January	°F	3.0	36.5	56.7	lb/ft^3	0.07	0.08	0.09
	°C	-16.1	2.5	13.7	kg/m^3	1.18	1.26	1.38
February	°F	7.2	36.3	54.3	lb/ft^3	1.19	1.26	1.36
	°C	-13.8	2.4	12.4	kg/m^3	0.07	0.08	0.08
March	°F	12.4	40.1	56.8	lb/ft^3	0.07	0.08	0.08
	°C	-10.9	4.5	13.8	kg/m^3	1.17	1.25	1.35
April	°F	22.8	46.8	61.5	lb/ft^3	0.07	0.08	0.08
	°C	-5.1	8.2	16.4	kg/m^3	1.18	1.23	1.29

Table 2.2-5 Monthly Statistics of Air Temperature and Air Density within the WTA for 1979-2018 (Continued)

Month	Unit	Air Temperature			Unit	Air Density		
		Mean	Avg	Max		Min	Avg	Max
May	°F	43.2	55.0	72.5	lb/ft^3	0.07	0.08	0.08
	°C	6.2	12.8	22.5	kg/m^3	1.16	1.21	1.26
June	°F	50.4	64.9	78.8	lb/ft^3	0.07	0.07	0.08
	°C	10.2	18.3	26.0	kg/m^3	1.14	1.19	1.24
July	°F	59.0	72.1	81.3	lb/ft^3	0.07	0.07	0.08
	°C	15.0	22.3	27.4	kg/m^3	1.14	1.17	1.21
August	°F	56.3	72.7	81.5	lb/ft^3	0.07	0.07	0.08
	°C	13.5	22.6	27.5	kg/m^3	1.11	1.17	1.22
September	°F	51.4	68.2	79.2	lb/ft^3	0.07	0.07	0.08
	°C	10.8	20.1	26.2	kg/m^3	1.12	1.19	1.23
October	°F	40.3	59.4	73.6	lb/ft^3	0.07	0.08	0.08
	°C	4.6	15.2	23.1	kg/m^3	1.12	1.21	1.27
November	°F	26.4	50.5	65.7	lb/ft^3	0.07	0.08	0.08
	°C	-3.1	10.3	18.7	kg/m^3	1.17	1.23	1.31
December	°F	10.6	42.3	61.5	lb/ft^3	0.07	0.08	0.08
	°C	-11.9	5.7	16.4	kg/m^3	1.18	1.25	1.34

2.2.1.5 Storms

The Atlantic Shores Offshore and Onshore Project Areas are subject to extreme weather, such as storms and hurricanes, which may impose hydrodynamic load and sediment scouring. The Projects will be designed to withstand extreme events including hurricanes and winter storms. Figure 2.2-5 shows the major historic storm tracks in the Offshore Project Area from 1851 to 2019 extracted from HURDAT2 dataset (Landsea and Franklin 2013). The different types of storms presented in Figure 2.2-5 are summarized in Table 2.2-6. The extreme event analysis and the return period of wind, wave, and hydrodynamics that will be generated due to different storms are presented in Appendix II-B2 and are being used in the design of the wind farm to assure withstanding and survival of the Project at the time of extreme conditions.



4/18/2023 | T:\20043_Atlantic Shores Offshore Wind_COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\2.2_Physical Oceanography and Meteorology\MXD\Figure 2.2-5_COP South - Storm Tracks within the Project Area.mxd

Figure 2.2-5
Storm Tracks in the Project Area
Offshore New Jersey

Table 2.2-6 Abbreviations Used in Figure 2.2-5

Abbreviation	Description
DB	Disturbance (of any intensity)
EX	Extratropical cyclone (of any intensity)
HU	Tropical cyclone of hurricane intensity (>64 knots)
LO	A low that is neither a tropical cyclone, a subtropical cyclone, nor an extratropical cyclone (of any intensity)
SD	Subtropical cyclone of subtropical depression intensity (<34 knots)
SS	Subtropical cyclone of subtropical storm intensity (>34 knots)
TD	Tropical cyclone of tropical depression intensity (<34 knots)
TS	Tropical cyclone of tropical storm intensity (34-63 knots)
WV	Tropical Wave (of any intensity)

The onshore substations and/or converter stations and Points of Interconnection (POI) proposed for the Projects are located inland from the ocean and not located in or proximate to any floodplain. The distance from the shore and elevation above sea level (greater than 45 feet [13.7 m]) is expected to be sufficient to shelter this infrastructure from the risk of coastal flooding due to storm surge. Although the landfall sites proposed for the Projects are located in flood zones, as presented in Figure 2.2-6, all cables will be buried to an appropriate design depth to protect them from sediment erosion and to prevent exposure due to flood and severe weather.

The storm wave direction in the Offshore Project Area varies throughout the year. Storm waves typically come from the north throughout the summer, which is the season with the lowest wave record. However, during the winter season, the largest storm waves come from the northeast. Typically, less than 40% of the total recorded waves have heights equal or larger than 4.9 ft (1.5 m), while wave heights equal or greater than 11.8 ft (3.6 m) constitute less than 10% of all waves (see Appendix II-B1). Wave data collected in October 2019 from a buoy deployed at 98.4 ft (30 m) water depth in the area near Delaware Bay southwest of the Atlantic Export Cable Corridor show that the highest significant wave height was approximately 13.8 ft (4.2 m), with a peak period of 15 seconds. Data were also collected in 2019 near the Monmouth Export Cable Corridor by a buoy approximately 12 nm (23 km) offshore of Long Branch, at approximately 43.2 nm (80 km) northeast of the Lease Area. Based on this record, the highest significant wave height was approximately 14.8 ft (4.5 m), with a peak period of 16 seconds in October 2019 (see Appendix II-B1). These values of highest significant wave height are consistent with records from other New Jersey locations (PNNL 2020).

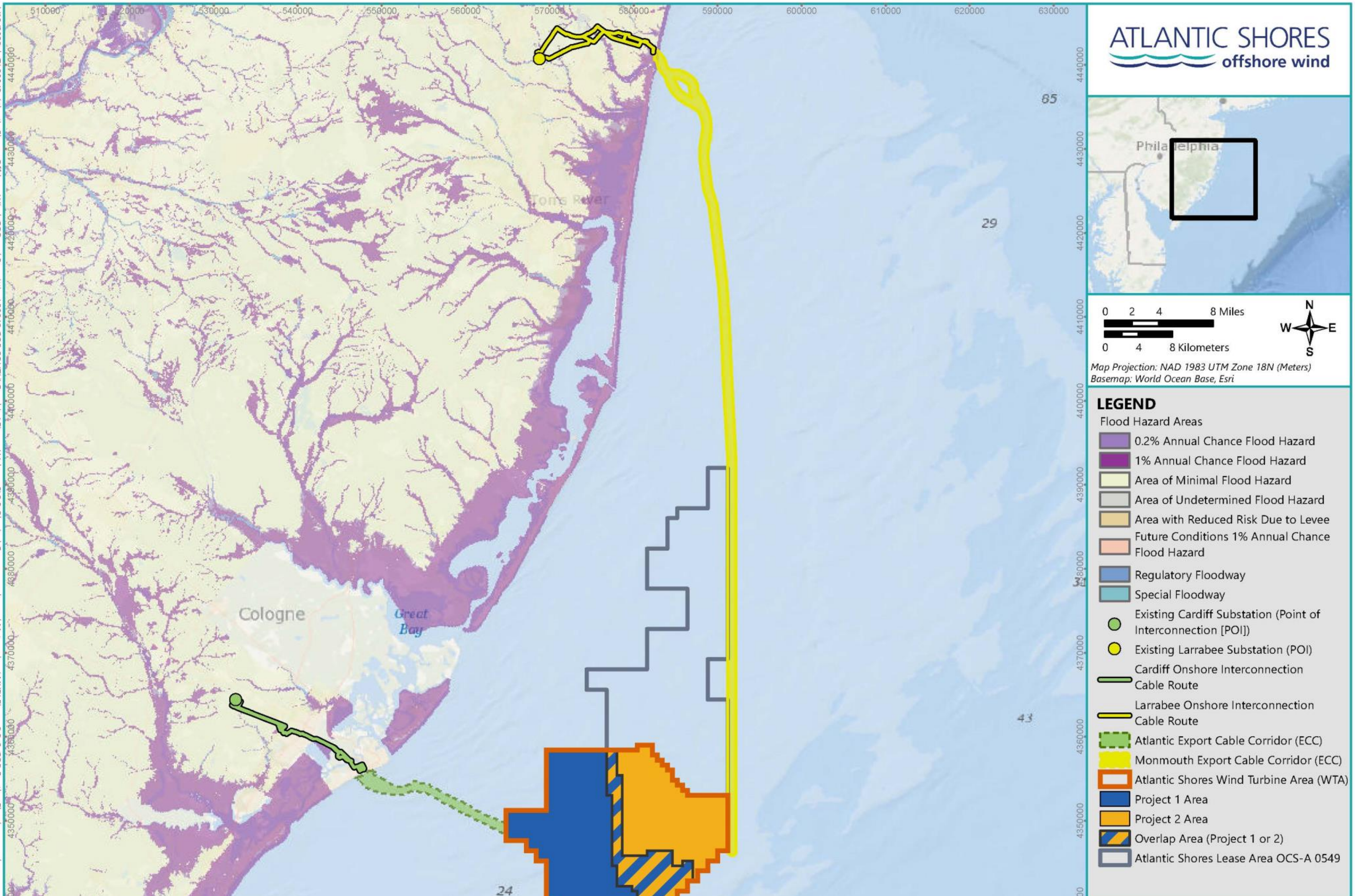


Figure 2.2-6

Flood Map, New Jersey. Modified from National Flood Hazard Layer (NFHL 2020) Offshore New Jersey

Table 2.2-7 provides extreme high-water level (EHWL) and extreme low-water level (ELWL) at offshore location relative to mean sea level (MSL) for different return periods. This dataset is obtained by analyzing all timeseries from the GFEC model (see Appendix II-B2). Based on the analysis, EHWL can be as high as 9.58 ft (2.92 m) AMSL, and ELWL can be as low as 7.94 ft (2.42 m) BMSL for a 1,000-year return period.

Table 2.2-7 Extreme Total Water Levels Relative to MSL from within the WTA

Variable	Unit	Return Period (Years)					
		1	10	50	100	500	1,000
EHWL	ft	2.92	4.95	6.14	6.59	8.46	9.58
	m	0.89	1.51	1.87	2.01	2.58	2.92
ELWL	ft	-2.62	-4.27	-5.38	-5.91	-7.28	-7.94
	m	-0.80	-1.30	-1.64	-1.80	-2.22	-2.42

Table 2.2-8 presents extreme wave heights (in feet relative to MSL) and associated wave periods for different return periods. Based on the analysis, the maximum wave height can reach 56.76 ft (17.3 m) and the peak wave period can be 18.2 seconds for a 1,000-year return period.

Table 2.2-8 Extreme Wave Heights (relative to MSL) and Associated Wave Periods from within the WTA

Variable	Unit	Return Period (Years)					
		1	10	50	100	500	1000
H_S	ft	16.1	23.0	28.2	30.5	37.1	39.7
	m	4.9	7.0	8.6	9.3	11.3	12.1
T_P	seconds	9.9	11.9	13.8	14.8	17.6	18.2
H_{MAX}	ft	30.2	40.7	46.3	48.9	56.4	56.8
	m	9.2	12.4	14.1	14.9	17.2	17.3
$T_{HMAX, LOW}$	seconds	7.9	9.5	11.1	11.8	15.8	16.4
$T_{HMAX, UP}$	seconds	9.5	11.5	13.3	14.2	16.9	17.4
C_{MAX}	ft	21.3	31.8	41.3	46.3	61.7	68.2
	m	6.5	9.7	12.6	14.1	18.8	20.8

Comparison of the storms during the tropical and extra-tropical storm periods suggests wave heights and wind speeds are greater during the tropical storm period.

2.2.1.6 Sea Level Rise

Sea level rise is the most predictable component of climate change, while there are also changes in the patterns of extreme events with potential increase in their frequency and severity. Both sea level rise and storm surge can impact coastal facilities more seriously than those farther offshore.

To find the trend of sea level rise in the area, data collected between 1910 and 2020 from NDBC Buoy No. 8534720 (located in the Atlantic City Steel Pier) shows a linear trend increment of the tide level of 0.16 inches per year (in/year) (4.12 millimeters per year [mm/year]) based on monthly sea level data as presented in Figure 2.2-7. A tidal elevation record obtained from a separate buoy (NDBC Buoy No. 8531680) located in Sandy Hook, New Jersey, shows the exact same sea level rise of 0.16 in/year (4.12 mm/year for the period of 1932–2020) as presented in Figure 2.2-8.

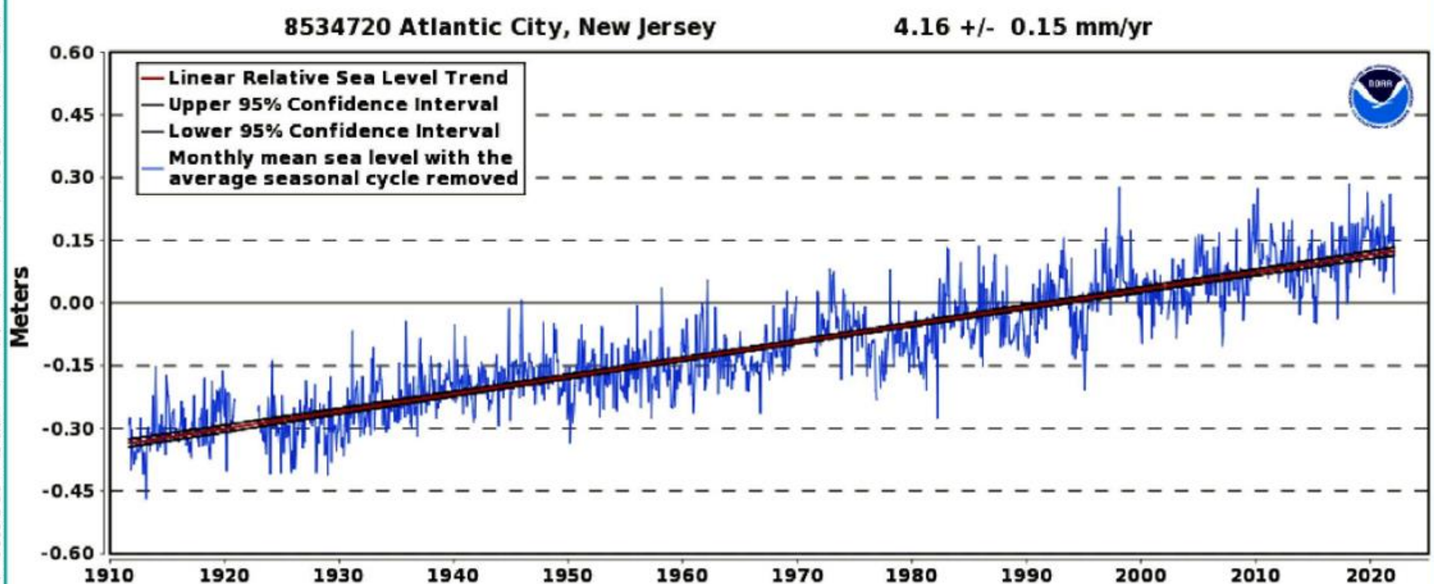
2.2.2 Potential Impacts and Proposed Environmental Protection Measures

The construction, O&M, and decommissioning of the Projects is expected to have potential localized effects on metocean conditions. These conditions may potentially disrupt Project phases, or damage Project components (e.g., foundations, WTGs, export cables, onshore elements) once installed. This section discusses how the Projects may be affected by the metocean conditions in the Offshore Project Area as well as how metocean conditions may be influenced by the presence of Project facilities.

2.2.2.1 Effects of Metocean Conditions on Project Facilities and Activities

As discussed in Sections 4.3 and 4.4 of Volume I, the WTGs and offshore substations (OSSs) will be designed according to site-specific conditions, including winter storms, hurricanes, and tropical storms, based on industry standards such as American Clean Power Association, International Electrotechnical Commission, American Petroleum Institute, and International Organization for Standardization standards.

Atlantic Shores will also design the Projects construction schedules to take into consideration both extreme weather and environmental conditions. In addition to the meteorological (met) tower, up to four temporary metocean buoys may be installed and kept in place during construction to monitor weather and sea state conditions to ensure safe working conditions for all personnel. During O&M, safe weather limits will be established for all installation and maintenance activities, including shutdown during extreme weather.

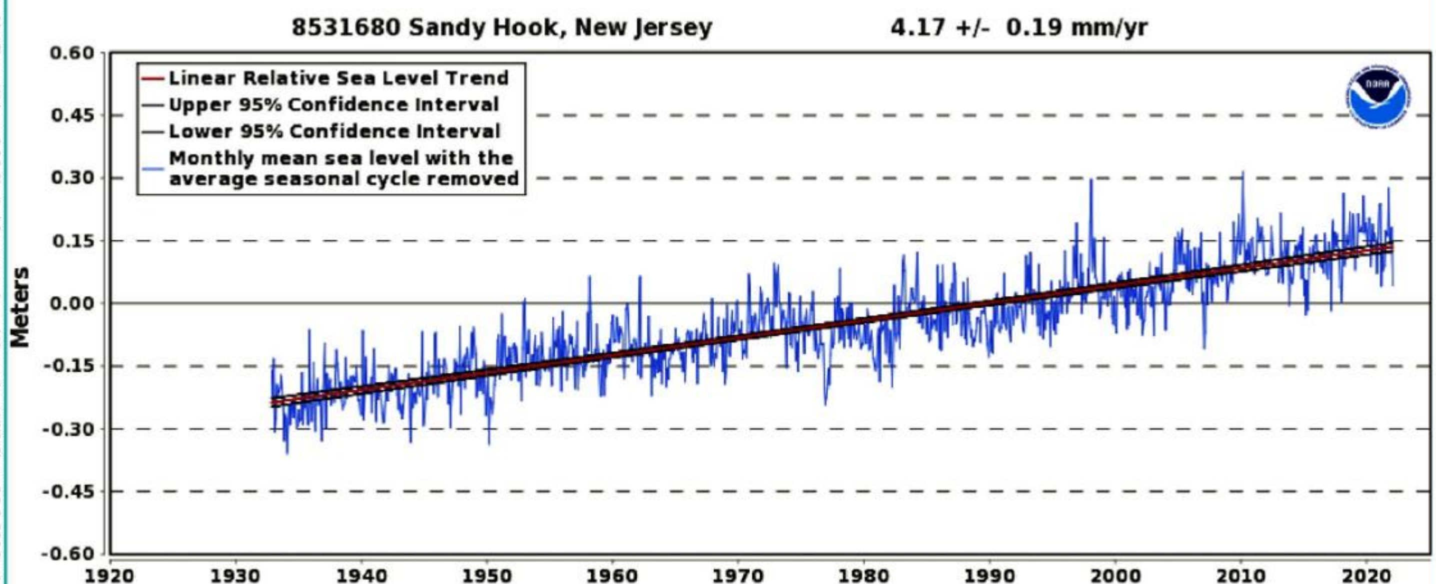


ATLANTIC SHORES offshore wind

Figure 2.2-7

Sea Level Rise Trend for 1910-2020, Atlantic City, New Jersey

Data Source: RPS Benthic Assessment Report (2020) (Appendix II-G2)



8/12/2022 | T:\2043 Atlantic Shores Offshore Wind_COP and Permitting\2043 COP SOUTH\Graphics\Figures\Volume 2\2.2_Physical Oceanography and Meteorology\MXD\Figure 2.2-8_COP South_Sea Level Rise Trend for 1932-2020 Sandy Hook NJ.mxd

ATLANTIC SHORES offshore wind

Figure 2.2-8

Sea Level Rise Trend for 1932-2020, Sandy Hook, New Jersey

Data Source: RPS Benthic Assessment Report (2020) (Appendix II-G2)

Hurricanes, strong storms, and associated waves and currents, tides, and tidal currents have the potential to cause seabed impacts through movements of sediments. This can expose buried cables and scour the sea floor around WTG, OSS, and met tower foundations. Inter-array, inter-link, and export cables will be buried to a target burial depth of 5 to 6.6 ft (1.5 to 2 m), which will help reduce these effects. The selection of equipment best suited for installation is an iterative process that involves reviewing seabed conditions, cable properties, laying and burying combinations, burial tool systems, and anticipated performance. Cable protection (e.g., rock placement, concrete mattresses, rock bags, or grout-filled bags) may be necessary if sufficient burial depth cannot be achieved (e.g., due to sediment properties or a cable joint). Cable protection may also be required to support the crossing of existing marine infrastructure such as submarine cables or pipelines (see Section 4.5.8 of Volume I). While Atlantic Shores will work to minimize the amount of cable protection required, based on sediment conditions in the Offshore Project Area, it is conservatively assumed that up to 10% of the export cables, inter-array cables, and inter-link cables may require cable protection. A cable burial risk assessment is underway that will support the design and selection of embedment techniques (to be submitted with the FDR/FIR). In addition, as discussed in Section 5.4 of Volume I, post-event inspections will be conducted after a storm during which measured environmental conditions exceed specified conditions (e.g., a hurricane or significant storm event) to assess the potential effects on Project components.

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

From the Monmouth and Atlantic Landfall sites, onshore interconnection cables will travel underground primarily along existing roadways, or utility ROWs, and/or along bike paths to proposed onshore substations. From the proposed onshore substations, the onshore interconnection cables will continue underground to the proposed POIs for interconnection to the electrical grid. HDD at the landfall sites will help ensure sufficient burial of the cables along the beachfront which is subject to erosion and coastal flooding. Also, cables will be buried underground and encased in a concrete duct bank to protect these components from the effects of storm surge and coastal flooding. Aboveground facilities (i.e., onshore substations and POIs) are outside of Federal Emergency Management Agency-designated flood zones.

2.2.2.2 Impact-Producing Factors on Metocean Conditions

The presence of Project structures in the ocean could result in localized changes to current and associated mixing of the water column near towers, foundations, and/or scour protection. However, the potential effect of offshore wind structures on oceanographic processes is highly dependent on the specifics of the wind farm and the underlying atmospheric and oceanographic conditions.

Monitoring the physical dynamics in the Mid-Atlantic Bight and Cold Pool are important to understanding how placement of wind turbines may affect ocean mixing. Modeling studies, considering varying sizes of wind projects and technology, have indicated that wind turbines may cause atmospheric disturbances to near-surface winds that influence ocean mixing (Afsharian and Taylor, 2019). The extent of changes to ocean mixing at local and regional, or mesoscale, scales is not well known and can vary widely in magnitude as local mixing depends on atmospheric forcing, daily heating and cooling, wind, changes in temperature and humidity associated with mesoscale weather, and other processes (Paskyabi et al. 2015). Measuring and predicting any possible effects to ocean mixing is highly dependent on the characteristics of the wind project (e.g., spacing between turbines, size of turbines), and the local and regional atmospheric and oceanographic conditions (Moum and Smyth 2019).

Drawing early conclusions from European or modeling studies have inherent differences, as the Mid-Atlantic Bight has weaker tidal currents and more intense stratification than the North Sea and is different from other western boundary currents or mesoscale circulation features in European waters. It has been suggested that slower ocean velocities in the southern Mid-Atlantic Bight would result in significantly less mixing than has been found in Europe (Carpenter et al. 2016), and that European studies are more representative of Mid-Atlantic Bight conditions during weaker stratification. It is considered unlikely that artificial structure-induced mixing could overcome the natural intense summer stratification sufficiently to influence the Cold Pool and cause broader ocean mixing (Miles et al. 2020). However, considering the seasonal, annual, and longer scale changes in the Cold Pool and Mid-Atlantic Bight, Atlantic Shores supports contributing to regional collaborative science to study and monitor the Cold Pool and is working with Rutgers University to provide information on the oceanographic conditions in the Offshore Project Area that are being used to monitor the region and its features.

2.2.3 Summary of Proposed Environmental Protection Measures

Atlantic Shores has already taken steps and has made commitments to avoid, mitigate, and monitor the effects on the Projects and metocean conditions through deployment of their offshore metocean buoy. Additional avoidance and mitigation measures will be evaluated further as the Project progresses through development and as site-specific metocean data becomes available.

The following is a summary of environmental protection measures proposed to minimize effects to the Projects and to metocean conditions:

- Offshore data collection is being conducted using metocean buoys and shared with the public. The data is available at https://ioos.noaa.gov/regions/maracoos and/or on Atlantic Shores' website https://www.atlanticshoreswind.com/mariners/.

- The Projects have been designed to consider site-specific metocean conditions.

- The WTG technology and construction schedules take into consideration both extreme weather and environmental conditions.

- Safe weather limits for all installation and maintenance activities, including shut down during extreme weather will be established.
- Inter-array, inter-link, and export cables will be buried to a target depth of 5 to 6.6 ft (1.5 to 2 m) which will help reduce exposure and/or scour.
- HDD will be employed at the landfall sites to ensure sufficient burial of the cables along the beachfront which is subject to erosion and coastal flooding.
- Buried onshore cables will be encased in a concrete duct bank which protects them from the effects of storm surge and coastal flooding.
- Onshore interconnection cables will be installed underground primarily along existing roadways, or utility ROWs, and/or along bike paths.

3.0 PHYSICAL RESOURCES

This section provides a detailed description of the physical resources including air quality and water quality within the Project Area.

3.1 Air Quality

This section describes air quality in the affected environment, associated impact producing factors (IPF), and measures to avoid, minimize, or mitigate potential effects from regulated sources during construction, operations and maintenance (O&M), and decommissioning. This section also describes the benefits from avoided air pollutant emissions associated with the Project.

Atlantic Shores recognizes the importance of air quality from a local, regional, and global perspective. Air quality protection is important because air quality affects human health, the health of ecosystems, and climate change, directly and indirectly.

Unlike traditional fossil-fuel based energy generation, the Projects' wind turbine generators (WTGs) will not generate any air pollutant emissions. Instead, the electricity generated by the WTGs has the potential to significantly reduce emissions from the regional electric power grid over the life of the Projects by displacing electricity generated from pollution-emitting fossil fuel-fired power plants that otherwise would be required to serve the projected increase in electric demand within regional electric markets. Atlantic Shores estimates that power generated by the Projects can reduce greenhouse gas (GHG) emissions, reported as carbon dioxide equivalents (CO_2e), by approximately 2,625 tons per year (tpy) for every megawatt generated. For Project 1, which has a nameplate capacity of 1,510 megawatts (MW), the reduction in GHG emissions regionally is estimated to be approximately 3.9 million tons (CO_2e) annually, which is the equivalent of removing about 777,000 cars from the road. A reasonable minimum size for Project 2 (960 MW) would reduce GHG by an estimated additional 2.5 million tons of CO_2e annually, which is the equivalent of removing an additional 500,000 cars from the road. Additional details are provided in Section 3.1.2.5.

While the WTGs will not generate air emissions, air emissions will occur in connection with Project construction, O&M, and decommissioning activities. Air emissions from these Project activities are directly associated with internal combustion engines generating power for vessels, vehicles, and tools needed to support the various phases of the Projects. These emitting activities in the Offshore Project Areas will be subject to air quality requirements under 40 CFR Part 55 and implementing New Jersey Department of Environmental Protection (NJDEP) regulations. Within the Onshore Project Area individual onshore stationary emissions sources are subject to relevant New Jersey air permitting jurisdiction, and stationary and mobile air emission sources throughout the Project areas are subject to relevant U.S. Environmental Protection Agency (EPA) jurisdiction.

3.1.1 Affected Environment

The affected environment is the airshed in the broader geographic area that may be affected by Project-related air emissions. For the purposes of the assessment of air emissions from the Projects, the Atlantic Shores Project Region is the airshed within 25 nautical miles (nm) (46.3 kilometers [km]) of the centroid of the Wind Turbine Area, and the airshed within 15.5 miles (mi) (25 km) from the Atlantic/Monmouth Export Cable Corridors (ECCs), the Onshore Project Area, and ports where Project-related activities could occur (see Figure 3.1-1). The Project Region encompasses the area subject to Outer Continental Shelf (OCS) air permitting (see Section 3.1.1.4) and provides a reasonable buffer for assessing effects from emissions of primary criteria and hazardous air pollutants (HAPs)[6].

The description of the affected environment includes descriptions of criteria air pollutants, HAPs, and GHGs. It also includes a description of the regulatory requirements in place to protect the affected environment.

---

6 The impact of air emissions on secondary pollutant formation (including the formation of ground-level ozone and fine particulate) is regional, and the impact of GHG emissions on climate is global.

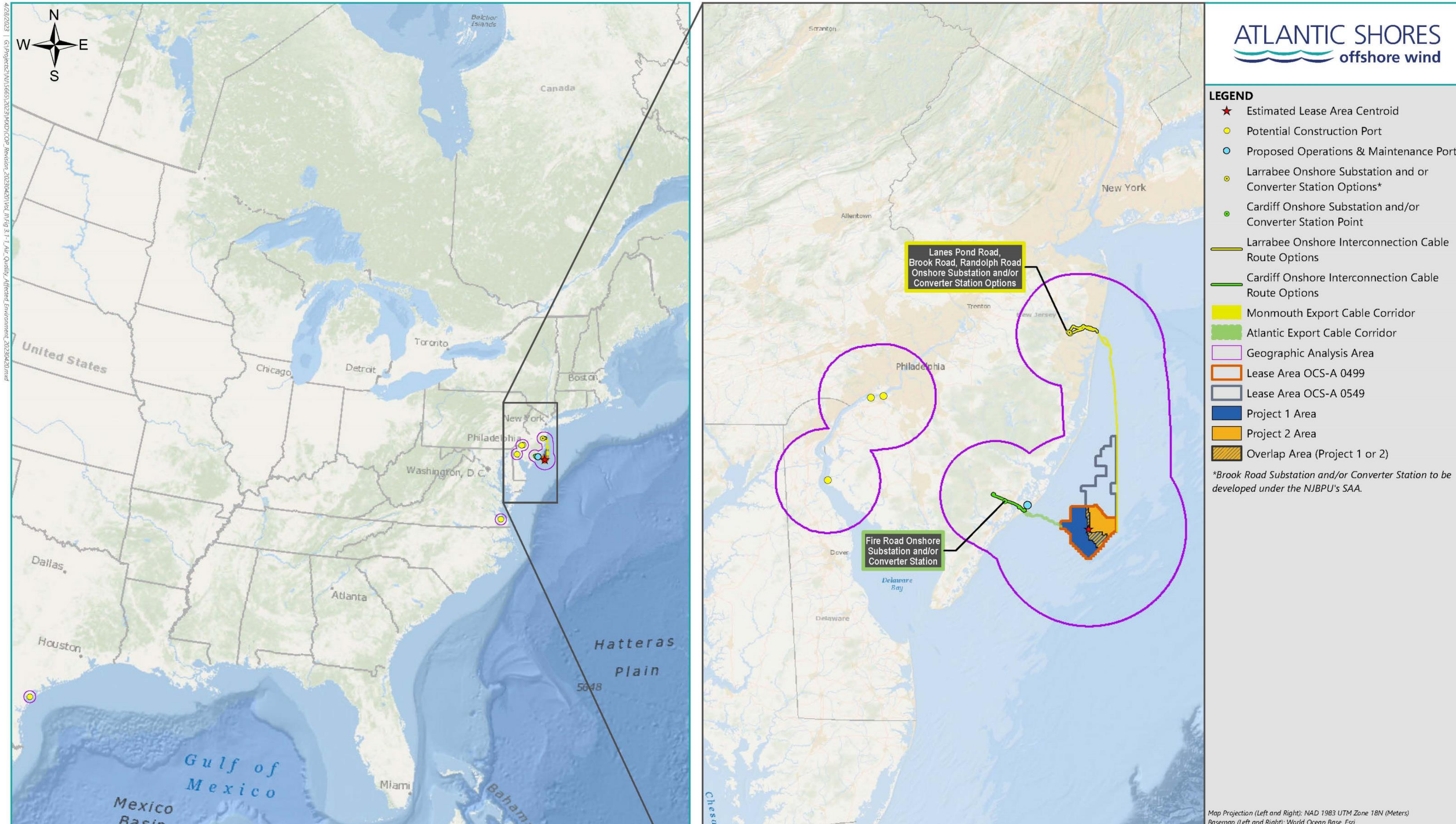


Figure 3.1-1

Air Quality Affected Environment

3.1.1.1 Criteria Air Pollutants

The Clean Air Act (CAA) (42 U.S.C. §§ 7401 et seq., amended 1990) and implementing Federal and State regulations, requires the EPA to established National Ambient Air Quality Standards (NAAQS) for pollutants that are considered harmful to public health and welfare and the environment. These pollutants come from a diverse set of sources, including cars and trucks, electric power plants, factories, office buildings, and homes. EPA has established NAAQS for six air contaminants, known as criteria pollutants. These criteria pollutants are sulfur dioxide (SO_2), particulate matter (with a diameter smaller than 10 microns as PM_{10} and a diameter smaller than 2.5 microns as ($PM_{2.5}$), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), and lead (Pb). For these pollutants, two types of NAAQs (40 CFR Part 50) may be established: primary standards that are adopted to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly, and secondary standards that set limits to protect public welfare, including protection against visibility impairment, damage to animals, crops, vegetation, and buildings.

The EPA has classified all areas of the country as being in attainment, nonattainment, or unclassified with respect to the NAAQS for each of the criteria pollutants. An area that complies with the NAAQS for all the criteria pollutants is classified as an attainment area. An area that is out of compliance with the NAAQS for one or more criteria pollutants is classified as a nonattainment area. An area that cannot be classified as meeting or not meeting the NAAQS based on available information is an unclassified area. Areas that were in nonattainment of a NAAQS standard within the previous 20 years but are currently unclassified or in attainment with the standards, are referred to as maintenance areas. Emissions standards, permitting requirements and other air quality protection provisions may vary depending upon whether the air quality effects associated with a proposed emissions source occur within or may affect a nonattainment, attainment, unclassified or maintenance area.

When the EPA designates a new NAAQS, older standards are not automatically revoked. Because of this, there are two different 8-hour ozone standards (designated as the 2008 and 2015 8-hour ozone standards), and the attainment classifications are different for the different standards. Also, the CAA required the EPA to classify areas that are designated as nonattainment for ozone standards by the severity of their pollution. These classifications, in order of severity, are marginal, moderate, serious, severe, and extreme.

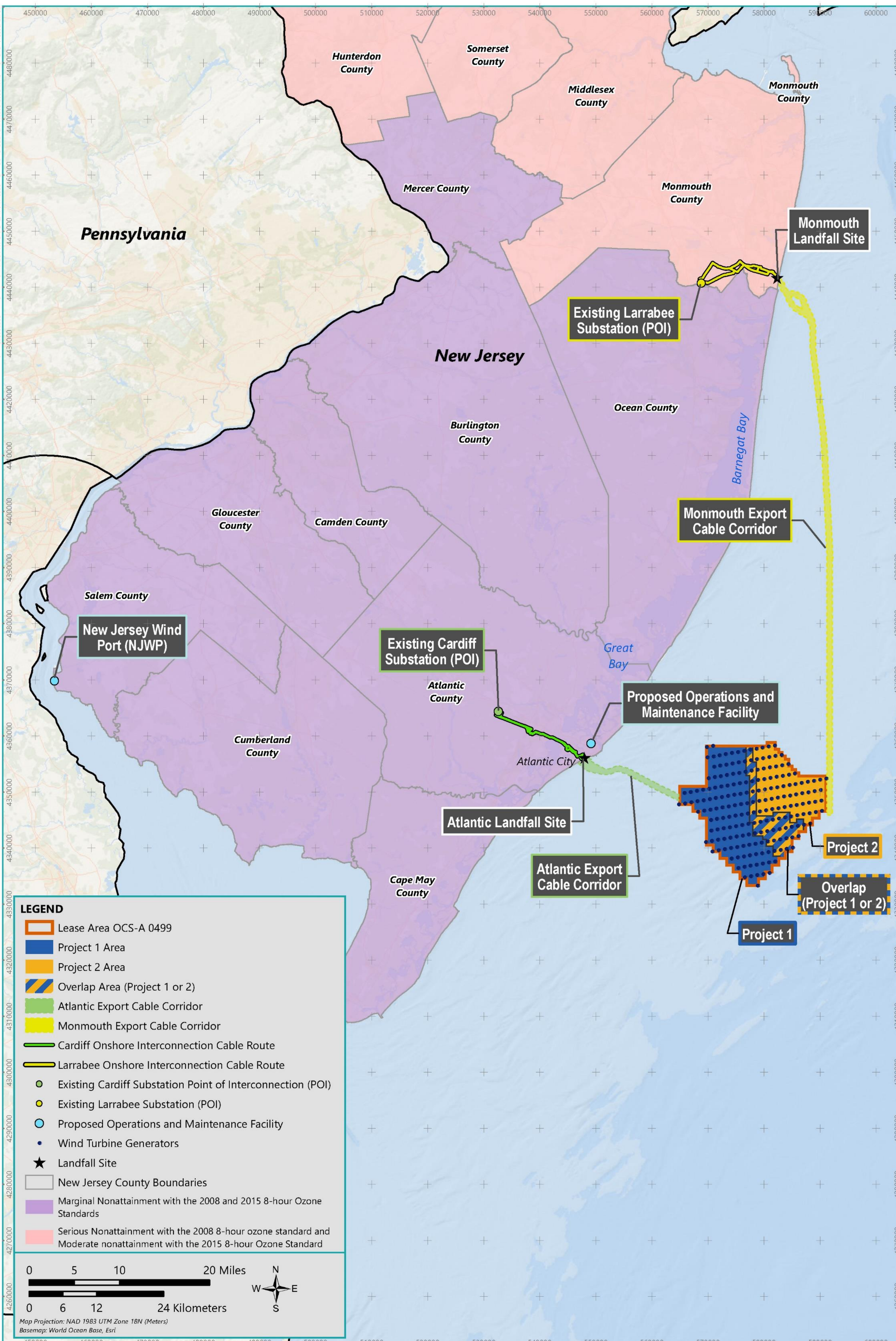
The EPA does not designate the attainment status of offshore areas. Offshore areas within 25 mi (40.2 km) of shore are subject to the regulations of the corresponding onshore area, including NAAQS-related regulations. Therefore, offshore areas are treated as having the same attainment status as the corresponding onshore areas. As shown in Figure 3.1-2, the WTA and the Atlantic ECC are closest to Atlantic County, New Jersey, which is designated as being in marginal nonattainment with the 2008 and 2015 8-hour ozone standards. The Monmouth ECC is closest to Monmouth County, New Jersey, which is designated as a serious nonattainment area for the 2008 8-hour ozone standard and moderate nonattainment with the 2015 8-hour ozone standard. Atlantic County and Monmouth County are in attainment (or unclassified) for other standards.

Appendix II-C includes a table listing the nonattainment and maintenance status for each county where Project activities could occur.

Figure 3.1-3 shows measured ambient concentrations of key criteria pollutants in and near the Project Region, over the last 10 years. The CAA gives special air quality and visibility protection to national parks larger than 6,000 acres (24.3 square kilometers [km^2]) and national wilderness areas larger than 5,000 acres (20.2 km^2) that were in existence as of the 1977 CAA amendments (NPS 2020). These areas are referred to as “Class I” areas. One Class I area, the Brigantine Wilderness Area, is part of the Edwin B. Forsythe National Wildlife Refuge located approximately 9 mi (14.5 km) northwest of the WTA. Figure 3.1-3 shows the WTA in relation to the Brigantine Wilderness Area.

Despite the current NAAQS attainment status for the Project Region, overall air quality in the northeastern United States has been improving over the last 10 years. Examples of this overall improvement are shown in Figure 3.1-4. The figure shows ambient air concentration trends as measured at the continuously operated monitoring stations that are nearest to the WTA, the ECCs, and the onshore transmission routes and substations and/or converter stations. Over the last 10 years both short- and long-term average concentrations of these criteria pollutants have decreased or remained constant.

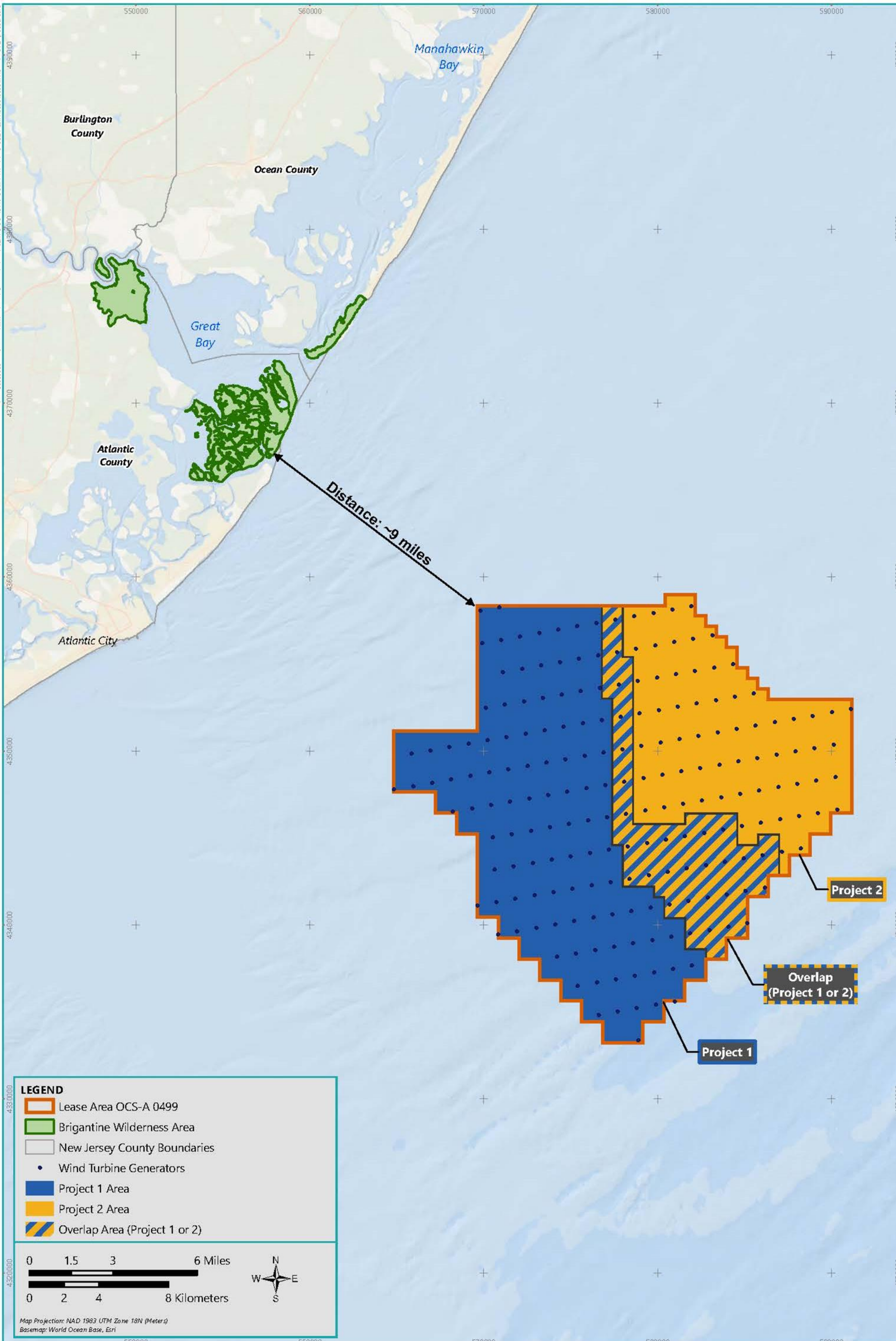
Air pollutant emissions derive from both naturally occurring (biogenic) and human-made (anthropogenic) sources. The NJDEP Bureau of Evaluation and Planning tracks state-wide anthropogenic emissions for the following source categories: point sources (large stationary sources such as coal- or natural gas-fired power plants), area sources (small stationary sources such as home furnaces and fireplaces), on road mobile sources (automobiles), and nonroad mobile sources (equipment engines). As shown in Figure 3.1-5, onshore anthropogenic air emissions have decreased for key criteria pollutants in New Jersey over the last 10 years.



ATLANTIC SHORES offshore wind

Figure 3.1-2

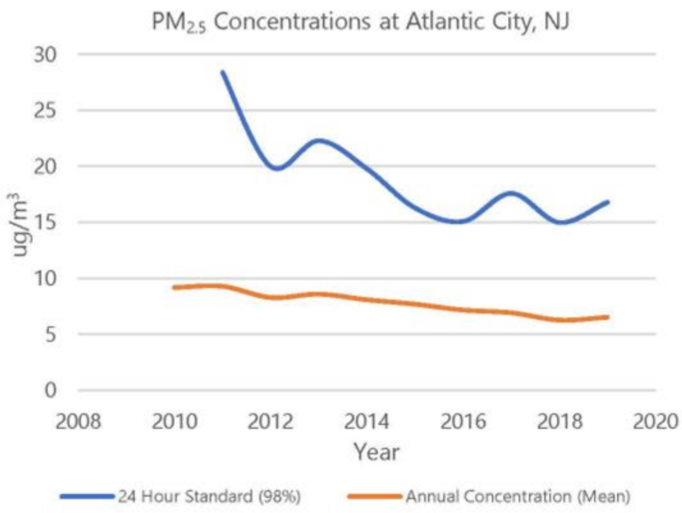
NAAQS Attainment Status



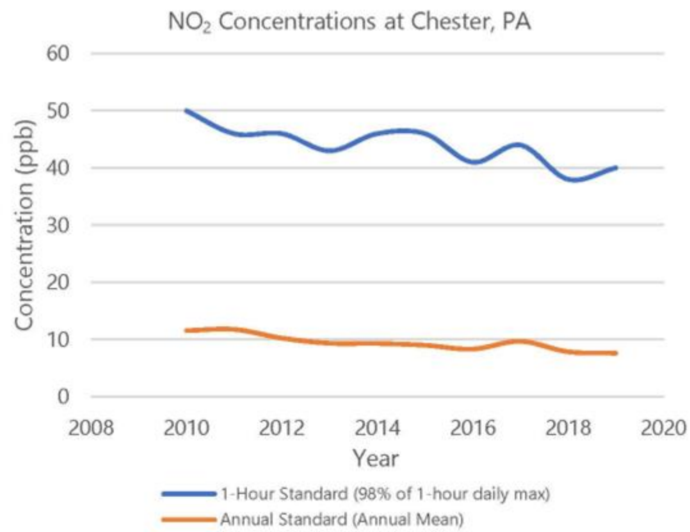
ATLANTIC SHORES offshore wind

Figure 3.1-3

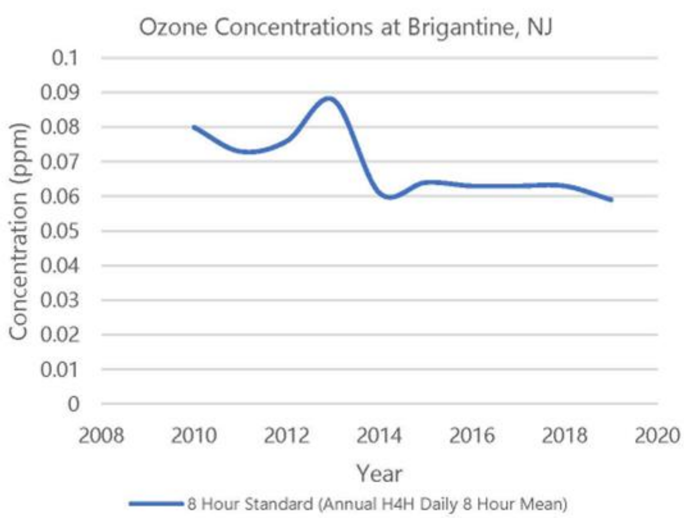
WTA in relation to Brigantine Wilderness Area



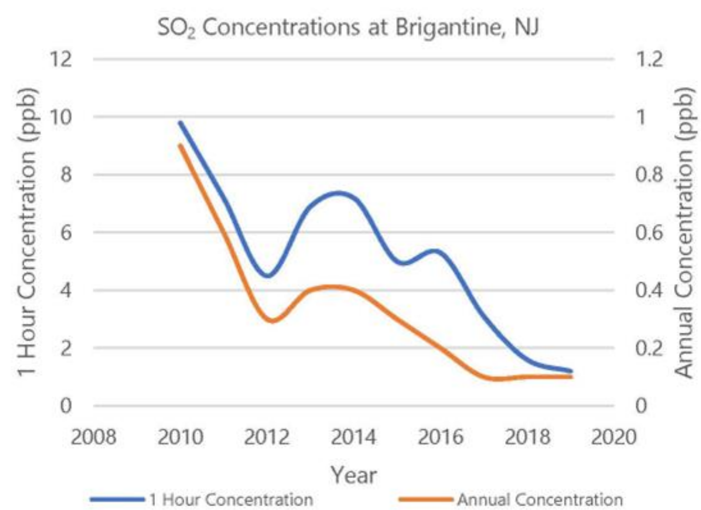
$PM_{2.5}$ NAAQS: 35 ug/m^3 (24 hour, 98th percentile averaged over 3 years) and 12 ug/m^3 Annual, not to be exceeded



NO_2 NAAQS: 100 ppb (1-hour, 98th percentile of 1 hour daily maximum concentrations averaged over 3 years) and 53 ppb (Annual, not to be exceeded)



Ozone NAAQS: 0.07 ppm (2008 EPA Ozone Standard) (8-hour , Annual fourth-highest daily maximum 8-hour concentration, averaged over three years)



SO_2 NAAQS: 196 ug/m^3 (1 hour, 99th percentile of one hour daily maximums averaged over 3 years) and 12 ug/m^3 Annual, not to be exceeded

Figure 3.1-4
Regional Ambient Air Concentrations

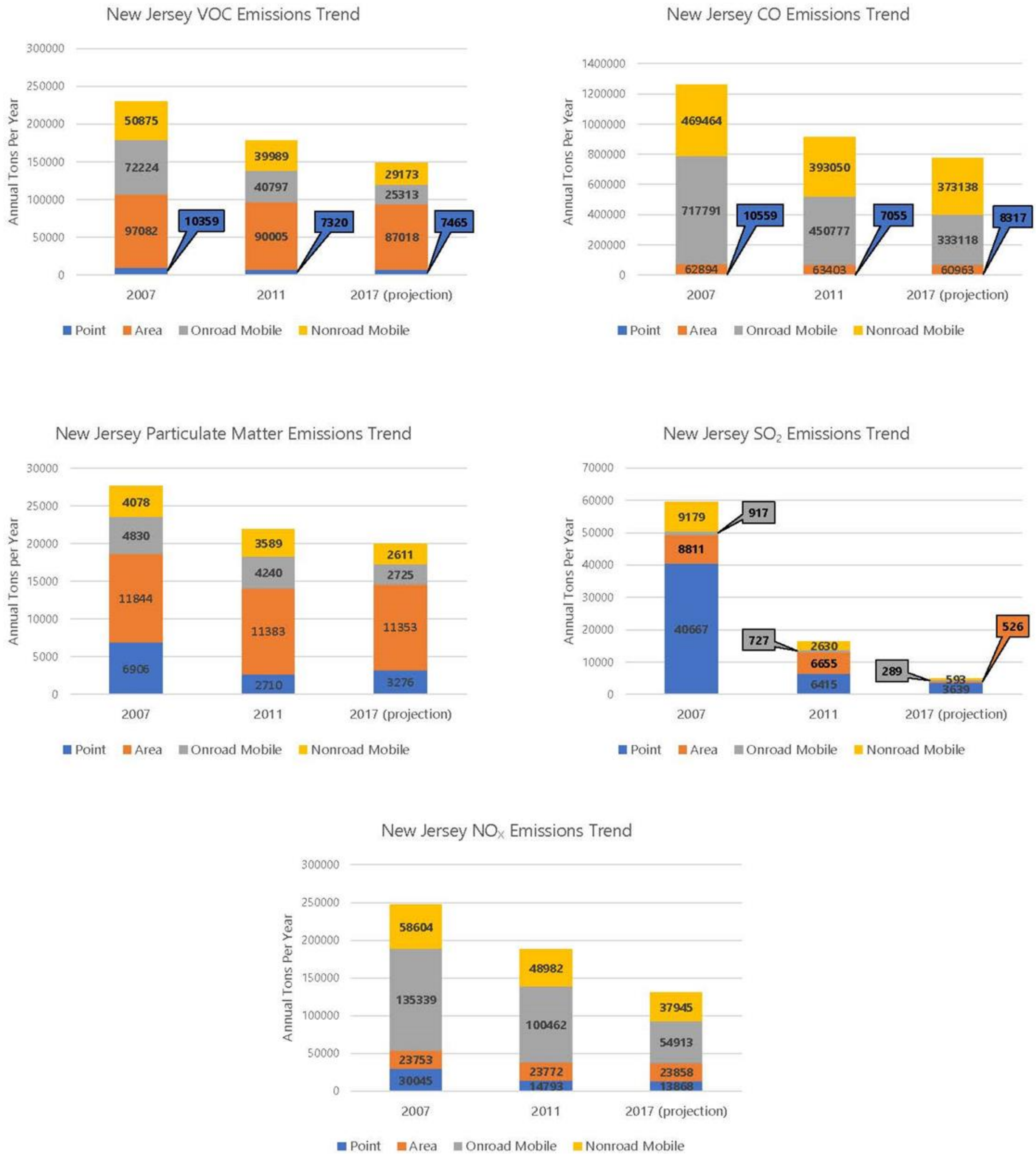


Figure 3.1-5
Anthropogenic Air Emissions in New Jersey

Marine vessels are the largest source of anthropogenic air pollutant emissions in the marine environment. For example, waterborne commerce generated 48,322 vessel trips to ports along the Delaware River in 2016 (over 24,000 roundtrips) (USACE 2017). Several of the ports under consideration for Project construction and O&M activities are in developed metropolitan and industrial areas with significant rail, road, vessel, and air traffic that generate associated air emissions.

3.1.1.2 Hazardous Air Pollutants

In addition to criteria pollutants, air pollutants may be classified as HAPs. HAPs are compounds that at varying exposure levels are known or suspected to cause serious health effects (e.g., certain forms of cancer or birth defects) or can result in serious adverse environmental effects. Some examples of HAPs are acrolein, formaldehyde, and cadmium.

HAPs may be emitted from fossil fuel combustion (due to the presence of impurities or products of incomplete combustion) and from industrial processes that involve the use of toxic chemicals. A portion of total PM and total volatile organic compound (VOC) emissions consists of HAPs, and air emission trends will generally follow the particulate matter and VOC trends described in Section 3.1.1.1.

3.1.1.3 Greenhouse Gases

A GHG is an atmospheric gas that slows the rate at which heat radiates from earth into space, thus having a warming effect on the atmosphere. Carbon dioxide (CO_2) is the most common GHG. Because CO_2 is relatively stable and uniformly mixed in the atmosphere, the effect of GHG emissions generally does not depend upon where within the earth's atmosphere the GHG emissions occur. Anthropogenic GHG emissions make the earth warmer than it would be due to naturally occurring air emissions and other effects alone, and global warming causes several other climate changes, including increases in the frequency and intensity of storms and other severe weather events, and sea-level rise. Based on National Oceanic and Atmospheric Administration (NOAA) data and analysis (NOAA 2020), CO_2 ambient air concentrations have an increasing trend, with the global monthly mean CO_2 concentration increasing from 340 parts per million (ppm) in 1980 to 413 ppm as of November 2020.

In addition to CO_2, GHGs include methane, nitrous oxide, and sulfur hexafluoride. Each of these compounds has an associated Global Warming Potential (GWP) that correlates the global warming effects of the compound to that of CO_2, which has a base value of one (for example, methane has a GWP of 25, which means each ton of methane has the equivalent greenhouse effect of 25 tons of CO_2). GHGs are typically multiplied by their GWP values to express the total as CO_2e.

Per the International Energy Agency (IEA 2020), global energy-related CO_2 emissions increased by 62% from 1990 to 2018. Over the same period, New Jersey's estimated GHG emissions for major sector activities[7] decreased by 20% (NJDEP 2020a).

3.1.1.4 Regulatory Requirements

As a result of the air quality and emissions standards set by the EPA and State of New Jersey, the Project activities which generate emissions will be subject to various Federal and State regulation. These regulations provide the basis for how Atlantic Shores has assessed and will manage emissions sources.

OCS Air Permitting

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

Authority to issue the OCS air permit currently lies with EPA Region 2, but the State of New Jersey is in the process of obtaining delegated authority to issue and enforce OCS air permits. Per 40 CFR Part 52.11(b), that delegation can occur when New Jersey has demonstrated that the State has adopted the appropriate portions of the regulation into State law, and has adequate authority, resources, and administrative procedures to implement the regulation. New Jersey incorporated 40 CFR Part 55 into the NJDEP regulations (at NJAC 7:27-30) effective May 4, 2020. There are two other key differences in air permitting requirements for operations in the OCS versus onshore operations:

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

- A facility's Potential to Emit (PTE) is used in onshore and offshore permitting to determine whether certain major source permitting requirements are triggered. For onshore air permits, the PTE is calculated based on the emissions from stationary sources at the facility, and generally exclude temporary sources associated with construction. For OCS facilities, 40 CFR Part 55 mandates that emissions from vessels that are servicing or associated with

[7] New Jersey reported categories are: Transportation; Electricity Generation; Residential; Highly Warming Gases; Commercial; Industrial; Waste Management; and Land Use & Sequestration.

the operation of OCS sources must be counted as direct emissions from the OCS source, while those vessels are at the source or transiting within 25 mi (40 km) of the source. EPA has previously determined for offshore wind projects that the PTE includes temporary operations associated with construction. Under this definition of PTE, the construction and operation of OCS sources in the WTA will trigger major source permitting requirements under the Prevention of Significant Deterioration (PSD) rules at 40 CFR Part 52.21, and the nonattainment New Source Review (NSR) rules at N.J.A.C. 7:27-18.

Through the OCS air permitting process, Atlantic Shores will document compliance with all applicable Federal and New Jersey air quality requirements. As described in Section 3.1.2.6, this will include documentation of compliance with ambient air standards, documentation of State of the Art (SOTA) emission controls and obtaining emissions offsets.

Other Regulatory Requirements

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

- Federal New Source Performance Standards (NSPS): Per Section 111 of the CAA, the EPA has developed technology-based standards which apply to specific categories of stationary sources. Potentially applicable NSPS include standards for Stationary Compression Ignition Internal Combustion Engines (40 CFR Part 60, Subpart IIII).

- Federal National Emissions Standards for Hazardous Air Pollutants (NESHAPs): EPA has developed NESHAPs for stationary sources of HAPs. Potentially applicable NESHAPs include standards for Stationary Reciprocating Internal Combustion Engines (40 CFR Part 63, Subpart ZZZZ).

- Federal standards for nonroad and marine diesel engines: Nonroad diesel engines and marine diesel engines installed on U.S. vessels are subject to regulations at 40 CFR Part 89, 40 CFR Part 94, and 40 CFR Part 1042.

- New Jersey stationary source preconstruction permit requirements: Individual stationary sources onshore could be subject to preconstruction permit requirements. This could include the requirement to obtain a general permit for emergency generators firing distillate fuels (GP-005A).

- General Federal Conformity Determination: The General Federal Conformity Rule (40 CFR Part 93, Subpart B and 40 CFR Part 51, Subpart W) ensures that Federal actions do not interfere with State plans to attain and maintain the NAAQS in areas that are or have been classified as nonattainment for those standards. Bureau of Ocean Energy Management (BOEM) is responsible for determining whether review under the General Conformity Rule is applicable to the Project. If applicable, the analysis would address direct and indirect air emissions from the Project that are not otherwise addressed by the OCS air permit and are within a maintenance or nonattainment area. If emissions are below certain *de minimis* thresholds, a General Federal Conformity determination is not required.

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

3.1.2 Potential Impacts and Proposed Environmental Protection Measures

While the WTGs will not generate air emissions, air emissions will result from Project-related activities. The potential IPFs which may affect air quality during construction, O&M, or decommissioning of the Projects are presented in Table 3.1-1.

Table 3.1-1 Impact Producing Factors for Air Quality

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Vessel Air Emissions	●	●	●
Onshore Air Emissions	●	●	●
Structures and Generators Air Emissions	●	●	●
Aircraft Air Emissions	●	●	●
Avoided Air Emissions		●	

Each IPF section addresses the potential effect of air emissions on air quality because contaminants in the airshed can affect human health, visibility, and soils and vegetation, and because on a global scale GHGs can affect climate.

Almost all the Projects' air emissions will be from internal combustion; that is, the use of fuel for vehicle/vessel propulsion, for mechanical work, or for generating electricity (e.g., when shore power is not available or practical).

The maximum Project Design Envelope (PDE) analyzed to assess potential affects to air quality is the maximum offshore and onshore build-out of the Project. Section 4.11 of Volume I describes the PDE, which includes several options for construction and O&M. Air emissions calculations use an amalgam of the different options identified for each step of the construction process, and the different options for O&M. The calculations use layers of conservatism in estimating the intensity and duration of each activity, and in calculating air emissions. While emissions from individual activities could be lower or higher than calculated, the totals are conservatively high estimates of overall Project air emissions. Additional details regarding the analysis and calculation methodology are provided in Appendix II-C.

As described in Section 1.1 of Volume 1, the Projects will include a combined maximum of up to 200 WTGs, inclusive of the Overlap Area. For the purposes of this affects assessment, calculated air emissions are presented separately for each Project at its maximum size (i.e., assuming each Project utilizes the entire Overlap Area) as well as the combined maximum for WTA of 200 total WTGs.

The Projects will be subject to air permit requirements for activities in the OCS, and stationary and mobile source emissions will be subject to regulation (see Section 3.1.1.4). This section first describes the IPFs, then describes regulatory compliance and proposed environmental protection measures. Each Project itself is an environmental protection measure because the electricity generated by the WTGs displaces electricity generated by pollution generating fossil fuel-fired power plants. The benefits associated with this emissions reduction profile are documented in Section 3.1.2.5.

3.1.2.1 Vessel Air Emissions

Table 3.1-2 summarizes the maximum calculated air emissions associated with PDE from both engine emissions and associated vessel activities during construction. As described in Table 4.1-1 of Volume I, offshore construction emissions will take place in stages over a 2- to 3-year period.

Table 3.1-2 Construction Vessel Air Emissions

Activity Group	NOX, Tons	VOC, Tons	CO, Tons	PM2.5, Tons	SO2, Tons	CO2E, Tons
Project 1 with Overlap Area						
Foundation Installation	398.7	6.4	93.4	12.5	0.9	26,382.8
Offshore Substation Installation	38.7	0.6	9.1	1.2	0.1	2,573.3
Scour Protection	113.6	2.6	27.0	3.8	0.7	7,664.0
Inter-Array Cable Installation	130.7	3.0	30.9	4.4	0.9	8,843.0

Table 3.1-2 Construction Vessel Air Emissions (Continued)

Activity Group	NOX, Tons	VOC, Tons	CO, Tons	PM2.5, Tons	SO2, Tons	CO2E, Tons
Project 1 with Overlap Area						
WTG Installation	972.4	13.7	220.3	28.6	1.4	61,743.3
Export Cable Installation	396.4	8.1	95.4	13.1	1.9	26,664.0
Fuel Bunkering	47.0	0.9	11.3	1.6	0.2	3,196.5
PROJECT 1 TOTAL	**2,097.5**	**35.3**	**487.2**	**65.3**	**6.0**	**137,067.0**
Project 2 with Overlap Area						
Foundation Installation	283.7	4.6	66.4	8.9	0.6	18,768.9
Offshore Substation Installation	38.7	0.6	9.1	1.2	0.1	2,573.3
Scour Protection	82.5	1.9	19.6	2.8	0.5	5,568.1
Inter-Array Cable Installation	98.4	2.3	23.2	3.3	0.7	6,657.1
WTG Installation	681.9	9.6	154.5	20.1	1.0	43,302.8
Export Cable Installation	396.4	8.1	95.4	13.1	1.9	26,664.0
Fuel Bunkering	33.0	0.6	7.9	1.1	0.1	2,247.1
PROJECT 2 TOTAL	1,614.6	27.7	376.1	50.6	4.9	105,781.4
Projects 1 and 2 Combined Total						
Foundation Installation	593.4	9.5	138.9	18.6	1.3	39,259.0
Offshore Substation Installation	77.4	1.2	18.1	2.4	0.2	5,146.6
Scour Protection	171.5	3.9	40.7	5.8	1.1	11,570.3
Inter-Array Cable Installation	198.3	4.6	46.8	6.7	1.4	13,419.7
WTG Installation	1429.7	20.1	323.8	42.1	2.0	90,786.5
Export Cable Installation	792.0	16.2	190.6	26.3	3.9	53,277.2
Fuel Bunkering	68.4	1.3	16.4	2.3	0.2	4,651.0
PROJECTS 1 AND 2 COMBINED TOTAL	**3,330.6**	**56.9**	**775.4**	**104.2**	**10.1**	**218,110.3**

During the O&M phase, Atlantic Shores is considering support from two main types of vessels: crew transfer vessels (CTVs) which generally return to port nightly, or a larger service operation vessel (SOV), which remains in the WTA for weeks at a time (see Section 5.6 of Volume I for vessel details). Based on preliminary evaluations, the SOV concept is estimated to generate slightly more air emissions than the CTVs; therefore, the SOV concept was used as the maximum PDE for assessing air emissions from O&M vessel activity. Table 3.1-3 summarizes the maximum calculated air emissions associated with the PDE from both engine emissions and associated vessel activities during O&M. The results presented in Table 3.1-3 represent a weighted average estimate, incorporating activities that are reasonably foreseeable, but expected to be required only once every several years (e.g., an OSS major repair or a WTG retrofit campaign).

Table 3.1-3 O&M Vessel Air Emissions

	NO_X, Tons/Year	VOC, Tons/Year	CO, Tons/Year	$PM_{2.5}$, Tons/Year	SO_2, Tons/Year	CO_2E, Tons/Year
Project 1 O&M Vessels	344.1	6.0	81.1	10.9	1.1	22,772.5
Project 2 O&M Vessels	284.6	5.2	67.1	9.1	1.0	18,823.7
Projects 1 and 2 Combined Total O&M Vessels	519.7	8.6	121.2	16.1	1.4	34,058.7

As described in Section 6.0 of Volume I, the decommissioning phase will likely be sequenced in the reverse order of construction, and vessels used to complete offshore decommissioning activities may resemble those used during installation. To the extent that these vessels combust fossil fuels, they will have effects associated with air emissions. Atlantic Shores is optimistic that current trends in vessel engine design will continue or accelerate; that is, vessel engines will become significantly cleaner and more efficient between now and when decommissioning will occur. Therefore, Atlantic Shores anticipates the quantities of vessel air emissions during decommissioning to be significantly lower than the quantities estimated for construction.

3.1.2.2 Onshore Air Emissions

Onshore air emissions are primarily associated with construction vehicles, equipment and vehicles supporting port activities, and commuter vehicle trips. Minor sources of additional emissions could include fugitive dust, use of paint solvents, and possibly external combustion for heating.

Onshore construction methods and ports are described in Sections 4.7 through 4.10 of Volume I. For purposes of this assessment, horizontal directional drilling (HDD) installation at the cable landfall site is included in the emissions calculations for onshore construction activities. The PDE assumes active marshalling of material to support offshore construction, using one or more of the identified ports, and conservatively assumes use of GBSMP/TP foundations, which will have more associated port activity than other foundation types identified in the PDE. Calculated construction onshore air emissions associated with the maximum PDE are summarized in Table 3.1-4. The use of onshore generators is described in Section 3.1.2.3.

Table 3.1-4 Construction Onshore Air Emissions

	NO_X, Tons	VOC, Tons	CO, Tons	$PM_{2.5}$, Tons	SO_2, Tons	CO_2E, Tons
Project 1 with Overlap Area						
Vehicles	51.2	6.5	35.4	1.9	0.1	7,092.3
Stationary Engines	0.4	0.1	0.4	0.0	0.0	79.3
PROJECT 1 TOTAL	**51.6**	**6.6**	**35.8**	**1.9**	**0.1**	**7,171.6**
Project 2 with Overlap Area						
Vehicles	44.0	5.6	31.2	1.7	0.1	6,226.3
Stationary Engines	0.4	0.1	0.4	0.0	0.0	79.3
PROJECT 2 TOTAL	**44.4**	**5.7**	**31.6**	**1.7**	**0.1**	**6,305.6**
Projects 1 and 2 Combined Total						
Vehicles	89.3	11.4	63.2	3.4	0.1	12,615.9
Stationary Engines	0.9	0.1	0.7	0.0	0.0	158.6
PROJECTS 1 AND 2 COMBINED TOTAL	**90.1**	**11.5**	**63.9**	**3.5**	**0.1**	**12,774.5**

Atlantic Shores does not anticipate significant onshore air emissions during O&M. Air emissions include some minor port activity and commuter vehicle trips. To the extent that commuter vehicle emissions or port-related material handling emissions are associated with the Projects, those emissions will not significantly contribute to existing on road vehicle emissions or emissions from port activities.

As described in Section 6.0 of Volume I, decommissioning sequencing will occur in the reverse order of construction, with similar activities. Atlantic Shores is optimistic that onshore vehicle engines will become significantly cleaner and more efficient between now and when decommissioning will occur, resulting in decreased quantities of decommissioning air emissions relative to the estimated quantities of construction air emissions.

3.1.2.3 Structure and Generator Air Emissions

During construction, diesel generators will be used to supply power in circumstances where connection to the electric power grid is not possible or practical, typically for limited periods to support specific activities such as initial equipment testing. The PDE includes estimates of generator use for activities where such generators may be more appropriate than using vessel power or the electric power grid. Also, some equipment (such as hammers, air compressors, and motion compensators) are powered by stationary diesel engines. The planned use of such engines (both onshore and offshore) will generate combustion air emissions, as shown in Table 3.1-5.

Additionally, offshore construction activities could also include emissions from smaller sources such as paint solvents and fuel evaporation.

Table 3.1-5 Construction Structure and Generator Air Emissions

	NO_X, Tons	VOC, Tons	CO, Tons	$PM_{2.5}$, Tons	SO_2, Tons	CO_2E, Tons
Project 1 with Overlap Area						
Stationary Generators	62.3	6.8	73.6	1.4	0.1	15,317.3
Miscellaneous Sources	-	0.9	-	-	-	-
Project 2 with Overlap Area						
Stationary Generators	45.1	5.0	53.1	1.0	0.1	11,021.9
Miscellaneous Sources	-	0.9	-	-	-	-
Projects 1 and 2 Combined Total						
Stationary Generators	98.5	10.9	114.7	2.2	0.2	23,596.8
Miscellaneous Sources	-	1.0	-	-	-	-

During O&M, diesel generators will be used to supply power in circumstances where electric grid power supply is interrupted (e.g., blackout or scheduled maintenance). The PDE includes estimates of generator use for maintenance and reliability testing. The planned use of such generators (both onshore and offshore) will generate combustion air emissions as shown in Table 3.1-6, along with an estimate of emissions from miscellaneous sources such as paint solvents and electrical equipment.

Table 3.1-6 O&M Structure and Generator Air Emissions

	NO_X, Tons/Year	VOC, Tons/Year	CO, Tons/Year	$PM_{2.5}$, Tons/Year	SO_2, Tons/Year	CO_2E, Tons/Year
Project 1 with Overlap Area						
Stationary Generators	0.23	0.03	0.20	<0.01	<0.01	29.5
Miscellaneous Sources	-	0.05	-	-	-	2,257
Project 2 with Overlap Area						
Stationary Generators	0.23	0.03	0.20	<0.01	<0.01	29.5
Miscellaneous Sources	-	0.05	-	-	-	1,690
Projects 1 and 2 Combined Total						
Stationary Generators	0.46	0.06	0.40	<0.01	<0.01	58.9
Miscellaneous Sources	-	0.1	-	-	-	3,519

While decommissioning might use internal combustion engines as temporary power sources, Atlantic Shores is optimistic that lower-emitting or non-emitting sources of temporary power will be available by the time decommissioning occurs.

3.1.2.4 Aircraft Air Emissions

As described in Sections 4.10 and 5.6 of Volume I, construction and O&M may include the transport of personnel by helicopter and the use of helicopters for rapid inspections. Such activity may cause air emissions at the appropriate local airport(s) but is expected to be within the bounds of normal airport operations. The maximum PDE analyzed in this section does not explicitly include air emissions from aircraft, because (owing to the reduction in total engine operation time) emissions from aircraft would be lower than emissions from vessels performing the same task. The maximum PDE analyzed includes crew transfer and inspections using marine vessels, as the conservative case with respect to total air emissions.

3.1.2.5 Avoided Air Emissions

As described in Section 2.2 of Volume I, the Projects will result in a significant net decrease in harmful air pollutant emissions region-wide by displacing electricity from fossil fuel power plants. Available data on avoided emissions is summarized in Table 3.1-7, based on the Project 1 nameplate capacity of 1,510 MW with 50% capacity factor and 4% transmission losses displacing the latest-available output emission rate for the Reliability First Corporation East subregion as published by the EPA (EPA 2020a).

Table 3.1-7 Avoided Air Emissions[1]

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

[1]Based on the non-baseload output emission rate for NO_X, SO_2, and CO_2E; based on the total output emission rate for $PM_{2.5}$.

[2] Based on a reasonable minimum Project 2 size of 960 MW.

The emissions savings shown in Table 3.1-7 provide only a partial description of the air quality-related benefits of the Projects, for the following reasons:

- Traditional power plants do not include emissions associated with plant construction, fuel delivery, maintenance, worker commute, safety systems, vehicles, or machinery when reporting direct emissions. A direct comparison of the avoided air emissions to the projected air emissions in Tables 3.1-3 through 3.1-7 would require the addition of emissions from those activities.
- The Project will also avoid emissions of HAPs including mercury, acrolein, formaldehyde, and cadmium associated with fossil fuel generation.
- The emissions reductions will occur at fossil fuel power plants that tend to be near population centers, or upwind of population centers, including overburdened Environmental Justice communities. Project-related air emissions will predominately occur offshore away from population centers.

The Project will support clean energy policies including the GWRA. Per the EPA:

> *Clean energy policies that reduce or avoid air pollution can enhance air quality and improve peoples' health and quality of life. For example, exposure to air pollution from fossil fuel-based energy can exacerbate respiratory diseases, like bronchitis and asthma, and cause heart attacks and premature death. Beyond the physical health effects, pollution-related illnesses impose other 'costs' on people, such as lost wages or productivity when someone has to miss work or school, the costs of medical treatment and outdoor activity restrictions when air quality is poor (EPA 2020b).*

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

3.1.2.6 Impacts from Air Emissions

As evidenced by the result of the vessel air emissions assessment summarized in Tables 3.1-2 and 3.1-3 and detailed in Appendix II-C, emissions from Project vessel activities will be highest during the 2- to 3-year construction period. These temporary vessel emissions will be localized to the Offshore Project Area with maximum emissions occurring predominantly in and near the WTA and the ECCs. Emissions associated with vessels activities during the O&M phase will also be predominantly localized to the WTA. The distance of the WTA from shore, combined with winds away from shore, will serve to limit the effect of vessel emissions on humans or sensitive environmental receptors.

Effects from pollutant emissions associated with onshore activities will likely be localized. Onshore interconnection cable installation and onshore substation and/or converter station erection would have effects in-line with similar-sized projects conducted regularly to support the existing electric grid. Port activities supporting the Projects will have similar emissions effects to other port activities. The addition of air pollutants associated with the temporary Project construction activities will be a small fraction of existing nonroad emissions in New Jersey.

O&M onshore emissions will have similar effects to other port activities and worker commutes; these emissions are not expected to affect local or regional air quality. Similarly, aircraft emissions will have similar effects to existing aircraft and airport operations, and emissions are not expected to affect local or regional air quality.

3.1.2.7 Summary of Proposed Environmental Protection Measures

While the Projects will result in a significant net decrease in harmful air pollutant emissions region-wide (as described in Section 3.1.2.5), Atlantic Shores is committed to avoiding, minimizing, and mitigating the effects of air emissions that could occur. This commitment includes the following environmental protection measures:

- Engines manufactured and installed to meet or exceed emission control requirements will be used. Engine manufacturers incorporate pollution control measures into their designs. Techniques used by engine manufacturers include: ensuring complete combustion in the engines, by control of the combustion air, controlling fuel flow, ensuring complete mixing, and staging combustion; avoiding hot spots in the combustion process that can form NO_x, by staging combustion, injecting water, recirculating flue gas, and otherwise cooling the system; and using post-combustion controls to remove air pollutants after they have formed, by adding particulate filters, oxidation catalysts, and selective catalytic reduction systems.

- Vessel engines will use a combination of combustion and post-combustion controls to meet or exceed applicable marine engine standards, including: The International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI (for foreign vessels); 40 CFR Part 1039 (for Tier 1 and 2 domestic marine diesel engines smaller than 37 kW); Control of Emissions from Marine Compression-Ignition Engines; 40 CFR Part 1042 (for Tier 1 and 2 domestic marine diesel engines larger than 37 kW); and Control of Emissions from New and In-Use Marine Compression-Ignition Engines and Vessels, 40 CFR

Part 1042 (for Tier 3 and 4 domestic marine diesel engines). On-road engines, nonroad engines, and aircraft engines will meet or exceed similar standards.

- The best engines available for the task will be used. Atlantic Shores will endeavor to minimize air emissions by using the cleanest vessel engines available for the task (i.e., meeting the safety, efficacy, scheduling, and contracting needs for the task). Construction vessels will be supplied by contractors for temporary use on each Project. For routine O&M, Atlantic Shores will have additional ability to specify the vessel(s) used, through long-term contracting or outright purchase. Atlantic Shores is actively evaluating opportunities to use liquefied natural gas or hydrogen as the primary fuel for the main CTVs or SOV to be used for routine O&M. Regardless of whether these technologies are practicable, the primary CTV or SOV to be used for O&M will likely be newly built and will meet top-Tier EPA marine engine standards for new construction. Nonroad engine emissions will be minimized using engines compliant with 40 CFR Part 1039, *Control of Emissions from New and In-Use Nonroad Compression-Ignition Engines*, i.e., "Tier 4" engines, where practicable.

- Clean fuels will be used to the maximum extent practicable. Marine diesel fuel will comply with the fuel sulfur limit of 15 ppm per 40 CFR Part 80, which is the same limit as onshore Ultra Low Sulfur Diesel (ULSD). For heavier residual fuel oils used in Category 2 and Category 3 engines, and for engines on foreign vessels, the Projects will comply with the fuel oil sulfur content limit of 1,000 ppm set in MARPOL VI and corresponding EPA regulations. Nonroad engines will use ULSD. The use of clean fuels will minimize emissions from fuel impurities and allow for cleaner combustion.

- During all Project phases, Atlantic Shores is committed to implementing BMPs and investigating the use of innovative tools and/or technologies to minimize air emissions from vessel operations. Specifically, Atlantic Shores will optimize construction and O&M activities to minimize vessel operating times and loads. This will include weather monitoring, forecasting, and Project tracking to minimize emissions resulting from non-productive time, and incentives for contractor fuel savings. Onshore construction mitigation will also include the development of dust-control plans for onshore construction areas to minimize effects from fugitive dust resulting from construction activities.

- Air permit requirements will be met or exceeded, and Atlantic Shores will comply with all applicable air quality regulatory requirements. A key element will be obtaining the OCS air permit. Atlantic Shores will comply with other air-related regulatory requirements by using engines manufactured and maintained in compliance with the appropriate standards, which include NSPS, NESHAPs, and Federal standards for nonroad and marine diesel engines as described in Section 3.1.1.4. If onshore stationary equipment triggers any requirement to obtain a New Jersey air permit (including obtaining coverage under a general permit), Atlantic Shores will obtain the required permit.

- Any required OCS air permit will address the following key requirements:
    - **Documentation of compliance with ambient air standards**. Atlantic Shores will use one or more EPA-approved air dispersion models to show that air emissions in the WTA will not cause or significantly contribute to a condition of air quality impacts. Applicable standards for assessing air quality impacts include the NAAQS described above, as well as PSD increments (allowed increases over a baseline set to prevent deterioration of air quality), and the NJDEP risk assessment process for air toxics (NJDEP Technical Manual 1003 as required per N.J.A.C. 7:27-22.3(cc)).
    - **Documentation of no adverse impact to air quality related values (AQRVs) at Class I Areas**. Per National Park Service guidance: "Under the CAA, the Federal Land Manager (FLM) and the Federal official with direct responsibility for management of Federal Class I parks and wilderness areas have an affirmative responsibility to protect the AQRVs (including visibility) of such lands, and to consider whether a proposed major emitting facility will have an adverse impact on such values" (NPS 2010). The FLM for the Brigantine Wildlife Refuge is the United States Fish and Wildlife Service (USFWS). Atlantic Shores expects to work with the USFWS through the OCS air permit review process to identify mitigation strategies that will alleviate potential adverse impact concerns.
    - **Control technology review**. Atlantic Shores will document that the emissions from the OCS sources meet the following related requirements: SOTA, per N.J.A.C. 7:27-22.35; Best Available Control Technology (BACT), per 40 CFR Part 52.21(j); and Lowest Achievable Emission Rate (LAER), per N.J.A.C. 7:27-18.3(b)1. Atlantic Shores will document compliance with these standards by evaluating alternative processes, designs, and technologies, evaluating, and ranking pollution control technologies, and proposing the lowest feasible emission rates for each OCS source. The SOTA requirements will apply to all air pollutants, the BACT requirements will apply to pollutants subject to PSD, and the LAER requirements will apply to pollutants subject to nonattainment NSR.
    - **Emission offsets**. Per N.J.A.C. 7:27-18.3(c), Atlantic Shores will secure emissions offsets for OCS source air pollutants subject to nonattainment NSR. These will be Certified Emission Reductions (CERs) banked through the NJDEP emissions offset program (generally through shutdown or emissions reduction at existing sources of air pollution), or offsets obtained through an alternative method in coordination with the OCS air permit reviewing agency.

3.2 Water Quality

This section describes water quality conditions in the Onshore Project Area and Offshore Project Area, which includes the WTA (Project 1, Project 2, and the Overlap Area) and the export cable corridors (ECC), associated impact producing factors (IPF), and measures to avoid, minimize, or mitigate potential effects during construction, operations and maintenance (O&M) and decommissioning of the Projects.

The Projects have been sited and designed to avoid or minimize adverse impacts to water quality within and proximate to the Project Areas such as sediment suspension and transport and accidental release of hazardous materials (i.e., from Project vessels, vehicles, or equipment) to the ocean or inland waters. Appropriate and targeted best management practices (BMPs) and operational controls will be implemented to minimize and mitigate potential impacts. The water quality discussion includes marine waters (offshore) and water supplies (onshore). Surface waters, including wetlands, streams, and other waterbodies, are discussed in Section 4.1 Wetlands and Waterbodies, which provides additional information on the potential Project-related effects on these inland resources.

3.2.1 Affected Environment

The affected environment with respect to potential Project-related water quality impacts includes the marine waters of the Offshore Project Area encompassing the outer continental shelf (OCS) waters of the WTA to the nearshore and intertidal waters along the ECCs to each landfall site. The affected environment also includes any documented water supplies within the Onshore Project Area. The characterization of water quality in the affected environment is based on available scientific literature, published State and Federal agency research, online data portals, and online mapping databases.

3.2.1.1 Marine Water Quality

Water quality within the Offshore Project Area is influenced by the bays and rivers that drain into the ocean, the composition of atmospheric deposition, and the influx of constituents from sediments (BOEM 2012). Oceanic circulation, influenced by tides, currents, bathymetry and upwelling, drives the dispersal, dilution and biological uptake of inorganic and organic matter deposited in the ocean. Water quality offshore in the waters of the WTA and along the ECCs is considered ‘good’ and supportive of marine life based on regional monitoring data syntheses for offshore waters (EPA 2015). Nearshore waters, within New Jersey’s jurisdictional limits and closer to recreation areas, population centers and industrial uses, are monitored closely by Federal and State authorities. Therefore, the water quality along the ECCs, closer to shore, is monitored more frequently than within the WTA (NJDEP 2019a).

Existing Pollution Sources in the Offshore and Onshore Project Areas

Most contaminants in the coastal and marine environment are derived from point and nonpoint sources from land-based and offshore anthropogenic activities. There are several permitted surface water discharges located along the New Jersey coast between the Monmouth ECC and the Atlantic ECC, including domestic (sewage), industrial or commercial facilities, and petroleum product cleanup site outfalls (NJDEP 2019d) (see Figure 3.2-1). None of these permitted discharges are located directly within the WTA or Monmouth and Atlantic ECCs, and proposed Project activities are not expected to interact with these permitted discharges. Water quality concerns related to these sources are regulated by permit effluent standards, and any related water pollution impacts are mitigated by the mixing and dilution occurring in the receiving bays, rivers, and ocean (NJDEP 2015b).

Stormwater is a nonpoint source that transports sediment and/or pollutants from the land to an aquatic system (e.g., wetlands or waterbodies). Most stormwater is not treated; as rainwater or snowmelt travels over surfaces mobilizing unstabilized soils and pollutants from human and animal activity (NJDEP 2020f; Mallin et al. 2008). Common pollutants found in stormwater runoff include fertilizers, insecticides, herbicides, oil, gas, sediment, and nutrients and bacteria from animals which drive water quality degradation due to high levels of fecal coliform, turbidity, orthophosphates, biological oxygen demand, total phosphorus, total suspended solids (TSS), surfactant compounds, and organic carbon (NJDEP 2020f). Acute and chronic nonpoint source pollution near ocean beaches, coastal bays, and other tidal systems can lead to harmful algal blooms, threats to human health, threats to wildlife, and destruction of habitat in these sensitive areas (NJDEP 2020f; Mallin et al. 2008). In contrast, in offshore waters (i.e., WTA, ECCs), where depth and circulation drive the transport and dilution of water pollution, impacts from stormwater runoff are limited.

Relevant Water Quality Assessments

The EPA's National Coastal Condition Assessment (NCCA) report (EPA 2015) provides regional estimates of coastal water quality conditions for the east coast of the United States. Water quality was evaluated using measurements of dissolved oxygen (DO), dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorus (DIP), light transmissivity, and turbidity to determine the overall water quality index at sampling sites. A summary of these key water quality indicators from the NCCA and relevant New Jersey Department of Environmental Protection (NJDEP) water quality reports provide an overall water quality characterization for the marine waters associated with the Offshore Project Area and are presented in Table 3.2-1. The EPA published results from 23 sampling sites located along New Jersey's coast extending from Sandy Hook Bay to Delaware Bay. No NCCA stations directly correspond to the WTA and ECCs, but they provide indicative coastal water quality conditions in the nearby waters (Figure 3.2-2).

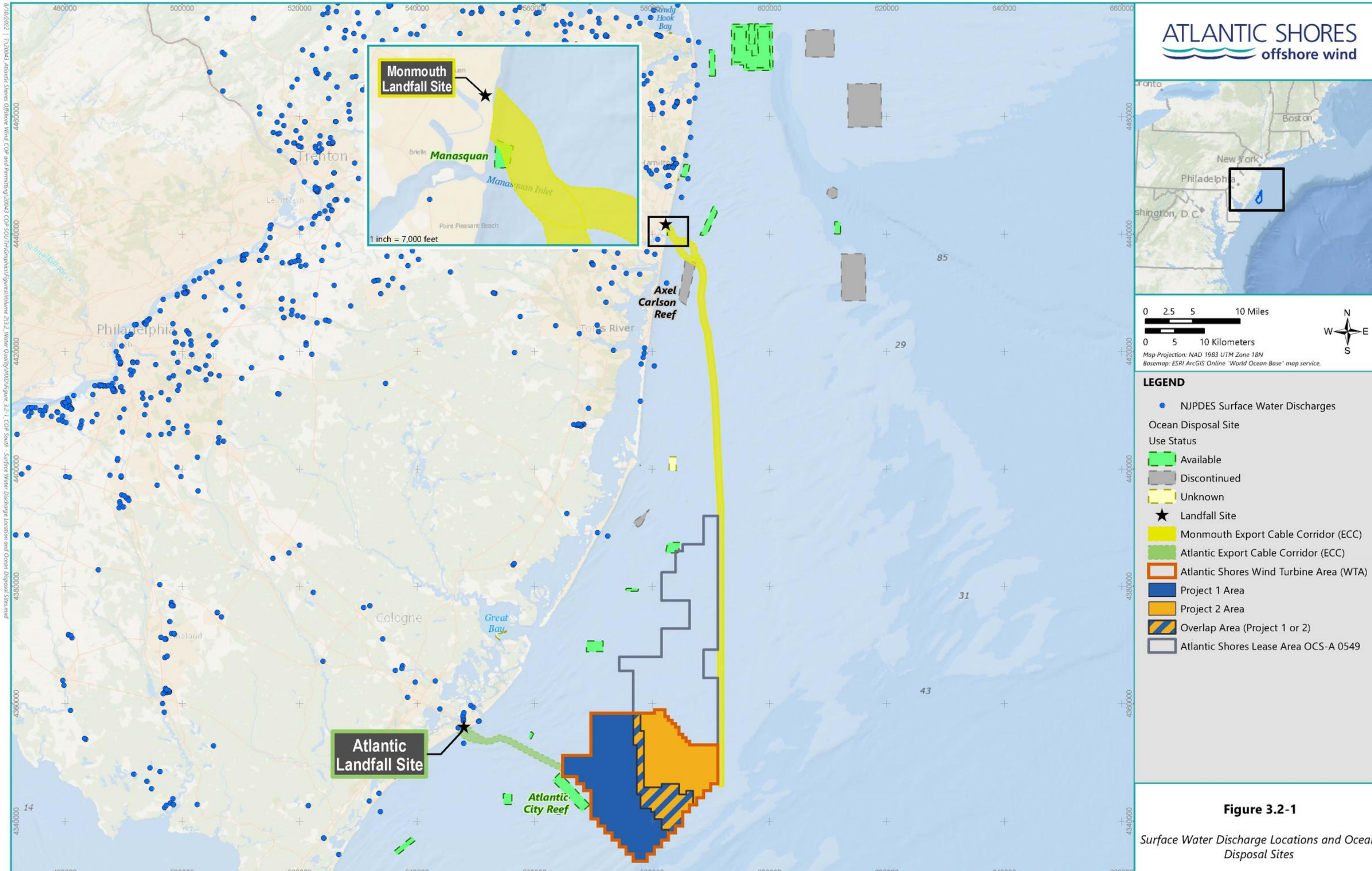


Figure 3.2-1

Surface Water Discharge Locations and Ocean Disposal Sites

Table 3.2-1 Summary of Water Quality Parameter Results Indicative of the Atlantic Shores Offshore Project Area, U.S. Environmental Protection Agency's National Coastal Condition Assessment

Parameter	Definition	Value	EPA NCCA Water Quality Indicator (see Figure 3.2-2)
Dissolved Oxygen (DO)†	DO refers to the amount of oxygen in the water generated from atmospheric oxygen exchange and photosynthetic processes from plants and phytoplankton.	2.6–9.1 milligrams per liter (mg/L)	15 sites – 'good' condition and eight sites – 'fair' condition
Chlorophyll *a*†	Chlorophyll *a* concentration tends to be most present where there are high levels of nutrients, which can stimulate an overproduction of algae, creating algal blooms which deplete oxygen levels used by aquatic organisms and block sunlight for underwater plants.	5.44–120.37 micrograms per liter (µg/L)	15 sites – 'fair'" condition and eight sites – 'poor'
Dissolved inorganic nitrogen (DIN)†	DIN is a common form of nitrogen found in coastal environments and is attributed to the formation of algal blooms.	0.02–9.7 µg/L	12 sites – 'good' condition, 10 sites – 'fair' and one site – 'poor'
Dissolved inorganic phosphorus (DIP)†	DIP is another nutrient that is used by photosynthetic organisms like phytoplankton.	0.007–0.284 µg/L	Two sites – 'good' condition, 13 sites – 'fair' condition, and eight sites – 'poor' condition
Total suspended solids (TSS)††	TSS is a measurement of the concentration of sediment particles in the water column obtained by measuring the total dry weight of particles in a water sample.	17.2–35.7 mg/L	N/A
Turbidity†† (water clarity or Secchi disk reading)	Turbidity is an optical characteristic of water and is a measurement of the amount of light scattered by suspended particulate matter.	3.2 feet (ft) (1 meter [m])-9.8 ft (3 m)	'Medium' turbidity

Notes:
† - EPA, 2015; †† - NJDEP, 2020e.

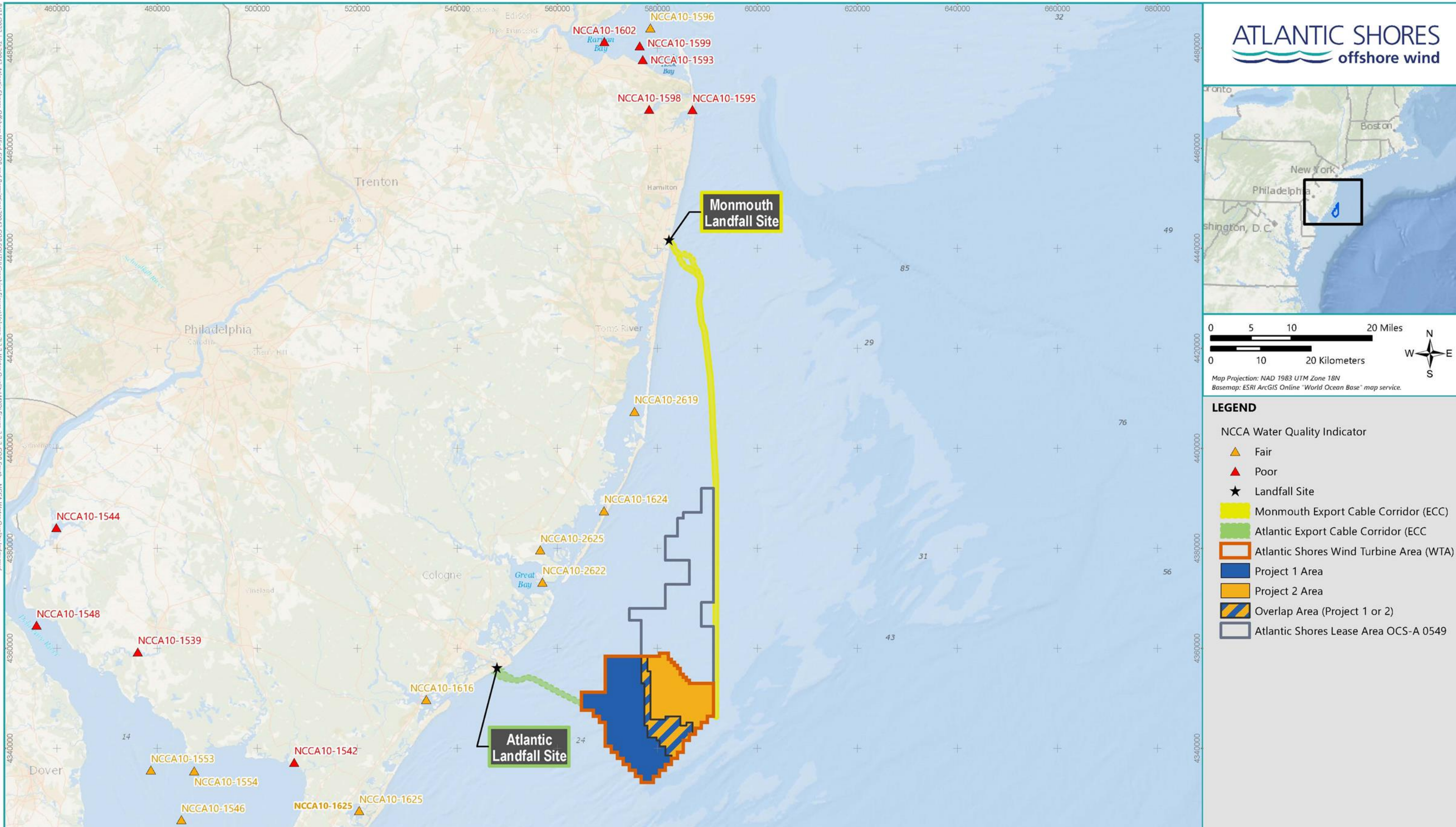


Figure 3.2-2

National Coastal Condition Assessment (NCCA) Water Quality Index

Two adverse water quality conditions resulting from water pollution that may directly affect the capacity of waterbodies to support human and wildlife uses are algal blooms and exceedances in bacteria levels. Excess nutrients (i.e., phosphorus and nitrogen) are primary contributors to algal blooms. In 2020, the NJDEP established the Harmful Algal Bloom (HAB) Interactive Mapping and Reporting System for monitoring and reporting algal blooms. No historical algal blooms have been recorded between 2017 and 2020 within estuarine or coastal environments along the New Jersey coastline, inclusive of the Offshore Project Area (NJDEP 2019b; NJDEP 2019c; NJDEP 2020b; NJDEP 2020c). One harmful agal bloom advisory was issued by NJDEP on July 27, 2022 for Fletcher Lake in Bradley Beach, New Jersey (NJDEP 2020b).

In addition to algal blooms, bacteria levels in a coastal environment threaten public health, shellfish, and fish. A common bacterium found in coastal environments is fecal coliform bacteria, which is linked to shellfish closures along the east coast of the United States (NJDEP 2020d; MDMR 2016; VDH 2020). Fecal coliform levels are monitored by the NJDEP as part of their participation in the National Shellfish Sanitation Program (NSSP). Figure 3.2-3 illustrates the NJDEP Shellfish Classification based on the State's water quality monitoring program and fecal coliform levels in the context of the Projects. According to the NJDEP, most of the New Jersey coastline in the vicinity of the ECCs is open for shell fishing. Prohibited areas for shellfish harvesting are located close to shore along the northern shore of New Jersey from Sandy Hook Bay to Point Pleasant Beach, south of Seaside Park, Surf City, Atlantic City, Ocean City, Avalon, Wildwood Crest, and around the U.S. Coast Guard Training Center (NJDEP 2018). Both the Atlantic and Monmouth ECCs traverse prohibited areas for shellfish harvesting close to shore.

In 2016, the NJDEP published an Integrated Water Quality Assessment Report (IWQAR) on the health of New Jersey waters in accordance with the Federal Clean Water Act, New Jersey Water Quality Planning Act, and New Jersey Pollution Control Act (NJDEP 2019a). A total of 958 assessment units were established throughout New Jersey to assess water quality conditions of fresh, brackish, and marine water habitats (NJDEP 2019a). Water quality was characterized by acceptable water uses given various chemical, physical, and biological parameters of waterways (e.g., public water supply, recreation). For the purposes of this section, the applicable IWQAR results for the ECC nearshore and landfall locations (i.e., approximately 3 miles (mi) or 4.8 kilometers [km]) offshore) were evaluated to determine current water quality conditions near the Projects.

A summary of the assessment ratings for waters near the Monmouth and Atlantic ECCs and landfall sites are presented in Table 3.2-2. The Monmouth and Atlantic ECCs and landfall sites are located along the NJDEP's Atlantic Coast—the largest of five water regions. The landfall sites are each located within one assessment unit. The Monmouth ECC is located within two assessment units, and the Atlantic ECC is located within one assessment unit (NJDEP 2019a). Assessment units were ranked by the NJDEP into categories for general aquatic life use, recreational use, fish consumption, and shellfish harvest.

Table 3.2-2 Summary of Water Quality Use Assessments from the 2016 New Jersey Integrated Water Quality Assessment Report for Marine Waters near the Monmouth and Atlantic ECCs and Landfall Sites

	Number of Applicable NJDEP IWQAR Assessment Units	Use Category and Assessment			
		General Aquatic Life	Recreational Use	Fish Consumption	Shellfish Harvesting
Monmouth Landfall Site	1	Unsupportive	Supportive	Undetermined	Unsupportive
Monmouth ECC	2	Unsupportive	Unsupportive	Undetermined	Supportive
Atlantic Landfall Site	1	Unsupportive	Supportive	Undetermined	Unsupportive
Atlantic ECC	1	Unsupportive	Supportive	Undetermined	Supportive

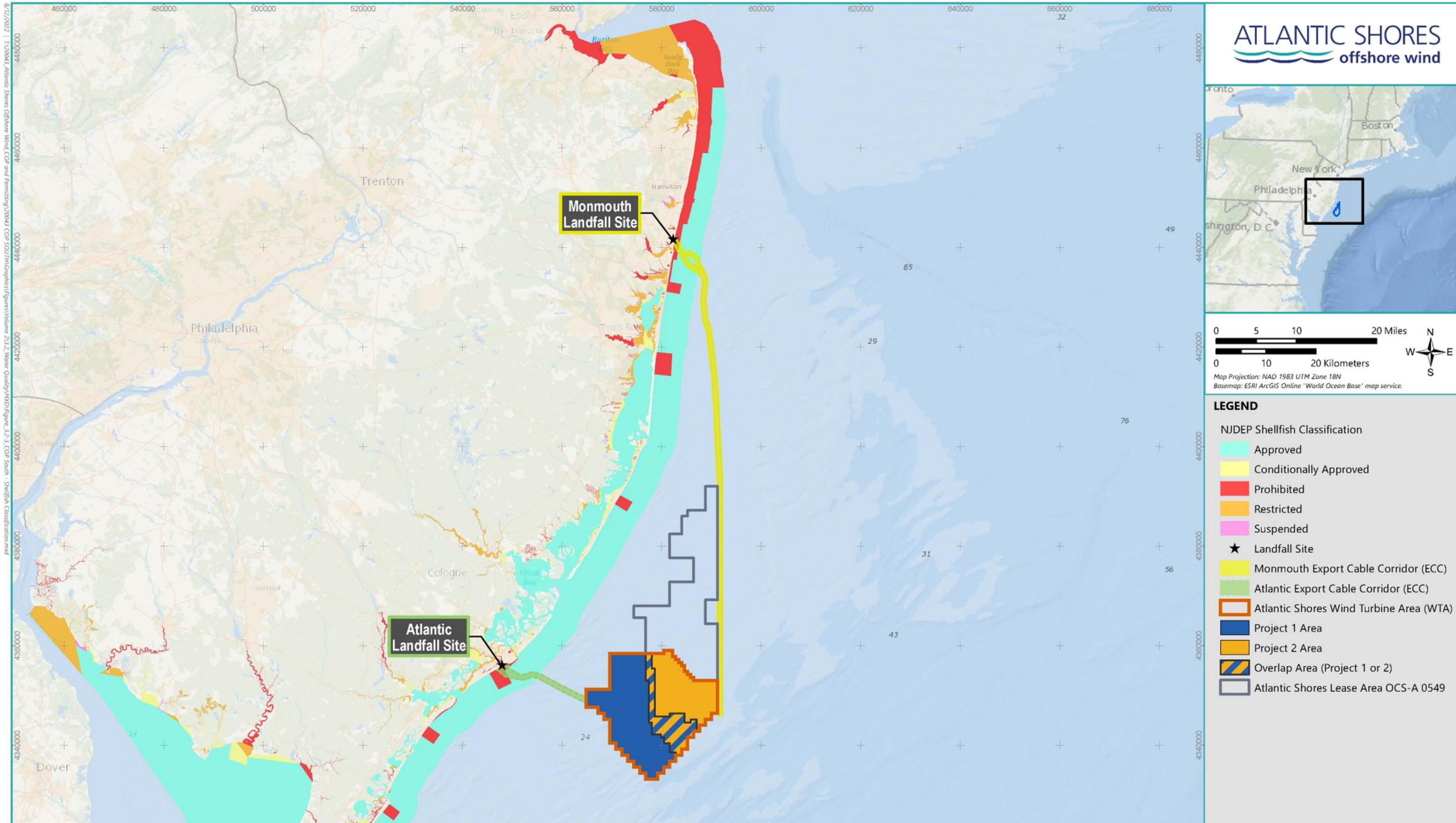


Figure 3.2-3

NJDEP Shellfish Classification

3.2.1.2 Water Supplies – Groundwater and Surface Water Reservoirs

As described in Section 2.1 Geology, groundwater reservoirs underlie portions of the Onshore Project Area and some of these groundwater resources are designated and monitored because they supply water to communities. There are several types of public and private water supplies within the Onshore Project Area, although none are at risk of Project-related effects. New Jersey has different types of public water supplies, including community public systems (i.e., municipalities and communities with at least 15 year-round service connections) and noncommunity transient or non-transient public systems (e.g., schools, factories, motels). Noncommunity systems typically obtain water from groundwater resources (NJDEP Division of Water Supply and Geoscience 2020). A third type of water supply is a private system, such as an individual well serving a household.

Monmouth County – Larrabee Onshore Project Area

Private groundwater wells may be located at individual residences and businesses along the Larrabee onshore interconnection cable route and are largely unregulated. According to NJDEP (2022), about 13% of New Jersey's drinking water comes from private wells, approximately 25% of which have been tested under the New Jersey Private Well Testing Act (New Jersey Department of Health 2020). The municipalities in Monmouth County along the Larrabee onshore interconnection cable route include Howell Township, Wall Township, Manasquan Borough, and Sea Girt Borough. Each town and borough obtain most of its domestic water from groundwater or surface water reservoirs as well as private residential wells (County of Monmouth 2022). Wellhead protection areas, indicating public community and noncommunity groundwater wells in these communities near the Onshore Project Area are shown on Figure 3.2-4. The color-coded tiers around the well locations delineate source areas from which groundwater flows over a certain number of years to reach the well itself (NJDEP Division of Water Supply and Geoscience 2020).

As shown on Figure 3.2-4, one public community water wellhead protection area is located immediately adjacent to the Onshore Project Area and Lakewood Farmingdale Road just north of Randolph Road in Howell Township. In addition, one public non-community wellhead protection area is mapped as intersecting a portion of Lakewood-Allenwood Road in Wall Township, which will contain a Larrabee onshore interconnection cable route option (Figure 3.2-4, Sheet 2).

A public community water system managed by the private New Jersey American Water company supplies Howell Township with potable water. The water is sourced by 14 groundwater wells drawing from various regional groundwater aquifers in north-central New Jersey and one surface water supply (New Jersey American Water 2019). These wells and surface water supply are over 1 mi (1.6 km) from the Onshore Project Area and are not shown on Figure 3.2-4. The Manasquan Reservoir in Howell Township supplies drinking water to approximately 60% of the Monmouth County communities of Sea Girt Borough and Wall Township as well as other area communities. The surface water supply is run by the New Jersey Water Supply Authority (NJ WSA 2017). The Manasquan Reservoir is located more than 1,000 ft (305 m) northwest of the Onshore Project Area at its closest point and will not be affected by the Projects.

Figure 3.2-4
Sheet 1 of 3

Larrabee Onshore Interconnection Cable Route - Groundwater Resources

4/19/2023 | T:\20043 Atlantic Shores Offshore Wind COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\3.2_Water Quality\MXD\Figure_3.2-4_COP South - Larrabee Wellhead Protection.mxd

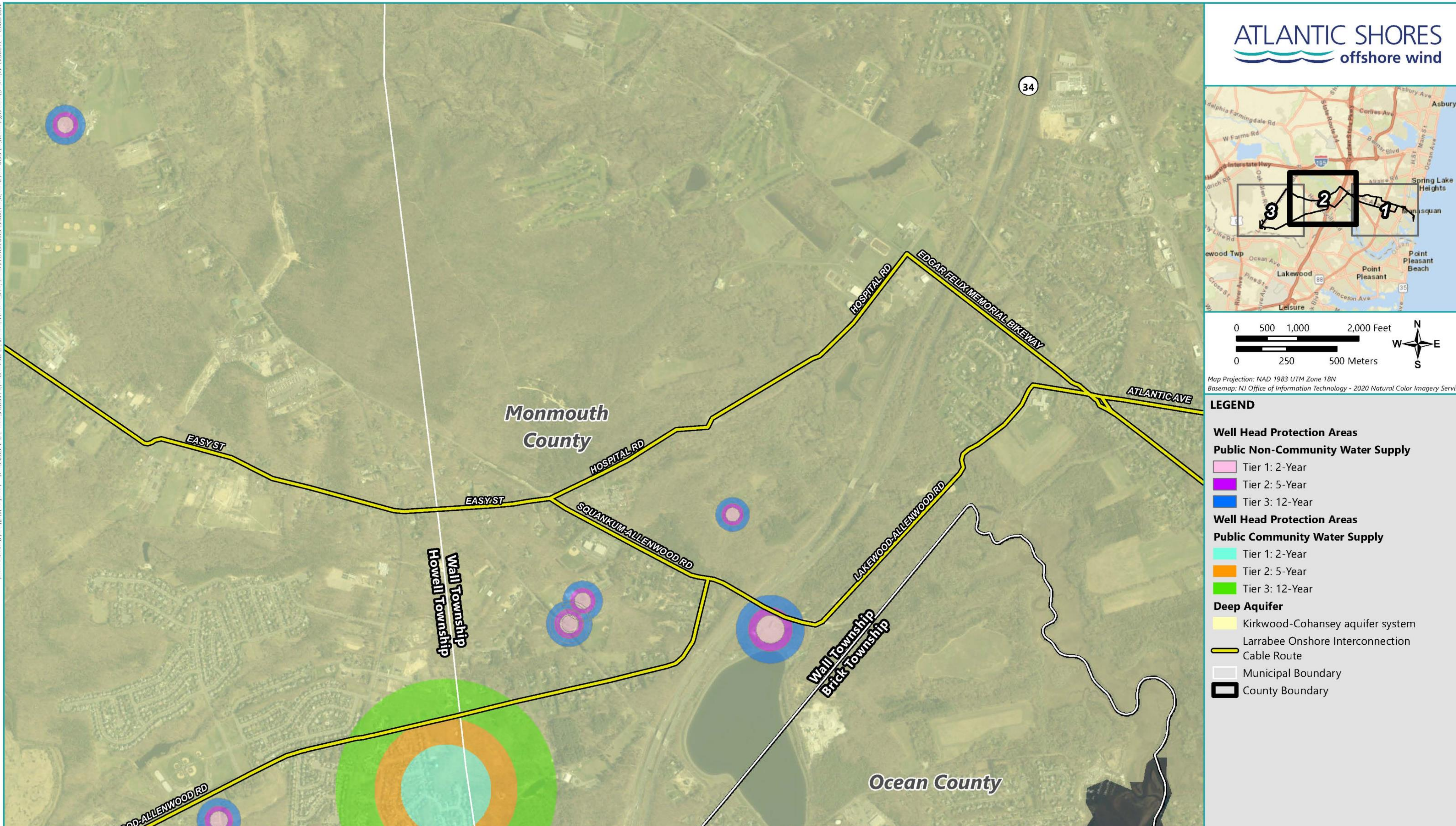
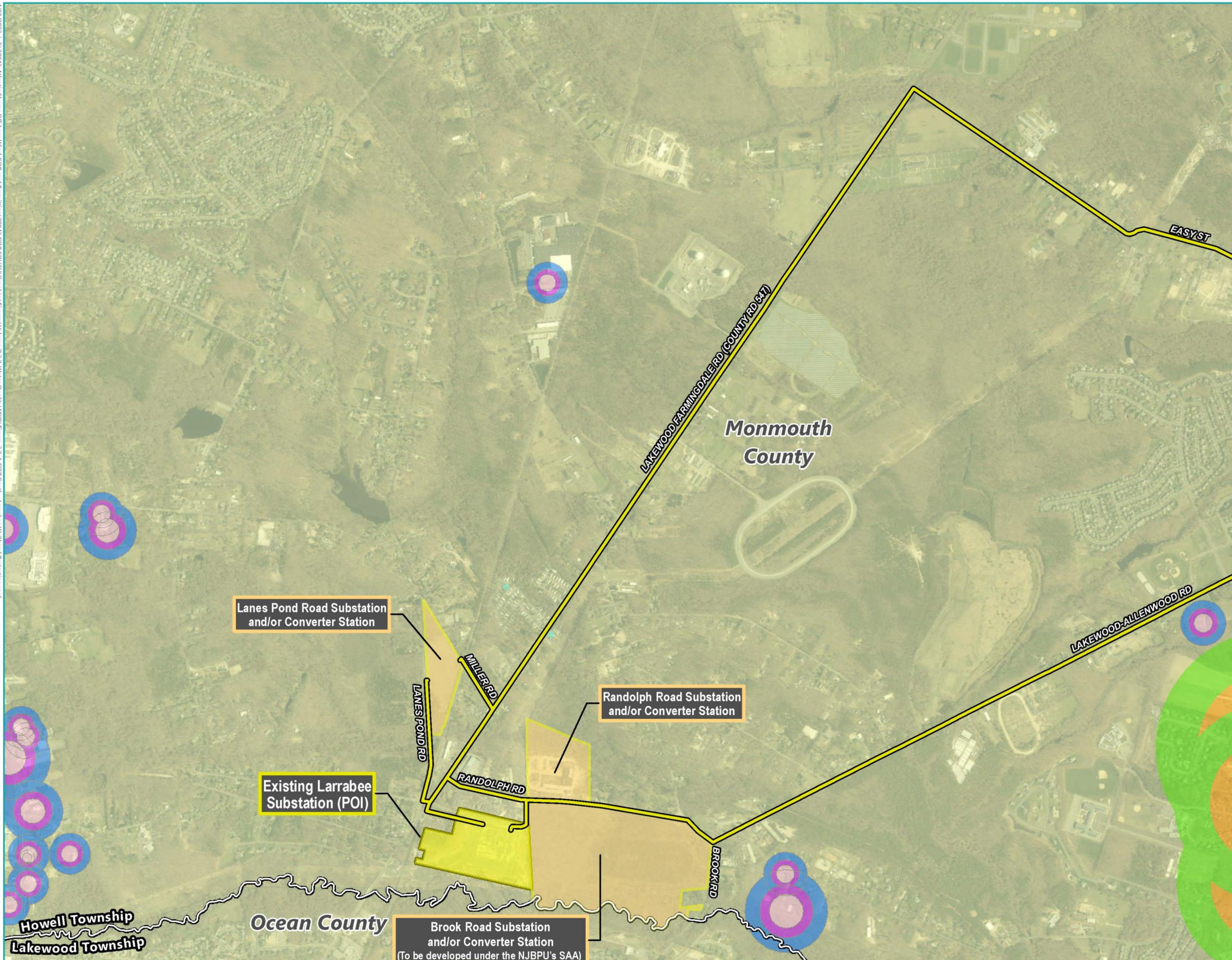


Figure 3.2-4
Sheet 2 of 3

Larrabee Onshore Interconnection Cable Route - Groundwater Resources



ATLANTIC SHORES offshore wind

0 500 1,000 2,000 Feet

0 250 500 Meters

N W E S

Map Projection: NAD 1983 UTM Zone 18N
Basemap: NJ Office of Information Technology - 2020 Natural Color Imagery Service

LEGEND

Well Head Protection Areas
Public Non-Community Water Supply
- Tier 1: 2-Year
- Tier 2: 5-Year
- Tier 3: 12-Year

Well Head Protection Areas
Public Community Water Supply
- Tier 1: 2-Year
- Tier 2: 5-Year
- Tier 3: 12-Year

Deep Aquifer
- Kirkwood-Cohansey aquifer system
- Larrabee Onshore Interconnection Cable Route
- Substation and/or Converter Station Option
- Municipal Boundary
- County Boundary

Figure 3.2-4
Sheet 3 of 3

Larrabee Onshore Interconnection Cable Route - Groundwater Resources

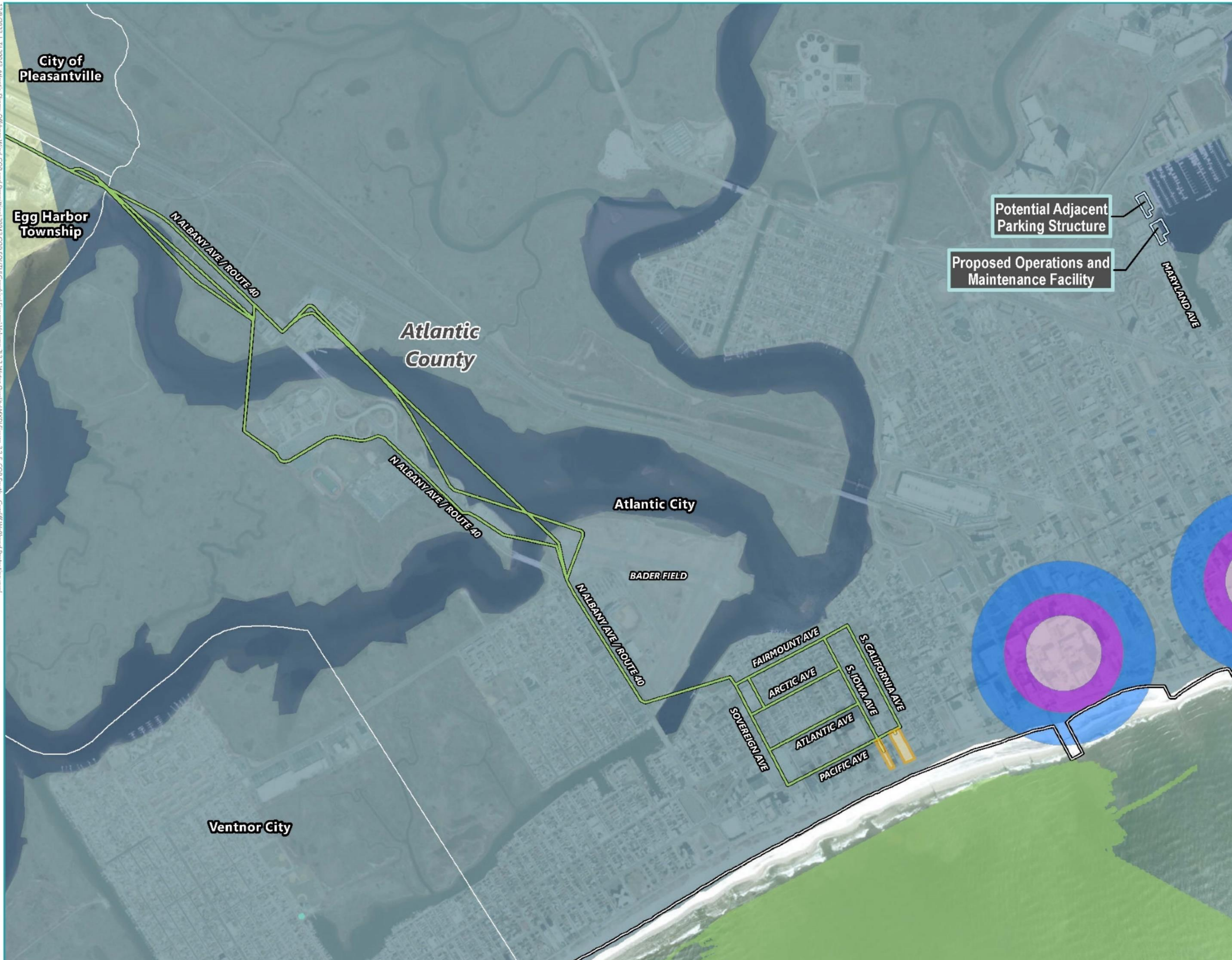
Atlantic County – Cardiff Onshore Project Area

Atlantic City obtains its public potable water supplies from both surface water and groundwater resources (Atlantic City Municipal Utilities Authority 2020). The surface water public supply servicing Atlantic County is drawn from the Atlantic City Reservoir, which was formed by damming the Absecon Creek at two locations in Atlantic County (the Kuehnle Pond Dam in Egg Harbor Township and the Doughty Pond Dam in Absecon). The reservoir is more than 1,000 ft (305 m) from the Atlantic Shores Onshore Project Area and will not be affected by the Projects.

Public potable water supplies from groundwater resources are also provided to Atlantic City by up to 13 community and noncommunity groundwater wells, with depths ranging from 200 to 675 ft (61 to 206 m) (Atlantic City Municipal Utilities Authority 2020). The wells draw from the Cohansey-Kirkwood Aquifer, a large deep subsurface aquifer of sands, silts, and clays that spans much of the New Jersey coastal plain (NJDEP 2009). The wellhead locations are secured, and access is restricted to protect the water supply. The water from the wellfields is transported and treated at Atlantic City's Water Treatment Plant Facility.

Wellhead protection areas for those community and noncommunity public wells near the Cardiff Onshore Project Area are shown on Figure 3.2-5. The color-coded tiers around the well locations delineate source areas from which groundwater flows over a certain number of years to reach the well itself (NJDEP Division of Water Supply and Geoscience 2020).

Within the Onshore Project Area, a portion of one public, non-community wellhead protection area partially extends across an existing railroad ROW and US Route 40 in the City of Pleasantville, where the onshore interconnection cable route will be co-located (Figure 3.2-5, Sheet 2). A second protection area occurs south of US Route 40, directly adjacent to the Cardiff Onshore Interconnection Cable Route options. The existing Cardiff POI Substation is located within the outermost Tier 3 (12-year source assessment) of a community wellhead protection area (Figure 3.2-5, Sheet 3).



0 500 1,000 2,000 Feet
0 250 500 Meters

N W E S

Map Projection: NAD 1983 UTM Zone 18N
Basemap: NJ Office of Information Technology - 2015 Natural Color Imagery Service

LEGEND

Well Head Protection Areas (Public Non-Community Water Supply)
- Tier 1: 2-Year
- Tier 2: 5-Year
- Tier 3: 12-Year

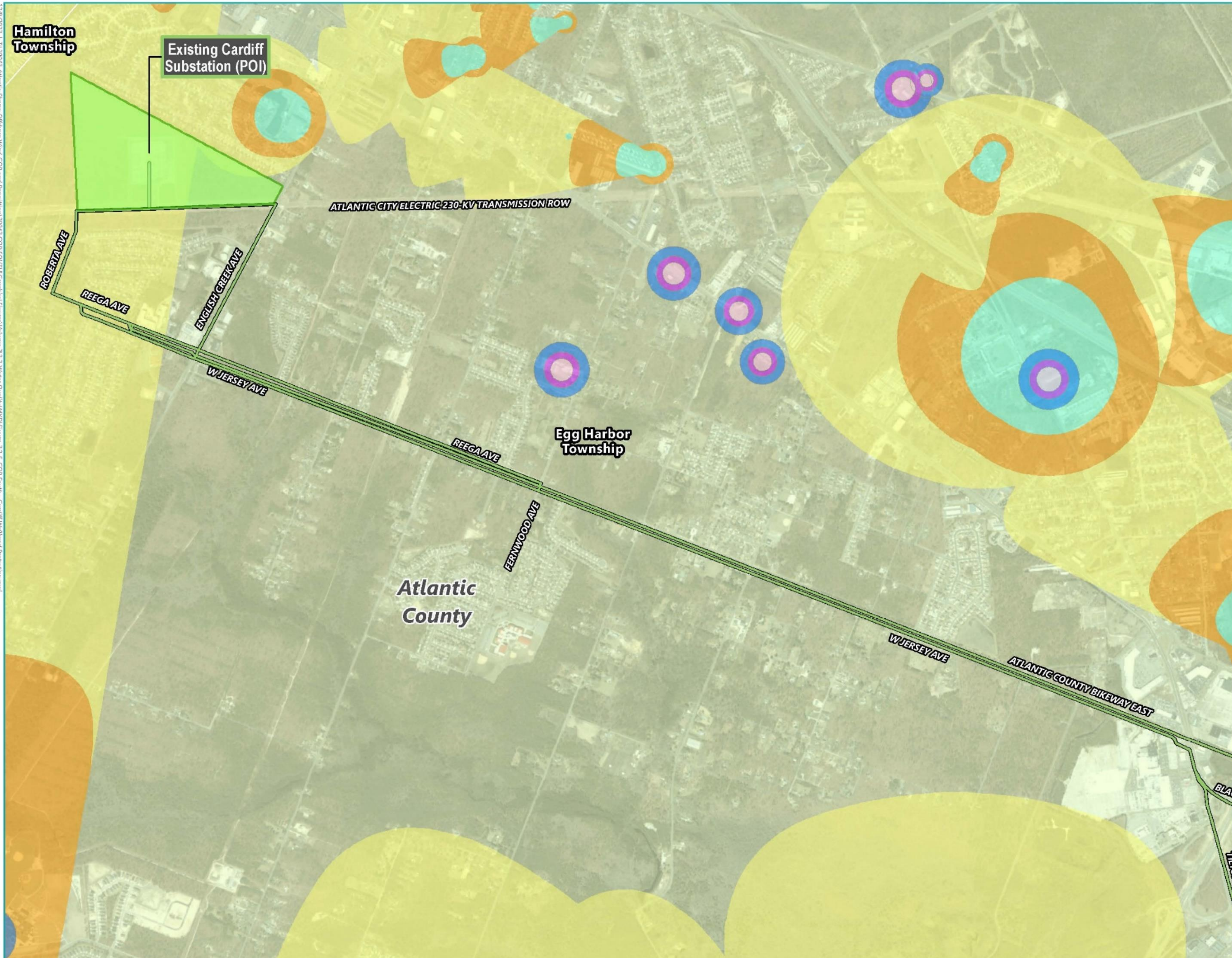
Well Head Protection Areas (Public Community Water Supply)
- Tier 1: 2-Year
- Tier 2: 5-Year
- Tier 3: 12-Year

Deep Aquifer
- Kirkwood-Cohansey aquifer
- Cardiff Onshore Interconnection Cable Route
- Atlantic Export Cable Corridor
- Proposed Operations and Maintenance Facility
- Atlantic Landfall Site
- Municipal Boundary
- County Boundary

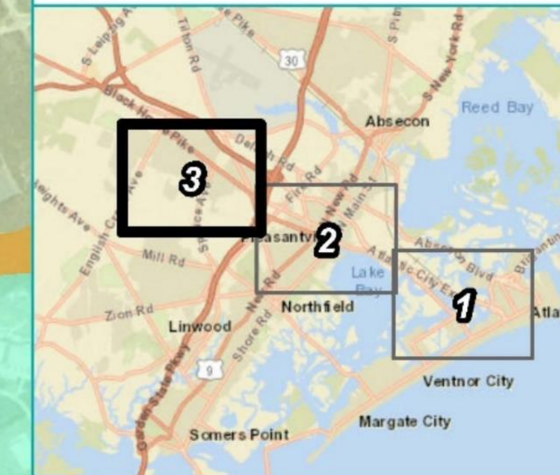
Figure 3.2-5
Sheet 1 of 3
Cardiff Onshore Interconnection Cable Route - Groundwater Resources

12/8/2023 | T:\20043 Atlantic Shores Offshore Wind COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\3.2 Water Quality\MXD\Figure 3.2 5 COP South - Cardiff Wellhead Protection.mxd

Figure 3.2-5
Sheet 2 of 3
Cardiff Onshore Interconnection Cable Route - Groundwater Resources



ATLANTIC SHORES offshore wind



0 500 1,000 2,000 Feet

0 250 500 Meters

N W E S

Map Projection: NAD 1983 UTM Zone 18N

Basemap: NJ Office of Information Technology - 2015 Natural Color Imagery Service

LEGEND

Well Head Protection Areas (Public Non-Community Water Supply)

- Tier 1: 2-Year
- Tier 2: 5-Year
- Tier 3: 12-Year

Well Head Protection Areas (Public Community Water Supply)

- Tier 1: 2-Year
- Tier 2: 5-Year
- Tier 3: 12-Year

Deep Aquifer

- Kirkwood-Cohansey aquifer
- Cardiff Onshore Interconnection Cable Route
- Existing Cardiff Substation (POI)
- Municipal Boundary
- County Boundary

Figure 3.2-5
Sheet 3 of 3

Cardiff Onshore Interconnection Cable Route - Groundwater Resources

12/8/2023 | T:\20043 Atlantic Shores Offshore Wind COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\3.2 Water Quality\MXD\Figure 3.2-5 COP South Cardiff Wellhead Protection.mxd

3.2.2 Potential Impacts and Proposed Environmental Protection Measures

The Projects have been planned and designed to minimize risk to marine water quality and onshore water supplies. Potential water quality risks associated with aspects of Project construction, O&M, and decommissioning, especially seafloor- and land-disturbing activities, will be mitigated by construction BMPs. Any Project-related effects to water quality would be short term and localized within areas of the Onshore and Offshore Project Areas. This section will mainly discuss those Project activities that disturb the seafloor or land because they can pose a threat to water quality by increasing the risks of elevated turbidity in the water column and water pollution, as well as indirect impacts to aquatic and marine habitats.

The potential IPFs that may affect water quality primarily due to sediment suspension offshore and soil erosion onshore during Project construction, O&M, or decommissioning are summarized in Table 3.2-3. The maximum Project Design Envelope (PDE) analyzed for all IPFs is the maximum build-out of the Projects. The potential impacts to water quality are anticipated to be the same for Projects 1 and 2.

Table 3.2-3 Impact Producing Factors for Water Quality

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Installation and maintenance of new structures and cables	•		•
Land disturbance	•		
Anchoring and jack-up vessels	•	•	•

Water quality may also be affected by accidental releases and discharges, onshore and offshore, from vehicles, equipment, or vessels. Atlantic Shores is accounting for the potential for accidental spills and releases of oils or other hazardous materials in a Project-specific Spill Prevention Control and Countermeasure plan (SPCC) and Oil Spill Response Plan (OSRP) (see Volume I Appendix I-D) that meets the requirements of the U.S. Coast Guard (USCG) and the Bureau of Safety and Environmental Enforcement (BSEE). Mitigation measures related to accidental releases and associated potential impacts are discussed in Sections 9.2.3 and 9.2.4.

3.2.2.1 Installation and Maintenance of New Structures and Cables

The installation of new Project structures and cables may result in the following:

- temporary disturbance to marine sediments and terrestrial soils during offshore and onshore construction and decommissioning

- temporary increases in turbidity and related water quality impacts from the suspension and transport of disturbed marine sediments or erosion and sedimentation of terrestrial soils.

Offshore

The installation of new WTG, OSS, met tower foundation structures, and offshore cables will temporarily disturb marine sediments causing localized increases in turbidity near the work activity including seabed preparation, placement of scour protection, limited dredging of the tops of mobile bedforms, cable installation activities, HDD operations (i.e., the inadvertent release of drilling fluids or frac-out) at the landfall sites, anchoring of support vessels, and use of jack-up vessels. A description of the seafloor disturbance anticipated under the maximum design scenario is presented in Section 4.11 of Volume I.

Seafloor disturbance will mobilize and temporarily suspend some shallow sediments into the water column, where they may be transported and re-deposited onto the sea floor causing a temporary increase in turbidity and decrease in water quality. Based on the Sediment Transport Modeling results, suspended sediment concentrations resulting from cable installation, HDD activities, and sandwave clearing are predicted to remain close to the route centerline or HDD pit, be constrained to the bottom of the water column, and occur for short durations (see Appendix II-J3).

Simulations of several possible inter-array cable or offshore export cable installation methods using either jet trenching installation parameters (for inter-array cable and export cable installation) or mechanical trenching installation parameters (for inter-array cable installation only) predicted above-ambient TSS of ≥10 mg/L[8] stayed relatively close to the route centerline. This is due to sediments being introduced to the water column close to the seabed. TSS concentrations of ≥10 mg/L traveled a maximum distance of approximately 1.8 mi (2.9 km), 1.6 mi (2.6 km), and 1.1 mi (1.7 km) for inter-array, Monmouth ECC, and Atlantic ECC cable installation, respectively. For the landfall approach scenarios, use of an excavator without a cofferdam was conservatively assumed and sediment was assumed to be introduced at the surface. This resulted in a maximum distance for the predicted above-ambient TSS concentrations ≥10 mg/L of approximately 2.1 mi (3.3 km) and 1.2 mi (1.9 km) for the Monmouth and Atlantic HDD pits, respectively.

For the inter-array cable and Atlantic ECC model scenarios, above-ambient TSS concentrations substantially dissipated within 2 to 4 hours and fully dissipated in 6 or less hours. For the Monmouth ECC model scenarios, above-ambient TSS concentrations substantially dissipated within 2 to 6 hours but required up to 13 hours to fully dissipate, likely due to the relatively longer route (i.e., larger volume of suspended sediment), route orientation in relation to currents, and more frequent occurrence of fine sediment. For the landfall approach scenarios, the tails of the plumes, with concentrations of ≥10 mg/L, were transported away from the source and were short-

[8] In the Mid-Atlantic Bight, 10 mg/L is considered within the range of ambient TSS concentration conditions (Balthis et al. 2009).

lived, while concentrations around the HDD pits dissipated within 12 hours for the Monmouth HDD pit and 11 hours for the Atlantic HDD pit. The larger areas of TSS concentrations above thresholds and the longer time for the plume to diminish to ambient conditions for the Monmouth HDD pit may be attributed to sediments being released in deeper water, the higher fraction of fine sediments taking longer to settle, and slightly stronger currents transporting the sediments parallel with the shore.

Predicted above-ambient TSS concentrations stemming from sandwave clearance activities also remained relatively close to the route centerline and were short-lived. The maximum distances for the predicted above-ambient TSS concentrations of ≥10 mg/L and 100 mg/L were approximately 2.0 mi (3.2 km) and 1.3 mi (2.1 km), respectively. Above-ambient TSS concentrations were predicted to substantially dissipate within 4 to 6 hours and fully dissipated in less than 12 hours for most areas.

These model predictions agree with modeling results conducted for similar projects in similar sediment conditions (BOEM 2021; Elliot et al. 2017; West Point Partners, LLC 2013; ASA 2008). Actual suspended sediment concentrations and sediment transport during installation may be even lower given that environmental monitoring surveys conducted during installation of the Block Island Wind Farm submarine cable found that suspended sediment levels measured during jet plow installation were up to 100 times lower than those predicted by the modeling (Elliot et al. 2017).

Impacts to water quality from elevated TSS concentrations are therefore expected to be temporary and localized, and no long-term impacts to water quality conditions are anticipated. Additional information on the effects of suspended sediment transport is provided in Section 4.5 Benthic Resources and Section 4.6 Finfish, Invertebrates, and Essential Fish Habitat.

Atlantic Shores will select cable installation techniques (e.g., jet plow embedment) that minimize sediment suspension to the maximum extent practicable. Atlantic Shores will also use anchor midline buoys and dynamically positioned vessels as practicable to minimize seafloor disturbance. Sediments disturbed during construction activities are not expected to contain contaminants given that sediments are predominantly sandy and known sources of anthropogenic contaminants (i.e., the mapped ocean disposal sites described in Table 2.1-2) will be avoided.

As indicated in Table 3.2-2, there are several areas along the coast near the Atlantic and Monmouth ECCs and landfall sites that NJDEP has determined do not meet their designated uses. For example, none of the waters are deemed supportive of general aquatic life and only portions of the waters support shellfish harvesting and recreational use. Any localized Project-related increases in turbidity would not further degrade the quality of surrounding marine waters in these areas because of the limited extent and duration of seafloor-disturbing activities and associated suspension and dispersion of sediments within the water column.

HDD installation of the export cables at the landfall locations will require the use of HDD drilling fluid, which typically consists of a water and bentonite mixture. While the mixture is not anticipated to significantly affect water quality if released, Atlantic Shores will implement BMPs during construction to minimize potential release of the fluid. These measures may include returning the drilling fluid to surface pits and collecting it for reuse. The HDD also creates a potential for frac-out during drilling activities. A frac-out occurs when the drilling fluids migrate unpredictably to the surface through factures, fissures, or other conduits in the underlying rock or unconsolidated sediments. In the unlikely event of a frac-out, the inadvertent release of bentonite into the water column could result in temporary and localized impacts to water quality in the nearshore marine environment. However, design considerations, operational controls and contingency planning will greatly diminish the likelihood of accidental releases. Furthermore, Atlantic Shores will develop an HDD Contingency Plan for the Inadvertent Releases of Drilling Fluid prior to construction to further minimize the potential effects to water quality associated with a frac-out.

During O&M, the degree of suspended sediment and increased turbidity will be significantly lower than during construction because any needed maintenance activities will be limited to discrete portions of offshore cables or structures. Any effects during O&M are expected to be short-term and temporary due to the predominantly sandy sea floor in the Offshore Project Area. Decommissioning of structures and cables is expected to have short-term and localized impacts similar to those described for construction because of seafloor disturbance from the removal of structures or cables.

Onshore

Atlantic Shores has located onshore facilities in previously disturbed and developed areas away from water supplies and surface waters to minimize the disturbance of terrestrial soils and the risk of sedimentation of nearby wetlands and waterbodies. Atlantic Shores also proposes to use specialized cable installation technologies (e.g., trenchless technologies) in certain areas to minimize environmental impacts (see Section 4.8.3 of Volume I). For example, HDD will be used to complete export cable landfall (i.e., offshore-to-onshore transition), which will minimize the amount of sediment and soil disturbance at the landfall sites, both offshore and onshore. Atlantic Shores will also use trenchless techniques (e.g., pipe jacking, jack-and-bore, and HDD) to install the onshore interconnection cables under wetlands, waterbodies, or roadways, which will minimize soil disturbances at these locations (see Section 4.1 Wetlands and Waterbodies).

As previously discussed, proper cable installation design and operational planning greatly diminishes the risk of accidental releases of drilling fluids (i.e., frac out) during HDD operations. Drilling fluids will consist of non-hazardous material such as bentonite and all drilling returns will be collected after use and recycled (see Section 4.7.1 of Volume I). Although accidental releases of HDD drilling fluids are expected to be a low probability event and not expected to affect water quality, an HDD Contingency Plan for the Inadvertent Releases of Drilling Fluid will be developed and implemented to further minimize potential effects.

During all onshore construction activities, Atlantic Shores will follow BMPs to properly contain excavated soils and sediments, stabilize disturbed soil areas, and minimize erosion and sediment runoff into waterbodies. Onshore Project activities have already targeted developed and previously disturbed areas for installing Project components. Prior to construction, appropriate soil erosion and sedimentation controls (e.g., silt fencing, filter socks, inlet protections and dust abatement) will be installed and maintained until site restoration has been achieved. Regular monitoring of disturbed areas and BMPs will be conducted by qualified inspectors. Post-construction, work sites will also be stabilized and restored with proper vegetation and landscape, in accordance with state and local permits. Disturbed areas along the onshore interconnection cable routes and the landfall sites will be returned to their preconstruction condition, except for manholes that will be installed for maintenance access.

During routine O&M, impact to onshore water quality is not expected as any specific maintenance to the below-ground components (i.e., onshore interconnection cables and splice/transition vaults) will be accessed via manholes. Onshore substation equipment would be repaired or replaced as needed but would not affect water quality. If any activities have the potential to impact water quality, Atlantic Shores will consult with the necessary regulatory agency and apply for applicable permits. Decommissioning of the onshore facilities would not impact water quality because the onshore facilities (i.e., onshore substations and buried duct banks) will be retired in place or reused for other purposes in consultation with state and municipal agencies (see Section 6.2.6 of Volume I).

3.2.2.2 Land Disturbance

Land disturbance will result from onshore Project activities that directly disturb the soil through trenching and excavation in uplands and previously disturbed areas. As previously discussed, land disturbance can lead to temporary increases in turbidity and related surface water quality impacts from erosion and sedimentation of terrestrial soils (potential effects of Project-related land disturbances on wetlands and waterbodies are addressed in Section 4.1). Land disturbance is the trenching, excavation, and grading associated with the installation of the onshore interconnection cables and splice vaults, the transition vault at the landfall sites, and construction of the onshore substations. In addition, land disturbance will occur in construction workspaces, staging areas, and access roads for construction equipment and materials.

As detailed in Section 3.2.1.2, the Onshore Project Area occurs within some community wellhead protection areas (see Figures 3.2-4 and 3.2-5). NJDEP regulates activities that adversely affect public well viability (i.e., groundwater withdrawals and excavation dewatering) or discharge to groundwater (i.e., contamination). The land disturbing activities associated with the trenching of the onshore interconnection cables, within the three identified wellhead protection areas along Lakewood Farmingdale Road, and the railroad spur in the City of Pleasantville, and at the existing Cardiff POI substation will occur within previously developed or disturbed ROWs where there is a lower likelihood of encountering groundwater. As a result, these installation activities are not expected to result in any discharges to groundwater or significant groundwater withdrawals. If shallow groundwater incursion occurs in limited areas during excavation of the onshore cable installation trench, dewatering may be necessary. Any discharge from dewatering will be managed according to applicable Federal and State regulations.

Where wetlands, waterbodies and other sensitive resources need to be crossed, the onshore interconnection cable will be installed using trenchless techniques such as jack-and-bore, pipe jacking and HDD. Installing the onshore interconnection cable in this manner will minimize the land disturbance in these areas and as discussed in Section 3.2.2.1, reduce potential water quality effects.

A stormwater management system will also be implemented at the onshore substation that includes but is not limited to, grassed water quality swales to capture and convey site runoff, deep sump catch basin(s) to pretreat surface runoff, and other approved measures to capture and treat stormwater runoff prior to groundwater recharge or surface water discharge. These systems will further reduce potential impacts to water resources during construction and O&M.

Construction equipment and material storage will be limited to designated work and staging areas within the Onshore Project Area to avoid any private wells that may be located along the onshore interconnection cable routes. Compliance with applicable environmental laws and regulations, and implementation of BMPs will prevent releases of oil and hazardous materials from Project vehicles or equipment. Spill containment measures around fuel tanks and refueling areas will be implemented in accordance with an SPCC plan (see Section 9.2.4).

Atlantic Shores will implement appropriate BMPs (e.g., silt fence, filter socks, inlet filters, dust abatement) and will restore temporarily disturbed areas (i.e., reseeding or repaving) in accordance with an approved Soil Erosion and Sediment Control Plan and New Jersey Division of Land Resource Protection Stormwater Management Control Plan (NJPDES and SWPPP) within the Onshore Project Area to avoid and minimize water quality impacts to nearby aquatic habitats.

Land disturbing activities are not anticipated as part of routine O&M or decommissioning because below ground facilities (e.g., splice vaults and transition vaults) will be accessed through manholes and decommissioning will involve retirement of the onshore facilities (i.e., onshore substations and buried duct banks) in place or used for other purposes in consultation with state and municipal agencies (see Section 6.2.6 of Volume I).

3.2.2.3 Anchoring and Jack-up Vessels

Seafloor disturbance and consequent suspension of sediments and turbidity increases will result from the positioning of anchors and jack-up vessel spuds as well as anchor chain contact with the seafloor (i.e., chain sweep). These vessel-related impacts are expected to result in localized, short-term increases in suspended sediment concentrations near the seafloor, limited to areas immediately adjacent to spuds, anchors, or jack-up legs. As detailed in the installation and O&M sections (see Sections 4.2, 4.4, 4.5, and 5.6 of Volume I), seabed disturbance from anchors and jack-up vessels will be temporary; therefore, no long-term impacts to water quality are anticipated.

The maximum PDE analyzed for anchoring and jack-up vessels is the maximum offshore build-out of the Projects, assuming use of anchored vessels for all export cables. Temporary anchoring and use of jack-up vessels within the Offshore Project Area will occur during construction and decommissioning and to a lesser extent during O&M with variations in duration and extent according to the specific work activity. The maximum seabed disturbance resulting from jack-up or anchored vessel use during construction for various Project components is summarized in the following tables from Volume I: Table 4.2-1 for WTG foundations, Tables 4.4-2 and 4.4-4 for OSS foundations, Table 4.5-1 for export cables, and Table 4.5-2 for inter-array and inter-link cables.

3.2.2.4 Summary of Proposed Environmental Protection Measures

Project design and construction planning has focused on avoiding and minimizing potential adverse effects to water quality. Both onshore and offshore water quality effects will be avoided and minimized through carefully locating Project infrastructure and use of specialized construction techniques and design considerations inclusive of the following measures.

Offshore

- Offshore construction techniques have been selected that minimize the disturbance and suspension of sediment and protect water quality:
    - Anchor midline buoys will be used on anchored construction vessels, where feasible, to minimize disturbance to the seafloor and sediments.
    - Dynamically positioned vessels and jet plow embedment will be used to the maximum extent practicable to minimize sediment disturbance and alteration during cable-laying process.
- Accidental spill or release of oils or other hazardous materials will be managed through the OSRP that meets USCG and the BSEE requirements (see Volume I Appendix I-D).
- HDD will be used to install the export cable to the landfall sites. All HDD activities will be managed by an HDD Contingency Plan for the Inadvertent Releases of Drilling Fluid to ensure the protection of marine and inland surface waters from an accidental release of drilling fluid. All drilling fluids will be collected and recycled upon HDD completion.
- Vessels will operate in compliance with regulatory requirements related to the prevention and control of discharges and accidental spills.

Onshore

- Project facilities have been sited/routed in previously disturbed areas and along existing ROWs.
- The Project facilities will avoid public water supplies/wellhead protection areas to the maximum extent practicable.

- The Project facilities will avoid stormwater outfalls and water intake structures that are identified during constructability studies, stakeholder consultation, and preconstruction surveys to the maximum extent practicable. Atlantic Shores will adhere to any buffers or offsets in accordance with state or local requirements to conduct work near these outfalls or structures.

- Trenchless cable installation methods (e.g., jack-and-bore, HDD) will be used to avoid impacts to wetlands and waterbodies. HDD will be used to install the export cable to the landfall sites. All HDD activities will be managed by an HDD Contingency Plan for the Inadvertent Releases of Drilling Fluid to minimize the potential effects from an accidental release of drilling fluid on marine and inland surface waters. All drilling fluids will be collected and recycled upon HDD completion.

- BMPs such as silt fence, filter socks, inlet protection, dust abatement and other approved BMPs will be implemented in accordance with the approved Soil Erosion and Sediment Control Plan to properly contain excavated soils and sediments and stabilize disturbed land areas, to avoid erosion and sediment runoff into waterbodies and impacts to water quality. Additionally, the Projects will be constructed in accordance with an approved New Jersey Division of Land Resource Protection Stormwater Management Control Plan (NJPDES and SWPPP) and County Soil Conservation District BMPs to avoid and minimize Project-related water quality impacts to nearby aquatic habitats (see Section 4.1 Wetlands and Waterbodies for additional discussion on the protection of wetlands and waterbodies).

- Temporarily disturbed areas will be stabilized through seeding or re-paving as appropriate and in accordance with the approved Soil Erosion and Sediment Control Plan.

- A NJDPES and a SPCC plan will be implemented.

- Environmental/Construction Monitor(s) will be assigned to ensure compliance with applicable permit conditions and that BMPs are functional.

4.0 BIOLOGICAL RESOURCES

This section provides a detailed description of the biological resources within the Onshore Project Area including wetlands and waterbodies, coastal and terrestrial habitat and fauna; birds, bats, benthic resources; finfish, invertebrates, and Essential Fish Habitat (EFH); marine mammals; and sea turtles.

4.1 Wetlands and Waterbodies

This section describes wetlands and other waterbodies such as vernal pools, streams, and rivers, within the Onshore Project Area, associated impact producing factors (IPFs), and measures to avoid and minimize potential effects to these resources during construction, operations and maintenance (O&M), and decommissioning.

Wetlands and waterbodies are a critical and valuable component of the ecosystem. Wetlands and waterbodies present within the Onshore Project Area have been assessed using targeted field surveys (e.g., wetland and waterbody delineations) and through consultation with Federal and State resource agencies, the primary purpose of which, was to develop an in-depth understanding of wetland and waterbody resources in the vicinity of the Project and identify steps to avoid and minimize impacts to these resources.

Wetlands and waterbodies in New Jersey are under the jurisdiction of the New Jersey Department of Environmental Protection (NJDEP) according to the Freshwater Wetlands Protection Act. NJDEP has formally assumed Federal jurisdiction based on a memorandum of agreement with the U.S. Army Corps of Engineers (USACE) for all non-tidal freshwater wetlands greater than 1,000 feet (ft) (305 meters [m]) from the head of tide (NJDEPE and USACE 1993). Wetlands that occur less than 1,000 ft (305 m) from the head of tide, including tidal wetlands, are under joint jurisdiction of the USACE and NJDEP. All Project activities within regulated wetlands and waterbodies will be conducted in compliance with applicable regulatory requirements and conditions of Nationwide or individual Federal and State permits that may be required for onshore Project activities.

4.1.1 Affected Environment

The affected environment for the purposes of this section consists of wetlands and waterbodies within the Cardiff and Larrabee Onshore Project Areas, inclusive of the landfall locations, onshore interconnection cable routes, onshore substations and/or converter stations,[9] and Points of Interconnection (POI). This section also covers wetlands and waterbodies within the O&M facility Onshore Project Area inclusive of the proposed O&M facility and potential adjacent parking structure (see Figures 4.8-1, 4.8-2, 4.9-1, and 4.9-2 of Volume 1). These Onshore Project Areas lie within the New Jersey Atlantic Coastal Plain along the coastal zone of New Jersey which generally includes tidal and non-tidal waters (including wetlands), dune and beach areas, forest areas and

[9] Potential parcels for an HVAC onshore substation and/or HVDC converter station have been identified along the Larrabee Onshore Interconnection Cable Route. The feasibility of these sites is currently being evaluated and additional information will be provided when site options are added to the PDE.

significant residential, commercial, industrial, and linear development. This coastal zone is managed by the NJDEP as the New Jersey Coastal Management Zone administrator under New Jersey Administrative Code (N.J.A.C.) 7:7 and encompasses approximately 1,800 miles (mi) (2,897 kilometers [km]) of tidal shoreline including 126 mi (203 km) of oceanfront from Sandy Hook to Cape May. The boundaries of the coastal zone include inland, seaward, and interstate areas (NJDEP 2020).

A wetland is an area that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation (NJ DLRP 2020). The area's glacial history plays a large role in wetland formation throughout the region. Geological processes and more recent events like sea level rise and erosion along rivers landward of the barrier islands, continue to influence wetland formation (Tiner et al. 1985). Five general wetland types occur throughout New Jersey based on the Cowardin Classification of wetlands: marine, estuarine, riverine, lacustrine, and palustrine (Cowardin et al. 1979). However, only riverine, palustrine, and or estuarine wetlands occur within or adjacent to the Onshore Project Areas (Figures 4.1-1, 4.1-2, and 4.1-3).

Specific information regarding wetland and waterbody characteristics within the Onshore Project Areas were obtained from several sources outlined within the wetland delineation reports. NJDEP wetlands and United States Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) mapping was used as a basis to determine areas of potential wetlands prior to any wetland and stream delineation survey. NJDEP and NWI mapped wetlands within the Onshore Project Areas are shown in Figures 4.1-1, 4.1-2, and 4.1-3.

In June and December 2020, September 2021, and June 2022, Atlantic Shores conducted ecological field studies within a study area that encompassed the Cardiff and Larrabee Onshore Project Areas. Field evaluations for wetlands and waterbodies for the O&M facility Onshore Project Area were completed from publicly accessible areas such as adjacent roadways and sidewalks due to access restrictions. The ecological field studies conducted included:

- Wetland and waterbody delineations
- Vernal pool surveys
- Terrestrial wildlife habitat assessments.

The purpose of these studies was to identify and evaluate sensitive ecological resources including the identification of habitat that could support threatened and endangered species (i.e., critical habitat assessments). The field evaluations for the O&M facility Onshore Project Area approximated the location and extent of wetlands and waterbodies and terrestrial wildlife habitats.

The results of the wetland delineation, habitat assessments, and vernal pool surveys are presented in the Cardiff and Larrabee Wetland and Stream Delineation Reports, in Appendix II-D1 and

Appendix II-D2 and Cardiff and Larrabee Habitat Suitability Assessment Reports in Appendix II-E1 and Appendix II-E2, respectively. The results of the field evaluations for the O&M facility Onshore Project Area are presented in the Cardiff Wetland and Stream Delineation Report (Appendix II-D1) and the Cardiff Habitat Suitability Assessment Report (Appendix II-E1).

The onshore Project facilities within the Cardiff, Larrabee, and O&M facility Onshore Project Areas are described in Sections 4.7, 4.8, 4.9, and 5.5 of Volume I. The documented wetlands and waterbodies within the Cardiff, Larrabee, and O&M facility Onshore Project Areas are detailed in Sections 4.1.1.1, 4.1.1.2, and 4.1.1.3, respectively. Detailed descriptions of the characteristically observed wetland types are provided in the Wetland and Stream Delineation Reports in Appendix II-D1 and Appendix II-D2.

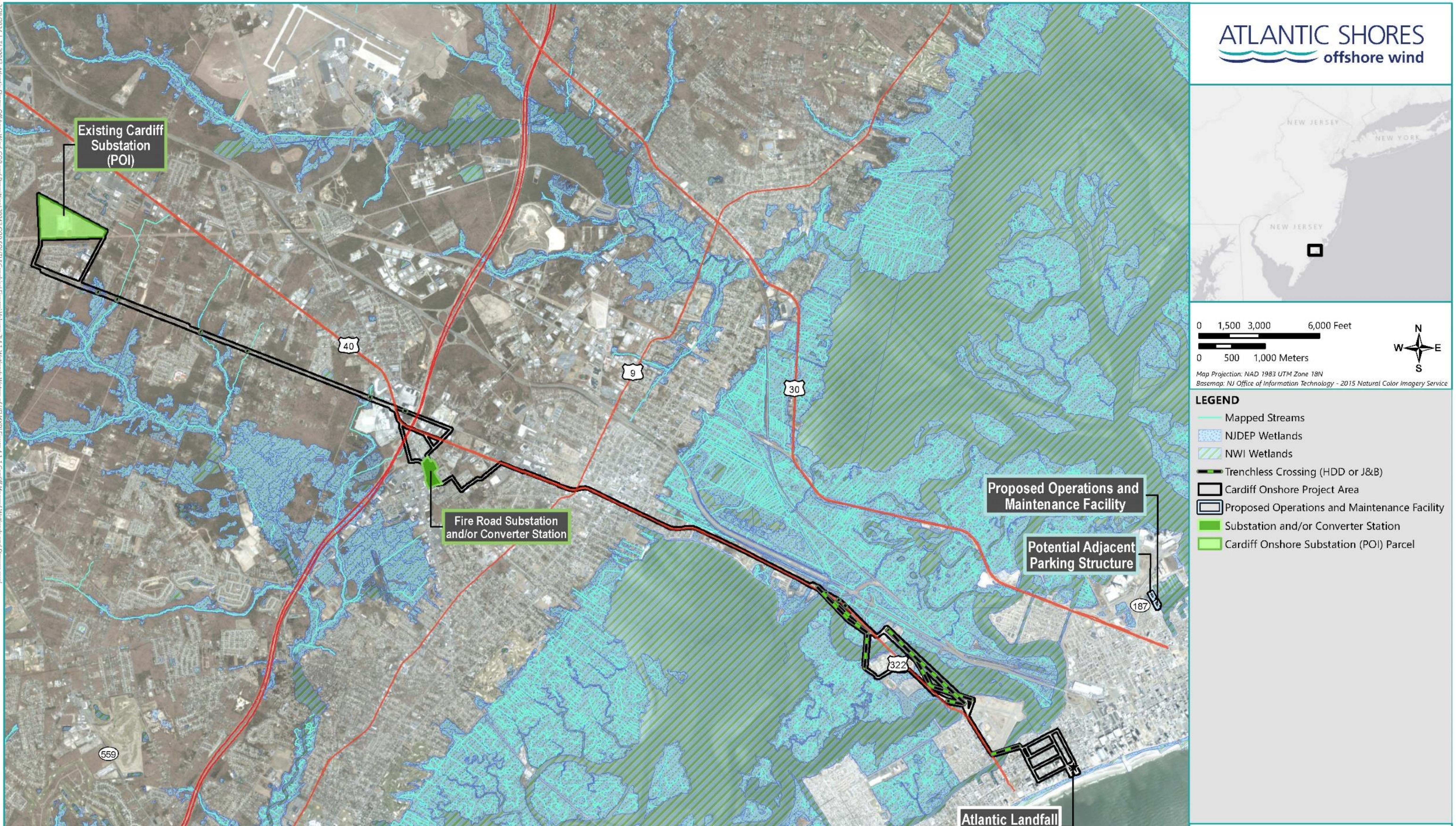


Figure 4.1-1

Mapped Wetlands and Streams along Cardiff and O&M Facility Onshore Project Areas

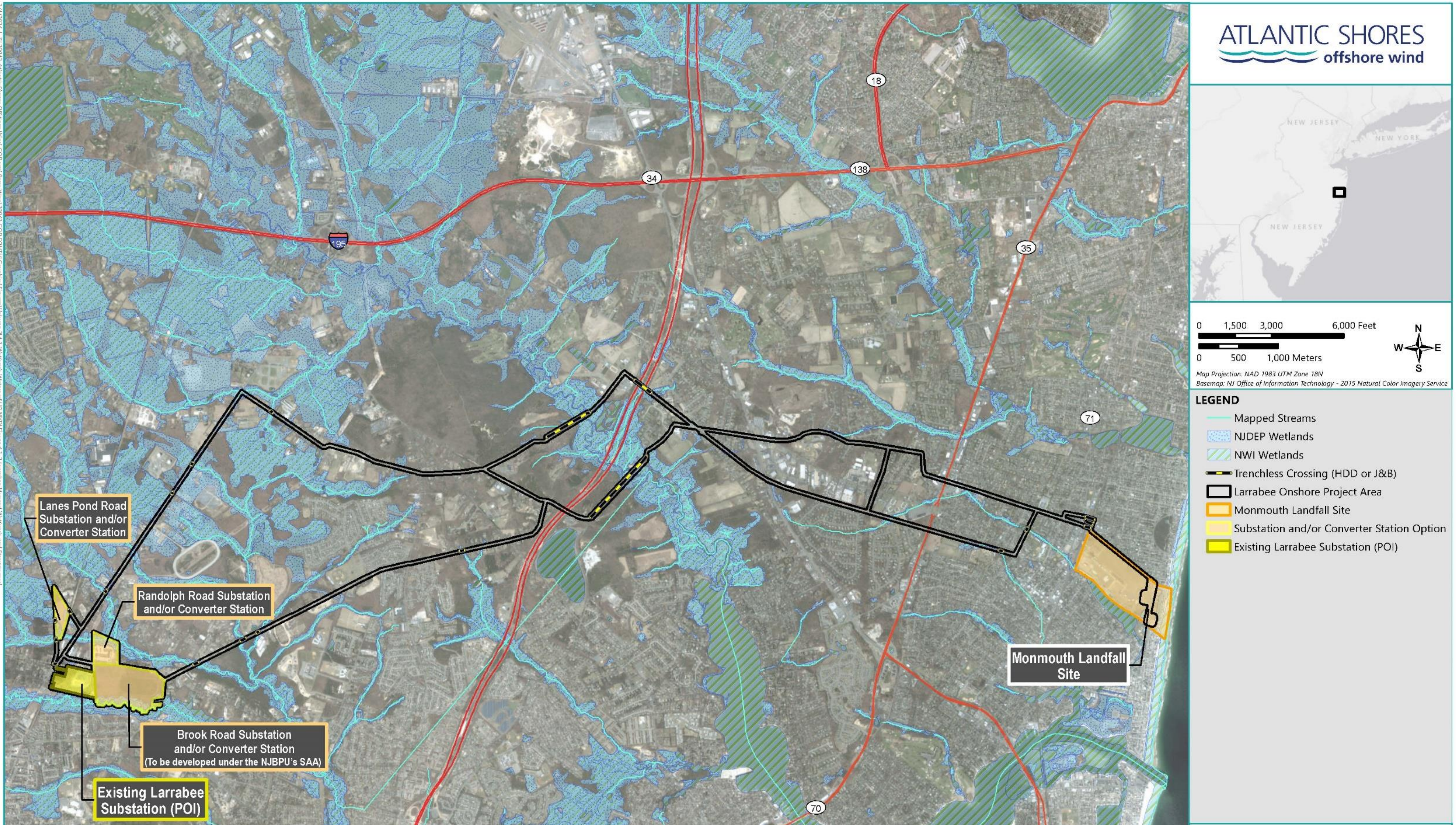


Figure 4.1-2

Mapped Wetlands and Streams along Larrabee Onshore Project Areas

Figure 4.1-3

Mapped Wetlands and Streams within the O&M Onshore Project Area

8/25/2022 | T:\20043 Atlantic Shores Offshore Wind COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\4.1 Wetlands Waters of US\MXD\Figure 4.1-3 O&M Mapped Wetlands and Streams.mxd

4.1.2 Wetlands and Waterbodies – Cardiff Onshore Project Area

The main Project facilities within the Cardiff Onshore Project Area are the Atlantic Landfall Site, onshore interconnection cables, onshore substation and/or onshore converter station, and Cardiff POI. These facilities were located to avoid wetlands and other waterbodies to the maximum extent practicable as shown in the Field Delineated Wetlands and Streams Plans in Appendix D of the Wetland and Stream Delineation Report (see Appendix II-D1). Wetlands and streams do not occur at the Atlantic Landfall site or the Cardiff POI. Delineated wetlands and waterbodies are largely situated adjacent to roadways, railroads, electric utility lines and other developed areas along the onshore interconnection cable route. Potential wetlands were identified on the onshore Fire Road substation/converter station site option (Fire Road Site); however, these areas are associated with stormwater management facilities that were constructed onsite. As a result, it is not anticipated that these wetlands are federal or state jurisdictional wetlands (see Appendix II-D1).

There are two wetland classes (palustrine and estuarine) present within the Cardiff Onshore Project Area. These wetland types are described as a characterization of typical wetlands in the Cardiff Wetland and Stream Delineation Report in Appendix II-D1, as well as descriptions of specific delineated wetlands. Estuarine wetlands include all tidal marshes and comprise most of the delineated wetlands. Palustrine wetlands are a diverse class of wetland and includes freshwater marshes, bogs, swamps, and bottomland forests. Table 4.1-1 summarizes the acreage of wetlands delineated by Atlantic Shores within the Cardiff Onshore Project Area.

Table 4.1-1 Delineated Wetlands within the Cardiff Onshore Project Area

Wetland Type	Delineated Wetlands (acres/ m^2)
Estuarine Emergent	1.39 acres (5,615 m^2)
Palustrine Emergent	0.60 acre (2,457 m^2)
Total	1.99 acres (8,072 m^2)

Waterbodies within the Cardiff Onshore Project Area fit into one subsystems of the riverine system—tidal. Tidal riverine systems occur along the onshore interconnection cable route within the back-bay/marshes associated with the tidal channels. Table 4.1-2 summarizes the acreage of waters delineated by Atlantic Shores within the Cardiff Onshore Project Area.

Table 4.1-2 Delineated Waters within the Cardiff Onshore Project Area

Waterbody Type	Delineated Waterbody (acres/ m^2)
Tidal/Riverine	6.61 acres (26,883 m^2)
Total	6.61 acres (26,883 m^2)

All delineated wetland communities are part of the larger ecosystem associated with freshwater, non-tidal and tidal wetlands and waterbodies that occur well beyond the Cardiff Onshore Project Area. The delineated tidal streams and inlets and estuarine wetlands have direct connections to the Great Throughfare that is part of the intra-coastal waterway and provides a direct connection to the Atlantic Ocean. Freshwater, non-tidal wetlands are associated with freshwater perennial watercourses Mill Branch and Cedar Branch that occur outside of the Cardiff Onshore Project Area and ultimately flow south to the Great Egg Harbor River.

4.1.3 Wetlands and Waterbodies – Larrabee Onshore Project Area

Like the Cardiff Onshore Project Area, the Project facilities located in the Larrabee Onshore Project Area have been located to avoid and minimize impacts to wetlands and waterbodies to the maximum extent practicable, as shown in the Field Delineated Wetlands and Streams Plan in Appendix D of the Wetland and Stream Delineation Report (see Appendix II-D2). Wetlands and streams do not occur at the Monmouth Landfall site or the Larrabee POI. All delineated wetlands and waterbodies are situated adjacent to roadways and other developed/disturbed areas along the onshore interconnection cable route.

The Project has been sited and designed to avoid possible impacts to wetlands and waterbodies associated with Allaire State Park and the Manasquan River Wildlife Management Area along the Larrabee onshore cable route. Allaire State Park is approximately 3,205 acres of mixed forest and maintained fields/trails located in Wall Township, Monmouth County, New Jersey. The state park contains high-quality wetlands and the Manasquan River and tributaries and large contiguous tracts of deciduous and mixed forests and wetlands. The Manasquan River Wildlife Management Area is an approximately 744-acre area that encompasses the lower Manasquan River and contains similar high-quality wetlands and large tracts of wetland and upland forested areas as found in Allaire State Park.

One wetland class (palustrine) is present within the Larrabee Onshore Project Area. This wetland class is described in the Larrabee Wetland and Stream Delineation Report (see Appendix II-D2). Palustrine wetlands are a diverse class of wetland and includes freshwater marshes, bogs, swamps, and bottomland forests and comprise all the wetlands found within the Larrabee Onshore Project Area. Table 4.1-3 summarizes the acreage of wetlands delineated by Atlantic Shores within the Larrabee Onshore Project Area.

Table 4.1-3 Delineated Wetlands within the Larrabee Onshore Project Area

Wetland Type	Delineated Wetland (acres/ m^2)
Palustrine Emergent	0.19 acres (789 m^2)
Palustrine Forested	1.15 acres (4,643 m^2)
Palustrine Scrub-Shrub	0.001 acre (4 m^2)
Total	1.34 acres (5,436 m^2)

Perennial and intermittent riverine systems occur within the Larrabee Onshore Project Area such as the Manasquan River and its tributaries. These features are located within deciduous and mixed forest habitats along the onshore interconnection cable routes and cross via culvert under existing paved roads and pedestrian/bike lanes. Intermittent systems also occur within the Larrabee Onshore Project Area and were typically identified in roadside ditches with hydrologic connection to either a perennial watercourse or palustrine wetland. These waterbodies were located on the fringes of mixed forest habitats along utility and roadway ROWs. Table 4.1-4 summarizes the acreage of waters delineated by Atlantic Shores within the Larrabee Onshore Project Area.

Table 4.1-4 Delineated Waters within the Larrabee Onshore Project Area

Waterbody Type	Delineated Waterbody (acres/ m^2)
Non-tidal/Perennial	0.18 acre (747 m^2)
Non-tidal/Intermittent	0.005 acre (22 m^2)
Total	0.19 acre (769 m^2)

All delineated wetlands are connected to, and part of, the larger freshwater ecosystems that occur well beyond the Larrabee Onshore Project Area. The delineated perennial rivers and streams are generally part of the Manasquan River drainage basin, including the Manasquan River itself, with minor waterbodies occurring closer to the coast draining directly to the Atlantic Ocean. None of these waterbodies within the Larrabee Onshore Project Area are tidal. Freshwater, non-tidal wetlands are associated with the Manasquan River, its tributaries and other streams or drainages within the Larrabee Onshore Project Area.

4.1.4 Wetlands and Waterbodies – O&M facility Onshore Project Area

The O&M facility Onshore Project Area has been located to avoid and minimize impacts to wetlands and waterbodies to the maximum extent practicable. Wetlands do not occur within the O&M facility Onshore Project Area due to the intensity of previous development and the bulkheaded/filled lands adjacent to the waters of Clam Creek and Delta Basin within the Atlantic City harbor area.

Clam Creek/Delta Basin is a lower tidal riverine system and the only waterbody that occurs within the O&M facility Onshore Project Area. There is approximately 0.81 acre of open water mapped by NJDEP within the O&M facility Onshore Project Area, all seaward of the existing bulkhead.

4.1.5 Potential Impacts and Proposed Environmental Protection Measures

The Cardiff and Larrabee Onshore Project Areas have been sited to maximize the use of existing linear infrastructure, such as roadway, electric utility, and pedestrian/bike lane ROWs. The landfall sites and onshore substations have also been intentionally located in largely disturbed or developed areas to avoid and minimize potential impacts to wetlands and waterbodies. In addition, trenchless construction techniques such as jack-and-bore and horizontal directional drilling (HDD) at all wetland and water crossings will be used to further avoid impacts to these resources. As a result, the only potential IPF on wetlands and waterbodies would be indirect and the result of land disturbance, soil erosion and sedimentation, or stormwater runoff during construction (Table 4.1-5). No direct or indirect impacts to wetlands are anticipated during routine O&M or decommissioning.

Table 4.1-5 Impact Producing Factors for Wetlands and Waters of the U.S.

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Land Disturbance	•		

Wetlands and waterbodies may also be inadvertently affected by discharges from accidental releases of fuel, fluids, and trash and debris. These potential impacts are considered to have a low likelihood of occurrence and are discussed in Sections 9.2.3 and 9.2.4.

The maximum Project Design Envelope (PDE) analyzed for potential impacts to wetlands and waterbodies is the maximum onshore build-out of the Project (see Section 4.11 of Volume I). Details describing the construction of the onshore Project components are presented in Sections 4.7, 4.8, and 4.9 of Volume I. Decommissioning is discussed in Section 6.2.6 of Volume I. Additionally, the Project will be supported by a new O&M facility that will be in Atlantic City which is described in Section 5.5 of Volume I.

4.1.6 Land Disturbance

Land disturbance associated with the construction of underground onshore Project components will involve trenching and excavation in upland and disturbed areas, thereby avoiding direct impact to wetlands and waterbodies. Trenching and excavation for cable conduit, duct banks, splice vaults, transition vaults, substation and/or converter station structure foundations and construction of the proposed the O&M facility will require earth-moving vehicles and equipment, which causes land disturbance; however, these facilities will be installed within existing ROWs (e.g., railroad, highway, pedestrian/bike lane ROWs), and developed areas that are largely disturbed and/or regularly maintained. Additional construction workspace for excavators and other construction equipment and excavated material will also be required. Specific cable design and installation details are provided in Section 4.8.3 of Volume I. Based on the wetland and stream delineation reports (see Appendix II-D1 and Appendix II-D2), Atlantic Shores has confirmed wetlands or waterbodies do not occur at the landfall locations, or the POIs. As discussed in Section 4.1.2, potential wetlands were identified on one of the substation/converter station site options; however, it was determined these areas are likely constructed stormwater basins and not federal or state jurisdictional wetlands. However, as noted in Section 4.1.1.1 and 4.1.1.2, the onshore interconnection cables for both Cardiff and Larrabee have the potential to cross several of these features. At these locations, the onshore interconnection cables will be installed using trenchless technology (e.g., jack-and-bore, pipe jacking, and HDD) beneath wetlands and waterbodies where crossing is necessary to avoid direct impacts to these resources. Entry/exit work areas will be in disturbed upland areas to further avoid impacts to wetlands and waterbodies. Wetlands and waterbodies also do not occur shoreward of the bulkhead at the proposed O&M facility and would not be impacted as a result of construction of the proposed O&M facility. Tables 4.1-6, 4.1-7, and 4.1-8 provide a summary of the potential temporary and permanent impacts resulting from construction of the Cardiff project, the Larrabee project, and the O&M facility, respectively, as well as impacts (permanent and temporary) avoided using trenchless installation technologies.

The temporary area of impact includes a 40-foot buffer zone on both sides of the centerline of the proposed onshore interconnection cable route. Actual project activities associated with the onshore interconnection cable route will occur solely within roadways and ROWs except at wetland and waterbody crossings where HDD will be utilized to avoid impacts.

The permanent impact calculations are derived from the assumption that the entirety of the Fire Road Parcel for Cardiff and the Lanes Pond Road and Randolph Road Parcels for Larrabee would be permanent impact areas.

Additionally, there is one area where limited permanent impacts could occur along the boundary of the O&M facility during the installation of the proposed new bulkhead.

Table 4.1-6 Wetlands and Waters of the United States Direct Impact Summary (Cardiff)

Wetland/Waterbody Type	Potential Project Impacts (acres/m^2)		Impacts Avoided Using Trenchless Installation (acres/m^2)
	Temporary	Permanent	
Estuarine Emergent	0 acre (0 m^2)	0 acre (0 m^2)	2.2 acres (8,911 m^2)
Palustrine Emergent	0.05 acre (193 m^2)	0.3 acres (1,298m^2)	0.2 acre (936 m^2)
Palustrine Forested	0.1 acres (431 m^2)	0.01 acre (60 m^2)	0 acre (0 m^2)
Tidal/Riverine	0 acre (0 m^2)	0 acre (0 m^2)	9.9 acres (39,892 m^2)
Non-tidal/Ephemeral	0.0002 acre (1 m^2)	0 acre (0 m^2)	0 acre (0 m^2)

Table 4.1-7 Wetlands and Waters of the United States Direct Impact Summary (Larrabee)

Wetland/Waterbody Type	Potential Project Impacts (acres/m^2)		Impacts Avoided Using Trenchless Installation (acres/m^2)
	Temporary	Permanent	
Palustrine Emergent	0.0008 acre (3 m^2)	0.2 acres (786 m^2)	0 acre (0 m^2)
Palustrine Forested	0.5 acres (2,008 m^2)	0.1 acre (371 m^2)	0.6 acre (2,263 m^2)
Palustrine Scrub Shrub	0 acre (0 m^2)	0 acre (0 m^2)	0.001 acre (4 m^2)
Non-tidal/Perennial	0.01 acre (52 m^2)	0 acre (0 m^2)	0.17 acre (694 m^2)
Non-tidal/Intermittent	0.002 acre (7 m^2)	0.0005 acre (0.2 m^2)	0 acre (0 m^2)

Table 4.1-8 Wetlands and Waters of the United States Direct Impact Summary (O&M Facility)

Wetland/Waterbody Type	Potential Project Impacts (acres/m^2)		Impacts Avoided Using Trenchless Installation (acres/m^2)
	Temporary	Permanent	
Estuarine Emergent	0 acre (0 m^2)	0.002 acre (8 m^2)	0 acre (0 m^2)
Tidal/Riverine	0 acre (0 m^2)	0.5 acre (2,069 m^2)	0 acre (0 m^2)

To prevent indirect impacts to wetlands and waterbodies, such as soil erosion and sedimentation from land disturbing construction activities, Atlantic Shores will comply with an approved Soil Erosion and Sediment Control Plan, New Jersey Pollutant Discharge Elimination System (NJPDES) permit and a Stormwater Pollution Prevention Plan (SWPPP). In accordance with these plans, best management practices (BMPs) including, but not limited to dust abatement, installation of silt fencing, filter socks, and inlet filters, will be implemented to minimize and/or avoid potential effects. Additionally, once construction is completed, areas of temporary disturbance will be returned to pre-construction conditions and at the onshore substations land will be appropriately graded, graveled, or grassed to prevent future erosion. Section 3.2 Water Quality provides additional detail on potential effects on water quality and the proposed BMPs to avoid or reduce impacts. An Environmental/Construction monitor will also be onsite to ensure that BMPs are installed in accordance with the approved Soil Erosion and Sediment Control Plan, NJPDES and other permit conditions.

During routine O&M and future decommissioning, land disturbing activities are not anticipated. Vehicle and equipment use would occur along roads using the manholes within the splice vaults and transition vaults for access and within previously developed areas such as onshore substations. As a result, impacts to wetlands and/or waterbodies are not anticipated during these phases of the Project.

4.1.7 Summary of Proposed Environmental Protection Measures

Atlantic Shores has routed the onshore interconnection cables along previously disturbed ROWs and sited its onshore substations and landfall sites on previously disturbed lands, to the maximum extent practicable, to avoid and/or minimize impacts to wetlands and waterbodies. Potential impacts have further been avoided by using trenchless installation methods such as jack-and-bore, pipe jacking, and HDD to install the onshore interconnection cables where wetlands and waterbodies are crossed.

Potential Project-related effects to wetlands and waterbodies mainly result from land disturbance during construction. To avoid and minimize these effects, Atlantic Shores has sited Project facilities to avoid and minimize impacts to wetlands and waterbodies and has incorporated mitigation measures into design elements, construction, O&M, and decommissioning plans.

The following environmental protection measures are proposed to mitigate potential Project-related impacts to wetlands and waterbodies. As the Project progresses through development and permitting, Atlantic Shores will continue discussions with resource agencies such as USACE and NJDEP to determine the need for appropriate avoidance/mitigation measures and will comply with applicable permit conditions.

- Project facilities have been sited/routed in previously disturbed areas and along existing ROWs.
- Onshore interconnection cables will be installed underground and using trenchless installation such as jack-and-bore, pipe jacking, and/or HDD, where feasible, to avoid direct impacts to wetlands and waterbodies.
- BMPs such as silt fence, filter socks, inlet protection, dust abatement and other approved BMPs will be implemented in accordance with the approved Soil Erosion and Sediment Control Plan to properly contain excavated soils and sediments and stabilize disturbed land areas, to avoid erosion and sediment runoff into wetlands and waterbodies. Additionally, the Project will be constructed according to an approved New Jersey Division of Land Resource Protection Stormwater Management Control Plan (NJPDES and SWPPP) to avoid and minimize Project-related effects to nearby aquatic habitats.
- All temporarily disturbed areas will be returned to pre-construction conditions and all onshore substation areas will be graded, grassed, graveled, or paved to prevent future erosion.
- Environmental/Construction Monitor(s) to comply with applicable plans and permit conditions, and to ensure that BMPs are functional.

4.2 Coastal and Terrestrial Habitat and Fauna

This section describes the coastal and terrestrial habitat and fauna in the Onshore Project Area (including threatened and endangered species), associated impact producing factors (IPFs), and measures to avoid, minimize, or mitigate potential effects to these resources during construction, operations and maintenance (O&M), and decommissioning. Terrestrial birds and bats are described in Sections 4.3 and 4.4 and therefore, are not addressed in this section.

4.2.1 Affected Environment

The affected environment for the purposes of this section is made up of the Atlantic and Monmouth Landfall Sites, onshore interconnection cable route options, onshore substations and/or converter stations,[10] proposed O&M facility and associated potential adjacent parking structure, and POI (see Figures 4.8-1, 4.8-2, 4.9-1, 4.9-2 of Volume 1). In this section, the three locations for onshore Project facilities will be referred to as the Cardiff, Larrabee, and O&M facility Onshore Project Areas, respectively, and collectively as, the Onshore Project Area. The Onshore Project Area occurs along the coastal area of New Jersey, which generally includes tidal and non-tidal waters (including wetlands), dune and beach areas, forest areas and significant residential, commercial, industrial, and linear development. This coastal area is managed by the NJDEP as the New Jersey Coastal Management Zone (coastal zone) under New Jersey Administrative Code (N.J.A.C.) 7:7 and encompasses approximately 1,800 miles (mi) (2,897 kilometers [km]) of tidal shoreline including 126 mi (203 km) of oceanfront from Sandy Hook to Cape May. The boundaries of the coastal zone include inland, seaward, and interstate areas (NJDEP 2020).

Outside of the coastal zone, portions of the Cardiff Onshore Project Area overlap with mapped New Jersey Pinelands (Figure 4.2-1). The Pinelands ecosystem is an expansive area in southern New Jersey characterized by unconsolidated sand and gravel with a shallow, but characteristically acidic and nutrient poor aquifer and specialized plant and animal species adapted to challenging conditions, particularly wildland fire. Many plant and animal species known to occur in the Pinelands require occasional wildfires to maintain habitat conditions and provide opportunities for reproduction. The Pinelands area is protected under the Pinelands Protection Act (N.J.S.A. 13:18-1 et. seq.), managed by the Pinelands Commission and is defined by three separate zones: protected areas, managed use areas, and zones of cooperation. The Cardiff Onshore Project Area

[10] Potential parcels for an HVAC onshore substation and/or HVDC converter station have been identified along the Larrabee Onshore Interconnection Cable Route. The feasibility of these sites is currently being evaluated and additional information will be provided when site options are added to the PDE.

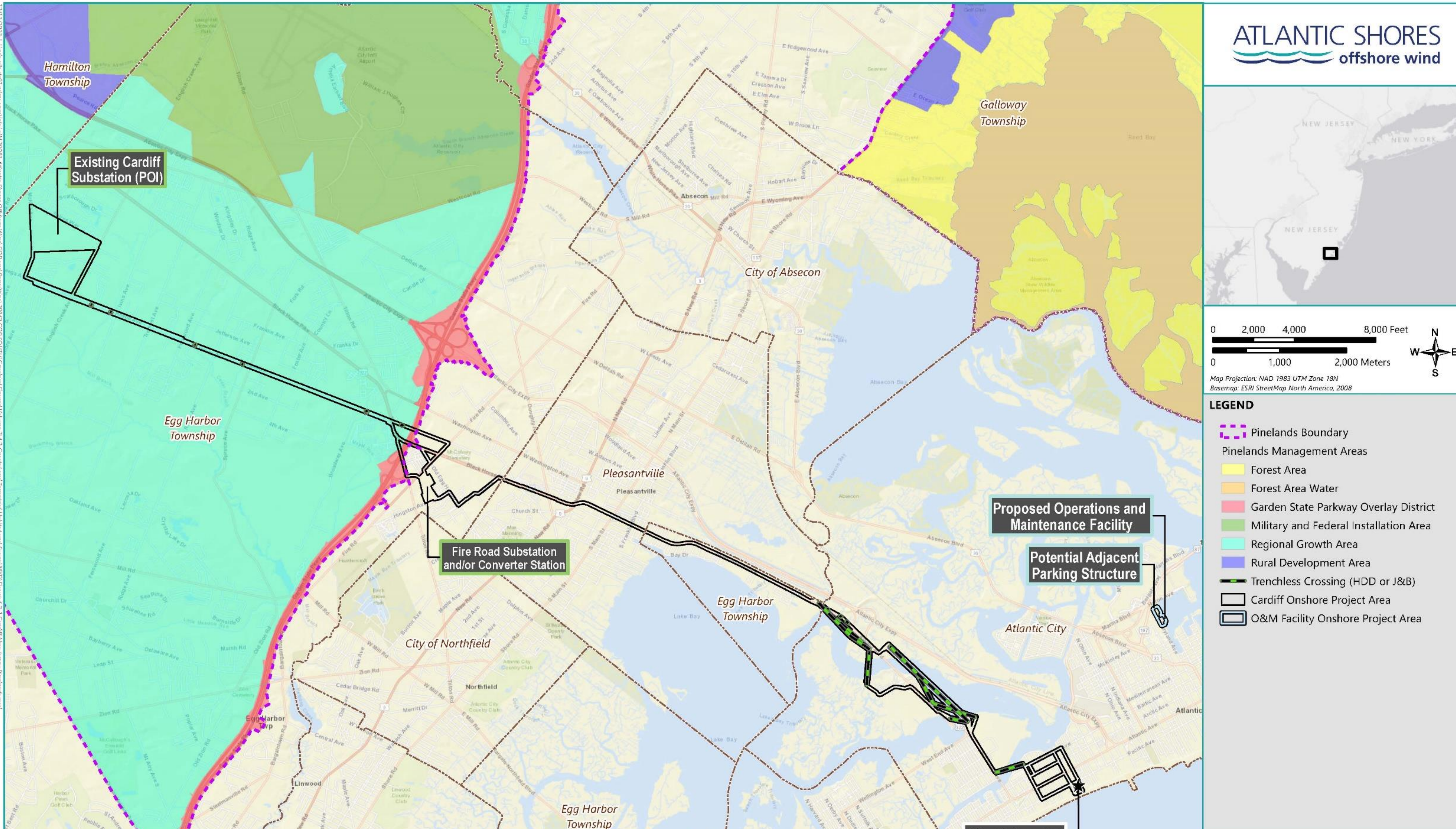


Figure 4.2-1

New Jersey Pinelands

overlaps with the Pinelands Area of Egg Harbor Township that is designated as a “Regional Growth Area” (a managed use area). The Cardiff Onshore Project Area entirely avoids the Pinelands designated “protected areas” (State of New Jersey 2021a, b; Pinelands Preservation Alliance 2021). No portions of the Larrabee or O&M facility Onshore Project Areas are within the Pinelands area.

Through targeted field surveys and consultations with Federal and State environmental agencies, Atlantic Shores has developed an in-depth understanding of the wildlife and habitats that occur in the vicinity of the Onshore Project Area and is taking reasonable and prudent measures to avoid, minimize, and mitigate potential effects to terrestrial wildlife and habitat communities. The following types of data sources were used to describe the Onshore Project Areas:

- Public data sources including information related to coastal and terrestrial habitats in Sea Girt Borough, Wall Township, Howell Township, Atlantic City, Pleasantville Township, Manasquan Borough, and Egg Harbor Township;
- Published documents from Federal and State agencies including United States Fish and Wildlife Service (USFWS), New Jersey Coastal Management Program, and New Jersey Department of Environmental Protection (NJDEP); and
- USFWS and NJDEP Natural Heritage Program (NHP) threatened and endangered species consultations.

In addition, Atlantic Shores surveyed the terrestrial ecological resources at the export cable landfall sites, onshore interconnection cable routes, onshore substations and/or converter stations, proposed O&M facility, and POI locations. Field evaluations for wetlands and waterbodies and terrestrial habitat for the O&M facility Onshore Project Area were completed from publicly accessible areas such as adjacent roadways and sidewalks due to access restrictions. The studies completed for the Onshore Project Area and immediately adjacent areas include:

- Wetland and stream delineations
- Vernal pool surveys
- Terrestrial wildlife habitat assessments (including threatened and endangered species/critical habitat assessments).

The purpose of these studies was to identify and evaluate sensitive ecological resources including the identification of habitat that could support threatened and endangered species (i.e., critical habitat assessments). The field evaluations for the O&M facility Onshore Project Area approximated the location and extent of wetlands and waterbodies and terrestrial wildlife habitats. The results of these collective surveys are provided in the Habitat Suitability Assessment Reports in Appendix II-E1 and Appendix II-E2 and the Wetland and Stream Delineation Reports in Appendix II-D1 and Appendix II-D2. The results of the field evaluations for the O&M facility Onshore Project Area are presented in the Cardiff Habitat Suitability Assessment Report (Appendix II-E1) and the Cardiff Wetland and Stream Delineation Report (Appendix II-D1).

The onshore Project facilities and their proposed locations within the Cardiff, Larrabee, and O&M facility Onshore Project Areas are detailed in Sections 4.7, 4.8, 4.9, and 5.5 of Volume I. The observed habitat types for the Cardiff, Larrabee, and the O&M facility Onshore Project Areas are detailed in Sections 4.2.1.1, 4.2.1.2, and 4.2.1.3, respectively. A detailed description of each of those typical and observed habitat types is provided in the Habitat Suitability Assessment Reports in Appendix II-E1 and Appendix II-E2.

4.2.1.1 Coastal Terrestrial Habitat and Fauna – Cardiff Onshore Project Area

Atlantic Shores has sited the Cardiff Onshore Project Area to avoid or minimize impacts to wildlife habitat to the maximum extent practicable by locating Project activities in urbanized and previously developed areas. Based on field survey data, the Cardiff Onshore Project Area is comprised of approximately 71.5% developed or disturbed areas (including the developed Bader Airfield). The remaining documented habitat within the Cardiff Onshore Project Area consists of mixed forest, scrub-shrub wetlands, evergreen scrub/shrub, deciduous scrub/shrub, forested wetlands, water, herbaceous fields, and herbaceous tidal and non-tidal wetlands. Apart from tidal herbaceous wetlands along the tidal waterways of Great Thorofare and Beach Thorofare, mixed upland forest at the Cardiff POI and substation/interconnection substation site options, all of these habitat types occur along the edge of the already developed and disturbed Cardiff Onshore Project Area, and were determined to be marginal, edge habitat.

To further avoid potential impacts, the onshore interconnection cable will be installed using trenchless installation techniques (e.g., jack-and-bore, pipe jackings or horizontal directional drilling [HDD]) at all wetland/water crossings (e.g., tidal emergent wetlands, non-tidal wetlands, and surface waters) to avoid impacts to these habitats. Trenching will be used to install the onshore interconnection cable within previously disturbed and developed upland areas such as along existing road, railroad, utility line, and pedestrian/bike lane rights-of-way (ROWs).

Many of the habitat-types that are typical of the area exist within the Cardiff Onshore Project Area. Surveys were conducted to identify and document wildlife habitat and the suitability to support wildlife species including Federal and State-listed threatened and endangered species. The Habitat Suitability Assessment report in Appendix II-E1 provides details on the types of habitats present within the Cardiff Onshore Project Area. Table 4.2-1 summarizes the acreage of each habitat type observed within the Cardiff Onshore Project Area according to the Atlantic Shores Habitat Assessment Survey. These habitat types and locations are shown on the Habitat Assessment Mapping in Appendix D of the Habitat Suitability Assessment Report in Appendix II-E1.

Table 4.2-1 Estimated Area and Percent Cover of Habitat Types within the Cardiff Onshore Project Area

Habitat Type	Acres	Percentage
Developed / Disturbed	103.5 acres (418,707 m^2)	71.5%
Forest - Mixed	22.1 acres (89,362 m^2)	15.2%
Water	11.0 acres (44,679 m^2)	7.6%
Herbaceous Field	3.9 acres (15,612 m^2)	2.7%
Herbaceous Wetland	3.0 acres (12,342 m^2)	2.1%
Scrub - Deciduous	0.8 acres (3,358 m^2)	0.6%
Scrub-Shrub	0.4 acre (1,642 m^2)	0.3%
Shrub – Evergreen	0.06 acre (246 m^2)	0.04%
Forested Wetlands	0.04 acre (142 m^2)	0.02%

As discussed in the Habitat Suitability Assessment Report (see Appendix II-E1), there are Federal and State records for threatened and endangered species and/or their habitat within the Cardiff Onshore Project Area. However, the habitat observed within the Cardiff Onshore Project Area is not critical nor suitable habitat for any Federal and State listed threatened and endangered species and is considered only marginally suitable for other common wildlife species. These habitats are considered marginal because they are within or adjacent to the edge of existing linear development (e.g., highways, railroads, utility transmission lines, and pedestrian/bike lanes) and other commercial, residential, and industrial development. All of these habitats have been disturbed from previous development and are subject to ongoing disturbance from high traffic roads, railroads, and pedestrian/bike lanes.

The only wildlife species observed within the Cardiff Onshore Project Area were transient individuals flying overhead and included species such as: herring gull (*Larus argentatus*), laughing gull (*Leucophaeus atricilla*), house sparrow (*Passer domesticus*), mourning dove (*Zenaida macroura*) and other common avian species adapted to developed/disturbed habitat types. No reptile, amphibian or mammal species were observed. Additionally, no Federal and State-listed threatened and endangered species were observed within the Onshore Project Area during field studies. One area within the Cardiff Study Area may satisfy the criteria to be classified as a vernal pool according to N.J.A.C. 7:7A 1.3. However, during field investigations, it was noted that the area is an excavation likely for the purpose of stormwater management and may not dry out during a normal rainfall season. The excavation was lined with a thick clay layer surrounding by significant soil disturbance. Further investigation will be conducted to confirm that this area is for stormwater management and is not a vernal pool. (Appendix II-E1).

The Atlantic Landfall Site is comprised of a vacant parking lot and California Avenue, as such there were no wildlife habitats or species observed at the potential landfall during field studies. The dune and beach habitat directly adjacent to the Atlantic Landfall Site and immediately east of the Atlantic City boardwalk will be entirely avoided because the export cable makes landfall via HDD from an offshore location beyond the toe-of-slope of the beach.

The Cardiff onshore substation and/or converter station site is located in Egg Harbor Township on a vacant lot. The Fire Road Site contains an isolated forest entirely surrounded by roadways and development. While this forest is potentially suitable for foraging by a number of species, it is not anticipated to be considered critical habitat for any listed species. There are no federal or state listed endangered or threatened species documented as occurring onsite. For the Cardiff Substation, the contiguous forest to the north, west and east is documented barred owl (*Strix varia*) habitat, a State threatened species and northern long-eared bat, a federal threatened species; however, tree clearing will be limited to the fragmented wooded areas proximate to the substation (see Section 4.3 Birds and Section 4.4 Bats).

4.2.1.2 Coastal Terrestrial Habitat and Fauna – Larrabee Onshore Project Area

Atlantic Shores has also located the Larrabee Onshore Project Area to avoid or minimize impacts to wildlife habitat to the maximum extent practicable by locating Project activities in urbanized and previously developed areas. Based on field survey data, the Larrabee Onshore Project Area is comprised of approximately 81.3% developed or disturbed areas. The remaining habitat that occurs within the Onshore Project Area consists of edges of mixed forest, deciduous forest, evergreen forest, water, herbaceous fields, agricultural pastures, forested wetlands, evergreen scrub-shrub, scrub-shrub wetlands, and herbaceous non-tidal wetlands. Apart from wetlands and stream crossings, all habitat types occur along the edge of the already developed and disturbed Larrabee Onshore Project Area and were determined to be marginal edge habitat.

Many of the habitat types that are typical for the area exist within the Larrabee Onshore Project Area. Surveys were conducted to identify and document wildlife habitat and the suitability to support wildlife species including Federal and State listed threatened and endangered species. The Habitat Suitability Assessment report in Appendix II-E2 provides details on the types of habitats present within the Larrabee Onshore Project Area, and the suitability of this habitat to support wildlife, particularly Federal and State-listed threatened and endangered species. Table 4.2-2 summarizes the acreage of each habitat type observed within the Larrabee Onshore Project Area according to the Atlantic Shores Habitat Assessment Survey. These habitat types and locations are shown on the Habitat Assessment Mapping in Appendix D of the Habitat Suitability Assessment Report in Appendix II-E2.

The only wildlife species observed within the Larrabee Onshore Project Area were transient birds flying overhead, including herring gull, laughing gull (near the Monmouth Landfall site), house sparrow, mourning dove, northern cardinal (*Cardinalis cardinalis*), northern mockingbird (*Mimus polyglottos*), gray catbird (*Dumetella carolinensis*), and other common avian species adapted to developed/disturbed habitats. No reptile, amphibian or mammal species were observed. No

Federal and State-listed threatened and endangered species were observed within the Larrabee Onshore Project Area during field studies.

Table 4.2-2 Estimated Area and Percent Cover of Habitats within the Larrabee Onshore Project Area

Habitat Type	Acres	Percentage
Developed / Disturbed	124.5 acres (503,991 m^2)	81.3%
Forest – Mixed	11.2 acres (45,359 m^2)	7.3%
Agricultural	9.5 acres (38,431 m^2)	6.2%
Forest – Deciduous	3.12 acres (12,725 m^2)	2.1%
Herbaceous Field	3.1 acres (12,637 m^2)	2.0%
Forested Wetland	1.1 acres (4,643 m^2)	0.7%
Forest – Evergreen	0.2 acre (843 m^2)	0.1%
Herbaceous Wetland	0.2 acre (789 m^2)	0.1%
Water	0.2 acre (769 m^2)	0.1%
Shrub – Evergreen	0.003 acre (12 m^2)	0.002%
Scrub-Shrub Wetland	0.001 (4 m^2)	0.0007%

As discussed in the Habitat Suitability Assessment Report (see Appendix II-E2), there are Federal and State records for threatened and endangered species and/or their habitat within the Larrabee Onshore Project Area. However, the habitat observed within the Larrabee Onshore Project Area is not critical nor suitable habitat for these listed species and is only considered marginally suitable for other common wildlife species. These habitats are considered marginal because they are within or adjacent to the edges of existing linear development (e.g., highways, roadways, and pedestrian/bike lanes) and other commercial, residential, and industrial development. These habitats have largely been disturbed from previous development and are subject to ongoing disturbance from high-traffic use highways/roads and pedestrian/bike lanes. Additionally, no vernal pool habitat was observed within the Larrabee Onshore Project Area.

Atlantic Shores has routed the onshore interconnection cable route options to generally avoid Allaire State Park and the Manasquan River Wildlife Management Area, which has documented occurrences of State-listed threatened and endangered species (see Appendix II-E2 - Habitat Suitability Assessment Report). The onshore interconnection cable route avoids this area by following Hospital Road, Easy Street, Lakewood Allenwood Road, and Country Route 547 ROWs. To further avoid impacts to potentially sensitive habitats, the onshore interconnection cable will be installed using trenchless technology such as jack-and-bore, jack piping HDD at all wetland/water crossings (e.g., non-tidal wetlands and surface waters) and other areas of sensitive habitat. Other than the use of trenchless installation techniques at wetland and water crossings and other sensitive habitats, construction of the onshore interconnection cable route will occur within previously disturbed and developed linear corridors such as road and pedestrian/bike lane ROWs (e.g., County Route 547).

The Monmouth Landfall site is located at the Army National Guard training facility within a maintained grass lawn and gravel parking area. There are no wildlife habitats, and no wildlife species were observed during field studies at this location. The dune and beach habitat located approximately 200 feet (ft) (60 meters [m]) east of the Larrabee Onshore Project Area will be entirely avoided because the export cable will make landfall via HDD from an offshore location beyond the toe-of-slope of the beach to the Monmouth Landfall Site. This habitat has been identified as potentially suitable for the Federally listed threatened piping plover (*Charadrius melodus*) and threatened seabeach amaranth (*Amaranthus pumilus*).

4.2.1.3 Coastal Terrestrial Habitat and Fauna – O&M facility Onshore Project Area

Atlantic Shores has also located the O&M facility Onshore Project Area to avoid or minimize impacts to wildlife habitat to the maximum extent practicable by locating the facilities in an urbanized and previously developed area. Based on field survey data, the O&M Onshore Project Area is comprised of approximately 80% developed or disturbed areas (2.1 acres) with the remaining area consisting of the waters (0.5 acre) and adjacent herbaceous wetlands (0.002 acre) of Clam Creek (Atlantic City Harbor).

The Habitat Suitability Assessment report in Appendix II-E1 provides details on the two habitat types present within the O&M facility Onshore Project Area and the suitability of this habitat to support wildlife. There are no documented occurrences of State or Federal listed threatened and endangered species within the O&M facility Onshore Project Area. These habitat types and locations are shown on the Habitat Assessment Mapping in Appendix D of the Habitat Suitability Assessment Report in Appendix II-E1.

While evaluating the site from publicly accessible areas, no wildlife species were observed directly within the O&M facility Onshore Project Area; however, species expected to be observed include common species adapted for developed/disturbed sites in urban environments such gulls (*Larus* spp.), rock doves (*Columba livia*), house sparrow, mourning dove, striped skunk (*Mephitis mephitis*), and raccoon (*Procyon lotor*).

4.2.2 Potential Impacts and Proposed Environmental Protection Measures

The Cardiff and Larrabee Onshore Project Areas have been co-located with existing linear infrastructure such as railroads, roadways, utility lines, and pedestrian/bike lane ROWs. The landfall sites, onshore substations and/or converter stations, and proposed O&M facility have also been intentionally located in disturbed or developed areas, to the maximum extent practicable, to avoid and minimize potential impacts to wildlife and their habitat. Most impacts will be avoided, and the remaining potential IPF that may affect coastal and terrestrial habitat and fauna during Project construction, O&M, or decommissioning are presented in Table 4.2-3. This section also provides an evaluation of potential effects during each Project phase for a given IPF and the anticipated environmental protection measures to be implemented to avoid potential effects.

Table 4.2-3 Impact Producing Factors for Coastal and Terrestrial Habitat and Fauna

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Land Disturbance	●		
Noise and Vibration	●	●	●
Presence of Structures and Cables		●	●
Traffic (Vehicles and Equipment)	●	●	●
Light	●	●	●

Coastal and terrestrial habitat and fauna may also be affected by discharges from onshore point and non-point sources and accidental releases, including fuel, fluids, hazardous materials, and trash/debris. These potential impacts are considered to have a low likelihood of occurrence and are discussed in Sections 9.2.3 and 9.2.4.

The maximum Project Design Envelope (PDE) analyzed for potential impacts to coastal and terrestrial habitat and fauna is the maximum onshore build-out of the Project (see Section 4.11 of Volume I). The construction of each onshore Project component is described in Sections 4.7, 4.8, and 4.9 of Volume I. Also included in Volume I are details of the anticipated routine O&M activities for the onshore facilities (see Section 5.4.5) and decommissioning (See Section 6.2.6). Additionally, the Project will be supported by a new O&M facility that will be located in Atlantic City (see Section 5.5 of Volume I).

4.2.2.1 Land Disturbance

As detailed in Section 4.2.1, construction of the Project's onshore facilities would occur predominantly within existing roadways, railroads, and other established ROWs and disturbed areas to the maximum extent practicable. Due to current human activity, the Onshore Project Area provides only marginal habitat for common wildlife. As such, any impacts to wildlife and their habitat from Project land disturbing activities (e.g., trenching/excavating, grading) are expected to be temporary and localized to the designated construction work areas.

The specific land disturbances associated with the installation of underground onshore interconnection cable duct banks and splice vaults will include direct trenching and excavation in uplands and disturbed areas of these established ROWs at a width sufficient to accommodate these components plus construction work areas. In locations where the onshore interconnection cables cross surface waters, wetlands or other sensitive habitats, trenchless installation of the onshore interconnection cables will be used such as jack-and-bore, jack piping, and HDD. Work areas for these installation types will be located in adjacent disturbed upland areas to entirely avoid impacts to wildlife habitats. Tree trimming/clearing may be necessary along portions of the onshore interconnection cable routes and/or substation/converter station site options but will be the minimum necessary to install the interconnection cable and/or substation converter station, will not include mature trees, and will be conducted during the winter months to avoid impacts to avian and bat species to the maximum extent practicable (see Section 4.3 Birds and Section 4.4 Bats).

Impacts to wildlife and their habitats are expected to be avoided entirely at the Atlantic and Monmouth Landfall Sites. The proposed cable transition vaults will be located in upland locations that are already developed and/or disturbed. Sensitive beach and dune habitats located east of the transition vaults will also be avoided by landing the export cable with HDD installation methods from the landfall site to a point in the ocean beyond the toe-of-slope of the beach.

Limited effects to wildlife habitat in and around the Cardiff and Larrabee POI locations are anticipated because these facilities are sited within previously disturbed areas. Existing forested habitat around the Larrabee POI does not support any Federal and State threatened or endangered species because of the surrounding land uses and fragmented forest characteristic of this area. The contiguous forest to the north, west and east of the Cardiff POI is documented barred owl habitat, a State threatened species and northern long eared bat, a federal threatened species. For these locations, limited tree clearing may occur, which could have a short-term effect on local wildlife, particularly bird and bat species (see Section 4.3 Birds and 4.4 Bats, respectively); however, any tree clearing would be limited to non-mature trees in fragmented wooded areas, the minimum necessary, and will only be conducted during the winter months for the substations and/or converter stations to be constructed. Limited, if any, effects to wildlife at the substation and/or converter station site options and proposed O&M facility are also expected because these facilities are sited within previously disturbed and developed areas or highly isolated/fragmented habitats to the maximum extent practicable. Moreover, the surrounding land uses at these locations are industrial/commercial with limited natural wildlife habitat proximate to the sites.

There are no wetlands or waterbodies located at the landfall site. Potential wetlands were observed on one of the onshore substation and/or converter station site options; however, as previously described, these areas are excavated areas for the purposes of stormwater management and are not anticipated to be state or federal jurisdictional wetlands or a vernal pool (see Section 4.1 Wetlands and Waterbodies and Appendix II-D1 and Appendix II-D2). Along the onshore interconnection cable routes, Atlantic Shores will avoid wetland and waterbody habitats by installing the cables using trenchless technology such as jack-and-bore, jack piping or HDD. To prevent indirect impacts to sensitive habitats, such as soil erosion and sedimentation from land disturbing construction activities, Atlantic Shores will comply with an approved Soil Erosion and Sediment Control Plan, New Jersey Pollutant Discharge Elimination System (NJPDES) permit and a Stormwater Pollution Prevention Plan (SWPPP). Best management practices (BMP) that would be implemented include dust abatement, installation of silt fencing, filter socks, inlet filters, and other approved BMPs. Section 3.2 Water Quality provides additional detail on potential effects on water quality and the proposed BMPs to avoid or reduce impacts. An Environmental/Construction monitor will also be onsite to ensure that BMPs are installed in accordance with the approved Soil Erosion and Sediment Control Plan, NJPDES and other permit conditions. All temporarily disturbed areas will be restored to preconstruction conditions as required and where necessary such as seeding or repaving. Tables 4.2-4, 4.2-5, and 4.2-6 provide a summary of the potential temporary and permanent impacts resulting from construction of the Cardiff Onshore Interconnection Cable Route, Larrabee Onshore Interconnection Cable Route, and the O&M facility, respectively, as well as impacts (permanent and temporary) avoided using trenchless technologies.

Land disturbing activities are not anticipated as part of routine O&M or decommissioning. Vehicle and equipment use would occur along roads using the manholes within the splice vaults and transition vaults for access and within previously developed areas such as onshore substations and/or converter stations.

Table 4.2-4 Habitat Direct Impact Summary (Cardiff)

Habitat Type	Potential Project Impacts (acres/m^2)		Impacts Avoided Using Trenchless Installation (acres/m2)
	Temporary	Permanent	
Developed/Disturbed	57.1 acres (230,915 m^2)	41.7 acres (168,631m^2)	4.8 acres (19,226 m^2)
Forest-Mixed	3.6 acres (14,667 m^2)	18.5acres (74,696 m^2)	0 acres (0 m^2)
Water	0.0002 acres (1 m^2)	0 acres (0 m^2)	11.0 acres (44,694 m^2)
Herbaceous Field	2.8 acres (11,189 m^2)	1.1 acres (4,434 m^2)	0 acres (0 m^2)
Herbaceous Wetland	0.05 acre (193 m^2)	0.01 acre (47 m^2)	3.0 acres (12,102 m^2)
Shrub-Deciduous	0.5 acre (2,220 m^2)	0.3 acre (1,139 m^2)	0 acre (0 m^2)
Scrub/Shrub	0.06 acre (240 m^2)	0.02 acre (98 m^2)	0.3 acre (1,304 m^2)
Shrub-Evergreen	0.03 acre (137 m^2)	0.02 acre (81 m^2)	0.007 acre (29 m^2)
Forested Wetlands	0.04 acre (143 m^2)	0 acre (0 m^2)	0 acre (0 m^2)

Table 4.2-5 Habitat Direct Impact Summary (Larrabee)

Habitat Type	Potential Project Impacts (acres/m^2)		Impacts Avoided Using Trenchless Installation (acres/m2)
	Temporary	Permanent	
Agricultural	0.01 acre (42 m^2)	9.5 acres (38,390 m^2)	0 acre (0 m^2)
Developed/Disturbed	59.0 acres (238,777 m^2)	63.4 acres (256,670 m^2)	0.4 acre (1,474 m^2)
Water	0.02 acre (75 m^2)	0.00005 acre (0.2 m^2)	0 acre (0 m^2)
Herbaceous Field	0.4 acre (1,611 m^2)	2.7 acres (11,026 m^2)	0 acre (0 m^2)
Herbaceous Wetland	0.0008 acre (3 m^2)	0.2 acre (786 m^2)	2.1 acres (8,581 m^2)
Shrub/Shrub Wetland	0 acre (0 m^2)	0 acre (0 m^2)	0.001 acre (04m^2)
Shrub-Evergreen	0.003 acre (12 m^2)	0 acre (0 m^2)	0 acre (0 m^2)
Forested Wetlands	0.5 acre (2,008 m^2)	0.09 acre (371 m^2)	0.2 acre (694 m^2)
Forest-Deciduous	0.4 acre (1,773 m^2)	2.3 acre (9,489 m^2)	0.6 acre (2,263 m^2)
Forest-Evergreen	0.1 acre (519 m^2)	0.08 acre (324 m^2)	0 acre (0 m^2)
Forest-Mixed	1.9 acres (7,846 m^2)	6.3 acre (25,564 m^2)	3.0 acres (11,990 m^2)

Table 4.2-6 Habitat Direct Impact Summary (O&M Facility)

Habitat Type	Potential Project Impacts (acres/m^2)		Impacts Avoided Using Trenchless Installation (acres/m2)
	Temporary	Permanent	
Developed/Disturbed	0 acre (0 m^2)	2.1 acres (8,394 m^2)	0 acre (0 m^2)
Herbaceous Wetland	0 acre (0 m^2)	0.002 acre (8 m^2)	0 acre (0 m^2)
Water	0 acre (0 m^2)	0.5 acre (2,069 m^2)	0 acre (0 m^2)

4.2.2.2 Noise and Vibration

Project-related noise and vibrations generated from onshore Project construction activities are discussed in detail in Section 8.1 In-Air Noise and the Onshore Noise Report in Appendix II-U. The

Onshore Project Area is situated within or adjacent to busy roadways or in industrial/commercial development where significant background noise and vibration regularly occurs. Area wildlife populations are expected to be habituated to the background noise and vibration levels and will either be unaffected by the additional noise and vibration during construction activities or will temporarily relocate away from the area. As a result, impacts are expected to be localized and short-term. Construction equipment will generate noise and vibrations at levels that could temporarily displace common wildlife species inhabiting areas near construction activities during the time of equipment usage. The localized and short-term impacts are not expected to result in population level impacts. To address the intermittent increases in noise levels during construction, Atlantic Shores will make reasonable efforts to minimize noise impacts from construction such as adhering to permitted hours of construction in each municipality and using lower decibel producing equipment (e.g., smaller backhoes) when feasible.

Anticipated O&M activities such as inspections of facilities, repair of substation and/or converter station equipment, and other routine O&M activities may generate noises and vibrations that could disturb nearby wildlife. However, the duration and severity of the disturbance would depend on the nature, and level of noise produced by the O&M activity and proximity of wildlife. Maintenance and other required repair activities to either cables or substations and/or converter stations may generate noise that could cause localized wildlife to be temporarily displaced but is consistent with the existing uses and activities within the Onshore Project Area and are not considered an impact.

When in operation, substation and/or converter station transformers and cooling fans would be the loudest equipment in use and generate relatively low-level, continuous noise. However, the Atlantic Shores Onshore Noise Report (see Appendix II-U) indicates that the Cardiff substation and converter stations are sited within commercial/industrial areas with existing industrial sound sources and relatively high ambient noise levels. The Larrabee substation and/or converter station site is anticipated to be sited within commercial/industrial areas that have relatively high ambient noise levels. Noise generated from substation and/or converter station equipment is not expected to significantly increase the background noise in the area to a level that would impact local wildlife and will be mitigated by the incorporation of noise-reducing design features such as strategically placed noise barriers on equipment and other features required to comply with local noise ordinances.

Decommissioning activities are not expected to result in any noise impacts to wildlife. The onshore Project facilities are expected to remain in place or repurposed for other uses. Occasional vehicle uses along the existing roadways or within the fenced area of the substation and/or converter station may cause additional noise and vibration but is expected to be of the magnitude and duration consistent with routine O&M activities and not have any impact to local wildlife. Any incidental impacts to wildlife species would be localized and short-term and not be materially different from existing conditions.

4.2.2.3 Presence of Structures and Cables

All substation and/or converter station locations are proposed in areas that are already disturbed to the maximum extent practicable. Any interactions between installed electrical components (such as cable and substation and/or converter station structures) and wildlife during routine O&M and decommissioning are expected to be incidental and infrequent with limited, if any, effect on wildlife, including threatened and endangered species. The cables, splice vaults, and transition vaults will be underground within existing road and other linear development ROWs and will not impact wildlife or their habitat.

4.2.2.4 Vehicle Traffic

Impacts to wildlife and their habitat from Project-related vehicle traffic are not anticipated in the portions of the Onshore Project Area that are within developed areas and currently experience regular traffic. Vehicle traffic associated with the construction and operation of onshore facilities will represent incremental increases in traffic volume mainly during construction and will be concentrated along the onshore interconnection cable routes and at the substations and/or converter stations and proposed O&M facility. The anticipated Project-related vehicle traffic over the phases of the Project is discussed in Section 7.9 Onshore Transportation and Traffic. There would not be any increase in vehicle traffic volume during routine O&M as the area roadways have high levels of traffic concentrated near ports, substations/converter stations, and the proposed O&M facility. Wildlife will not be exposed to greater risk of disturbance or injury from Project-related vehicle traffic because most Project-related vehicle traffic will travel along existing roadways, accesses, and ROWs, which already experience a substantial daily traffic volume.

Risks of impacts to wildlife from Project-related vehicle traffic may increase along the portions of the Onshore Project Area that occur within areas that do not currently experience consistent vehicular traffic (e.g., electric utility and pedestrian/bike lanes ROWs). During construction, mechanized equipment traffic could disturb or displace local wildlife, but these impacts would be similar to those caused by human presence, land disturbance, and noise/vibration that already occur. Any vehicle-related impacts on wildlife are expected to be localized and limited to the duration of construction. Limited mobility species, such as snakes and turtles, have a low probability of directly encountering vehicles because of the limited populations of these types of species proximate to the current high traffic use areas within the Onshore Project Area. Use of standard erosion and sedimentation control BMPs such as silt fences along the limits of construction would prevent these species from entering the construction work areas. Additionally, vehicle-related impacts on wildlife during routine O&M and decommissioning activities would be accidental and rare. All other species are expected to temporarily avoid areas of higher vehicle traffic but return once activities have ceased. Any impacts are expected to be highly localized, short term and not result in any population level impacts.

4.2.2.5 Light

During construction, it may be necessary to illuminate portions of the Onshore Project Area in order to maintain safety standards for workers and the surrounding communities. However, nighttime work is expected to be limited for a variety of reasons, including adherence to local zoning ordinances, building permit conditions, and community agreements. Many of the areas along the Onshore Project Area are already illuminated by artificial light due to dense development in the area (i.e., existing substations/converter stations, commercial/industrial areas, or roadways within or adjacent to the Onshore Project Area). Impacts to wildlife foraging, nesting, and/or navigation behavior from Project construction lighting during low light hours could occur if nighttime construction is conducted. Any such impacts would be incidental, localized, and short term and the presence of construction workers, equipment, and overall traffic of roadways would likely deter most wildlife species that may be attracted to the light.

The onshore substation and converter stations will require security lighting on buildings during O&M. The lighting will be the minimum necessary to comply with security/safety guidelines and local laws and ordinances. Use of ground-directed lighting will be used so areas adjacent to the onshore substation and/or converter stations, and the proposed O&M facility are not illuminated. No other portions of the Onshore Project Area will have permanent lighting. As a result, there are no impacts anticipated to wildlife species or their habitats.

4.2.2.6 Summary of Proposed Environmental Protection Measures

Atlantic Shores has routed the onshore interconnection cables along previously disturbed ROWs and sited its onshore substations, converter stations, landfall sites, and the proposed O&M facility on previously disturbed lands, to the maximum extent practicable, to avoid and minimize impacts to wildlife and associated habitat. Impacts to wetlands and streams and other sensitive habitat will be further avoided by installing the onshore interconnection cables using trenchless installation techniques such as jack-and-bore, pipe jacking, and HDD. Additionally, HDD will be used to landfall the export cable from the landfall sites to a point in the ocean beyond the toe-of-slope of the beach (see Section 4.1 Wetlands and Waterbodies). One potential vernal pool has been identified within at one of the Cardiff onshore substation/converter station site options; however, as described, this area is an excavation in uploads, likely for the purposes of stormwater management. As a result, no critical habitat would be affected along the Onshore Project Area ROWs or at the Cardiff or Larrabee POIs for Federal and State-listed threatened and endangered species (see Appendix II-E1 and Appendix II-E2). To further avoid and minimize potential impacts to wildlife and their habitat, Atlantic Shores has incorporated various mitigation measures, best management practices, and monitoring into design elements and construction, O&M, and decommissioning plans. As the Project progresses through development and permitting, Atlantic Shores will continue its discussions with the USFWS and NJDEP to determine the need for additional avoidance/mitigation measures.

- Project facilities and work areas/construction zones have been sited in previously disturbed areas and along existing ROWs to avoid sensitive habitats (e.g., wetlands, waterbodies, forest) to the maximum extent practicable.
- The Project will avoid removing mature trees, remove only the minimum necessary, and do so during the winter months to minimize potential impacts to wildlife species.
- Onshore interconnection cables will be installed underground and use trenchless installation methods such as jack-and-bore, jack piping, and HDD, where there are wetlands, waterbodies, and other sensitive habitats, particularly threatened and endangered species habitats, such as the dune and beach habitat east of the Monmouth Landfall Site.
- Lower dB construction equipment (e.g., smaller backhoes) will be implemented when feasible.
- Construction will be conducted during permitted hours, to the maximum extent practicable, when ambient noise levels are highest.
- Time of year restrictions for construction will be followed, as required, through permitting and resource agency consultation (USFWS and NJDEP)
- IA certified Soil Erosion and Sediment Control Plan from the appropriate County Conservation District and approved New Jersey Division of Land Resource Protection NJPDES permit will be implemented which includes a Stormwater Pollution Prevention Plan (SWPPP) to avoid and minimize Project-related water quality impacts to nearby aquatic habitats (see Section 3.2 Water Quality).
- Temporarily disturbed areas will be restored in accordance with NJDEP and local permitting requirements.
- Atlantic Shores will implement conservation measures during the construction and operations and maintenance phases to accommodate species-specific Monarch Butterfly (*Danaus plexippus*) habitat requirements per USFWS request. The following measures will be implemented, as necessary:
    - For any areas where vegetation disturbance will occur, whether during Project construction or related to post-construction O&M activities, survey the affected area for milkweed (*Asclepias* spp.) before the start of work. Atlantic Shores will avoid clearing milkweed from May 15 through September 30 when Monarch caterpillars may be present.
    - Develop a Revegetation Plan to enhance monarch butterfly habitat for areas of temporary disturbance and incidental to other Project activities. Consult the New Jersey Monarch Butterfly Conservation Guide in developing the plan and submit the plan for USFWS review.
    - Atlantic Shores will not use herbicide for right-of-way maintenance and in other portions of the Project where milkweed is likely to occur.

- Atlantic Shores will follow NJDEP requirements with regards to soil disturbance, including the use of only native milkweeds when revegetating disturbed areas.

- Environmental/Construction Monitor(s) will be assigned to ensure compliance with applicable permit conditions and that BMPs are functional.
- Atlantic Shores will implement the following measures in accordance with the Offshore Renewable Energy Credit (OREC) allowance that the New Jersey Board of Public Utilities (NJBPU) awarded to Atlantic Shores on June 30, 2021:

    - Make public through appropriate data portals, all data collected in the development of the Project from pre-construction activities through decommissioning activities. All collected information and scientific data not deemed confidential by statute or regulation will be made publicly available. Specifically, data with particular emphasis on natural resources including, but not limited to, finfish and shellfish, sea turtles, marine mammals, avian species, bat and benthic populations, as well as data regarding vessel strikes, avoidance, observations on habitat, and routine data collection on ocean conditions will be shared in a manner that is in keeping with best practices for the reporting of these types of data. Atlantic Shores will report annually to BPU and NJDEP beginning June 30, 2022, describing the type of data shared, and where the data is shared. Should a common database for New Jersey-related, scientific data generated in association with offshore wind development be created, Atlantic Shores will archive all data collected with the development of the Project in that data repositor.

4.3 Birds

This section describes the presence of birds and suitable bird habitat in the Offshore and Onshore Project Areas, associated impact producing factors (IPFs), and proposed environmental protection measures to avoid, minimize, or mitigate potential effects to birds during Project construction, operations and maintenance (O&M), and decommissioning. Native birds are federally protected under the Bald and Golden Eagle Protection Act (BGEPA), the Migratory Bird Treaty Act (MBTA), and the Endangered Species Act (ESA), and at the State level.

Atlantic Shores recognizes the importance of birds from an ecological and recreational perspective and is committed to understanding patterns of species exposure throughout the Project Areas. Atlantic Shores is participating in ongoing consultation and a research partnership with the New Jersey Department of Environmental Protection (NJDEP), the U.S. Fish and Wildlife Service (USFWS), Wildlife Restoration Partnership (WRP), and New Jersey Audubon, as well as coordinating with the Bureau of Ocean Energy Management (BOEM), the USFWS, and the NJDEP as it implements a Project-specific Avian and Bat Survey Plan (Appendix II-F1) that includes digital aerial surveys and a satellite telemetry study (Appendix II-F3) of the Federally protected red knot (*Calidris canutus rufa*). Atlantic Shores has worked with the USFWS to affix two Motus Wildlife Tracking System (Motus) receiving antennas to separate meteorological buoys in the WTA to monitor the movement of tagged migratory bird species offshore. These studies are designed to build upon and fill gaps from previous survey efforts to support a more complete understanding of the spatial and temporal distributions of bird species throughout the Offshore Project Areas.

4.3.1 Affected Environment

The Projects occur within the Mid-Atlantic Bight, which includes an area from Cape Cod, Massachusetts, to Cape Hatteras, North Carolina, and has a gradually sloping sandy bottom without significant underwater features. This shelf area extends up to 93 mi (150 km) offshore, where the waters are approximately 650 ft (200 m) deep. Most of this Mid-Atlantic coastal region is influenced by cool Arctic waters introduced by the Labrador Current, and the region exhibits strong seasonal cycles, with sea surface temperatures ranging from 37 to 86 °F (3 to 30 °C; Williams et al. 2015).

A high diversity of birds may overlap with the WTA, which includes Project 1, Project 2, and the Overlap Area because it is located towards the middle of the Mid-Atlantic Bight. This area overlaps with the ranges of both northern and southern species, and falls within the Atlantic Flyway, which is a major migratory pathway for birds in the eastern United States and Canada. Many marine birds migrate along the Atlantic coast in spring and fall, leading to shifts in community composition and variable temporal and geographic patterns. The Mid-Atlantic supports populations of coastal and marine birds in summer, some of which breed in the area (e.g., gulls and terns). Other summer residents, such as shearwaters and storm-petrels, visit from the Southern Hemisphere (where they breed). In the fall, many of the summer residents leave the area and migrate south to warmer areas and are replaced by species that breed farther north and winter in the mid-Atlantic. Some migrant terrestrial species follow the coastline on their annual migrations, while others choose more direct flight routes over expanses of open water and may overlap with the WTA. To learn more about some of these patterns, Atlantic Shores is partnering with the USFWS, the New Jersey Audubon Society, and Wildlife Restoration Partnerships to investigate the migration of red knots (*Calidris canutus rufa*), a federally protected species under the ESA.

For the purpose of this assessment, the affected environment is defined by the bird species expected to occur in the Offshore Project Area and Onshore Project Area during all phases of the Projects and the avian habitats that are associated with these areas. Bird species were identified by reviewing multiple, public datasets that contain observations of bird usage in areas overlapping with the Offshore and Onshore Project Areas.

For the Offshore Project Area, the primary datasets considered include the following:

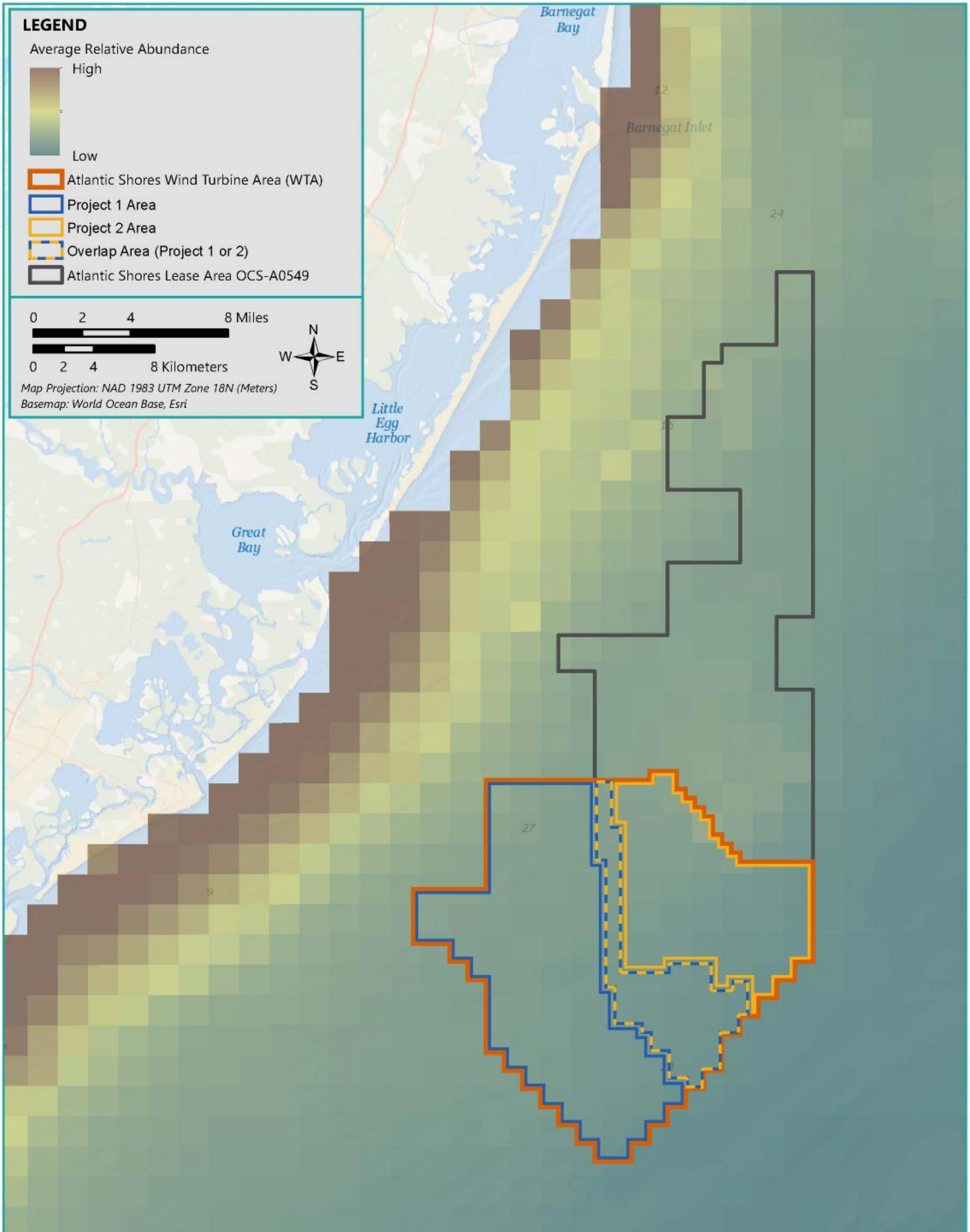
- NJDEP Ocean/Wind Power Ecological Baseline Studies (NJDEP Baseline Studies) conducted by Geo-Marine, Inc. (2010);
- Atlantic Shores digital aerial surveys (APEM surveys);

- Marine-life Data and Analysis Team (MDAT) models (Curtice et al. 2019);
- NJDEP Geographic Information System (GIS) Data (NJDEP 2020; NJDFW 2020);
- Northwest Atlantic Seabird Catalog (managed by NOAA);
- Federal ESA tracking studies (Loring et al. 2018, 2019, 2020); and
- Atlantic Shores Red Knot satellite telemetry study (Appendix II_F3).

For birds with no available site-specific data, species accounts and literature are used to conduct a qualitative assessment. The NJDEP vessel-based surveys and the Atlantic Shores digital aerial surveys provide baseline data for the WTA.

4.3.1.1 Offshore Project Area

Species that may pass through the Offshore Project Area include terrestrial migrants (e.g., songbirds), coastal birds (e.g., shorebirds), and marine birds (e.g., loons and sea ducks). Offshore waters provide habitat for marine bird species, including sea ducks, loons, gulls, scoters, terns, auks, gannets, shearwaters, and petrels. The Projects occur within in an area of relatively deep water (62 to 121 ft [19 to 37 m]) that is devoid of significant underwater features, such as shoals, that would provide regionally important foraging areas (Figure 4.3-1). The Atlantic Shores digital aerial surveys indicate that distribution of marine birds is variable between species and seasons, with no consistent overall pattern, although scoters were generally more concentrated in the survey buffer area closer to shore (Appendix II-F2). Due to their federally protected status, the piping plover (*Charadrius melodus*), red knot, and roseate tern (*Sterna dougallii*) are each discussed in more detail. State-listed species are unlikely to be exposed to the WTA, and so are not discussed further in this section. Table 4.3-1 provides a summary of the avian species of conservation concern within the Project Region. The species list was derived from the NJDEP vessel-based surveys (which, in total, recorded 148 species in offshore waters), Atlantic Shores digital aerial surveys, federally listed species, and species that were cross-referenced with the USFWS IPaC database (there were no species in the IPaC that were not already represented in the species list).



5/18/2022 | T:\20043_Atlantic Shores Offshore Wind_COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\4.3_Birds\MXD\Figure 4.3-1_Total predicted long-term average relative abundance for all MDAT modeled birds.mxd

ATLANTIC SHORES offshore wind

Figure 4.3-1

Total Predicted Long-term Average Relative Abundance for all MDAT Modeled Birds, Offshore New Jersey

Table 4.3-1 List of Species Detected within the WTA and Federally Listed Species that may Occur in the Project Areas, including Conservation Status

Common Name	Latin Name	Source				Conservation Status	
		NJDEP	MDAT	APEM	IPAC	Federal	State
Ducks, geese, and swans							
Snow Goose	*Anser caerulescens*	•					
American Black Duck	*Anas rubripes*	•					
Sea ducks							
Surf Scoter	*Melanitta perspicillata*	•	•		•		
White-winged Scoter	*Melanitta fusca*	•	•	•	•		
Black Scoter	*Melanitta americana*	•	•		•		
Red-breasted Merganser	*Mergus serrator*	•	•		•		
Loons							
Red-throated Loon	*Gavia stellata*	•	•	•	•		
Common Loon	*Gavia immer*	•	•	•	•		
Herons and egrets							
Great Blue Heron	*Ardea herodias*	•					SC
Black-crowned Night-Heron	*Nycticorax nycticorax*	•					T
Petrels and shearwaters							
Black-capped Petrel	*Pterodroma hasitata*					Cand.	
Cory's Shearwater	*Calonectris diomedea*	•	•			BCC	
Sooty Shearwater	*Ardenna grisea*	•	•				
Great Shearwater	*Ardenna gravis*	•	•		•		
Audubon's Shearwater	*Puffinus lherminieri*	•	•			BCC	
Wilson's Storm-Petrel	*Oceanites oceanicus*	•	•		•		
Gannets							
Northern Gannet	*Morus bassanus*	•	•	•			
Cormorants and pelicans							
Double-crested Cormorant	*Phalacrocorax auritus*	•	•		•		
Brown Pelican	*Pelecanus occidentalis*	•	•		•		
Jaegers and gulls							
Parasitic Jaeger	*Stercorarius parasiticus*	•	•				
Black-legged Kittiwake	*Rissa tridactyla*	•	•	•			
Bonaparte's Gull	*Chroicocephalus philadelphia*	•	•	•			
Laughing Gull	*Leucophaeus atricilla*	•	•	•			
Ring-billed Gull	*Larus delawarensis*	•	•		•		
Herring Gull	*Larus argentatus*	•	•	•			
Great Black-backed Gull	*Larus marinus*	•	•	•			

Table 4.3-1 List of Species Detected within the WTA and Federally Listed Species that may Occur in the Project Areas, including Conservation Status (Continued)

Common Name	Latin Name	Source				Conservation Status	
		NJDEP	MDAT	APEM	IPAC	Federal	State
Terns							
Black Tern	*Chlidonias niger*	•					
Common Tern	*Sterna hirundo*	•	•				SC
Forster's Tern	*Sterna forsteri*	•					
Roseate Tern	*Sterna dougallii*	•			•	E	E
Royal Tern	*Thalasseus maximus*	•	•		•		
Auks							
Dovekie	*Alle alle*	•	•		•		
Common Murre	*Uria aalge*	•	•		•		
Razorbill	*Alca torda*	•	•		•		
Atlantic Puffin	*Fratercula arctica*	•	•		•		
Shorebirds							
Black-bellied Plover	*Pluvialis squatarola*	•					
Piping Plover	*Charadrius melodus*					T	E
Red Knot	*Calidris canutus rufa*					T	E
Sanderling	*Calidris alba*	•					SC
Least Sandpiper	*Calidris minutilla*	•					
Red-necked Phalarope	*Phalaropus lobatus*	•	•				
Red Phalarope	*Phalaropus fulicarius*	•	•				
Passerines							
Purple Martin	*Progne subis*	•					
Tree Swallow	*Tachycineta bicolor*	•					
Barn Swallow	*Hirundo rustica*	•					
House Finch	*Haemorhous mexicanus*	•					
Pine Siskin	*Spinus pinus*	•					
American Goldfinch	*Spinus tristis*	•					
Song Sparrow	*Melospiza melodia*	•					
Red-winged Blackbird	*Agelaius phoeniceus*	•					
Brown-headed Cowbird	*Molothrus ater*	•					
Northern Waterthrush	*Parkesia noveboracensis*	•					
Northern Parula	*Setophaga americana*	•					SC
Yellow-rumped Warbler	*Setophaga coronata*	•					
Black-throated Green Warbler	*Setophaga virens*	•					

Note:
Includes federally listed coastal and marine birds, and their federal and state status (E = Endangered, T = Threatened, SC = Special Concern, Cand. = Candidate for listing under ESA, BCC = Birds of Conservation Concern [MBCR 18; USFWS 2021]).

Listed Species

Three ESA-listed species may pass through the Offshore Project Area during migration—the roseate tern (Endangered), piping plover (Threatened), and red knot (Threatened). According to the New Jersey Baseline Studies, these protected species are rarely observed offshore near the WTA and occur primarily in coastal New Jersey in spring and summer (Geo-Marine 2010) and they were not detected during the Atlantic Shores digital aerial surveys. It should be noted that shorebirds are generally nocturnal migrants and would not necessarily be detected in visual surveys).

Piping Plover

The Atlantic Coast population of the piping plover breeds on beaches from Atlantic Canada to North Carolina, and winters in coastal areas of eastern Mexico and the Caribbean. Current tracking data indicates minimal use of the Lease Area by piping plovers (Loring et al. 2018; 2020). In a tracking study, involving 102 piping plovers, two individual tracks were calculated to overlap with the northern portion of the New Jersey Wind Energy Area (NJWEA; Loring et al. 2019). Modeled flight paths from the same study estimated that the tracks of two bird were in the WTA and one stopped just before the WTA (Appendix II-F2). It is important to note the terrestrial receiver stations did not fully cover the offshore environment and no piping plovers were tagged south of Rhode Island, so flight paths are interpolated from point data. Peak piping plover detections occurred on evenings in early August during southwest winds (Loring et al. 2019). The experimental placement of a Motus antenna on one or multiple Atlantic Shores buoys in 2021, are meant to provide future information on piping plover movements within the WTA.

Red Knot

Red knots migrate each year from the Canadian Arctic, where they breed, to wintering grounds in the southern United States, Caribbean, Brazil, Mexico, and Argentina. On their way, they stop over at a few sites in the Mid-Atlantic region, including coastal New Jersey, to renew depleted energy reserves. This population of red knots has two distinct migratory strategies: long- and short-distance migrants. The long-distance migrants generally are expected to fly offshore from coastal New Jersey, while the short-distance migrants are expected to fly down the Atlantic coast. A Motus study tracked red knots tagged in James Bay and the Mingan Islands in Canada, and in Massachusetts and New Jersey. The receiver network was primarily land-based and had limited offshore coverage. Out of 388 birds tagged, three birds (one from Massachusetts and two from New Jersey) were estimated to cross the New Jersey WEA (Loring et al. 2018) and coastal tracking stations indicating that some individuals may be flying offshore (Appendix II-F2). The tagged fall migrants' flights across Federal WEAs, from Massachusetts to Virginia, occurred during fair weather conditions when there were clear skies with little to no precipitation (Loring et al. 2018). The Motus receiving antennas offshore on the Atlantic Shores metocean buoys as well as GPS tracking should provide further information on red knot movements in the WTA.

Atlantic Shores is currently funding a multi-year study of the migratory patterns of red knots using GPS satellite tags deployed on birds staging in New Jersey. The study was initiated in 2020, in collaboration with Wildlife Restoration Partnerships and the USFWS. The second phase, in 2021, also includes the New Jersey Audubon Society as a partner. To date, a total of 60 tags have been deployed on red knots in New Jersey (29 in 2020, 31 in 2021). In 2020, 11 of the tags deployed returned data, while in 2021, 29 of the tags deployed returned data. Of the 11 individuals with tags that provided data in 2020, one was recorded flying through the WTA at an altitude of 1,886 ft (575 m). The straight-line flight paths of six other birds suggests they may have flown through or near to the WTA. Overall, the altitude of individual birds varied during their offshore migratory flights, ranging from under 66 ft (20 m) to over 9,843 ft (3,000 m), suggesting that red knots adjust their flight height in response to wind and weather, or other factors (Appendix II-F3).

Roseate Tern

The northwest Atlantic population of the roseate tern has been federally listed as Endangered under the ESA since 1987. This population breeds in Atlantic Canada and the northeastern United States, and migrates to wintering areas in South America, primarily eastern Brazil. There are no breeding colonies in New Jersey but migrating roseate terns can be expected off the coast from late-April to September (see records from the Northwest Atlantic Seabird Catalog in Appendix II-F2). No modeled roseate tern flight paths were estimated in the WTA by Loring et al. (2019; note that the detection range of coastal receivers is typically less than 9.3 mi [15 km] and the one estimated track of roseate terns in coastal New Jersey was well to the west of the WTA) or in the NJDEP Baseline Studies data (Geo-Marine, Inc. 2010), suggesting exposure events within the WTA are rare (Appendix II-F3). Some data collected using radio-tracking indicate roseate terns may occur over 62 mi (100 km) from shore, and that offshore use is higher during morning hours and under high barometric conditions (i.e., fair weather; Goyert et al. 2014; Loring et al. 2019).

Black-capped Petrel

The black-capped petrel (*Pterodroma hasitata*) is currently proposed for listing as Threatened under the ESA, due to a declining global population (estimated at less than 2,000 breeding pairs; USFWS 2018). Black-capped petrels breed on Caribbean islands and forage over the deep waters (656 to 6,562 ft [200 to 2,000 m]) of the southwestern North Atlantic, the Caribbean basin, and the southern Gulf of Mexico (Simons et al. 2013). Outside the breeding season, they use U.S. Atlantic waters, especially along the shelf edge of the South Atlantic Bight and are found north to Cape Hatteras and occasionally beyond (Jodice et al. 2015).

Black-capped petrels are expected to have little to no exposure to the WTA because they rarely use areas not directly influenced by the Gulf Stream (Haney 1987) and are found in Atlantic coastal waters of the United States usually only as a result of tropical storms (Lee 2000). None of the Black-capped petrel observations in the Seabird Catalog (approximately 5,000 records; 1979–2006) are in shelf waters north of Virginia (O'Connell et al. 2009, Simons et al. 2013) and tracking of black-capped petrels with satellite transmitters indicates that the birds primarily use areas beyond the shelf break (Atlantic Seabirds 2019; Appendix II-F3). Because these birds have little to no exposure to the WTA, they will not be discussed further.

Eagles

Eagles are federally protected under the BGEPA. Bald eagles (*Haliaeetus leucocephalus*) generally nest and perch close to water in both freshwater and marine habitats, and often stay close to the shoreline. Bald eagles were only observed within 3.7 mi (6 km) from shore in digital aerial surveys of the Mid-Atlantic offshore region (Williams et al. 2015b), and no eagles were observed offshore during the NJDEP vessel-based surveys, only in nearshore waters (Appendix II-F2). Golden eagles (*Aquila chrysaetos*) use open habitats and forested regions (Katzner et al. 2012). They commonly winter in the southern Appalachian Mountains and are observed in the Mid-Atlantic United States but are not expected to fly offshore. Because the general morphology of both species discourages long-distance movements in offshore settings (Kerlinger 1985)—they generally rely on thermal formation during long-distance movements, which develop poorly over the open ocean—they are not expected in the WTA and will not be discussed further.

4.3.1.2 Onshore Project Area

As detailed in Sections 4.7 and 4.9 of Volume I, the Project includes two landfall sites and associated onshore interconnection cable routes, substations, and/or converter stations. Onshore interconnection cables will travel underground primarily along existing roadways, utility rights-of-way (ROWs), and/or along bike paths.

Because the onshore Project components will predominantly be located underground (except for the substations and/or converter stations, which will be built on previously developed land), limited bird habitat will be altered or lost (62 to 71% of these routes is co-located with existing linear infrastructure and a majority of the habitat adjacent to the routes is already disturbed [Appendix II-F2]). Some tree and brush clearing may be necessary at the substation and/or converter station sites, but these sites are in or adjacent to fragmented habitat. Otherwise, only temporary disturbances are expected to affect onshore areas during the construction phase as the onshore Project components are almost entirely co-located with existing disturbed areas.

While any disturbance of bird habitat will be limited to areas in existing developed areas, and little to no important bird habitat is expected to be altered, there is a high diversity of birds present in the broader Onshore Project Area. Within a 9.3 mi (15 km)[11] radius of Onshore Project Area, eBird records indicate that 276 species have been recorded in the area (eBird 2020). The data show that waterfowl are most abundant between October and March, and that shorebird abundance generally peaks during spring and fall migration. Gull species are generally most abundant during the fall and winter, although some species such as the herring gull and great black-backed gull can be observed year-round. Terns occur almost exclusively during spring,

[11] The radius captures the onshore infrastructure associated with the Projects plus a buffer to account for both variable eBird effort and the migratory birds that may occur but were not directly observed in the Onshore Project Area.

summer, and fall, with most arriving in April and May and leaving by October. Most raptor species that occur in the Onshore Project Area can be found throughout the year at varying levels of abundance; however, broad-winged hawks (*Buteo platypterus*) only occur during the summer and rough-legged hawks (*Buteo lagopus*) only occur in winter. Many species groups of songbirds are primarily spring and summer residents, including flycatchers, vireos, swallows, and warblers. Temporal trends of other songbirds are highly species-specific.

There are many State-listed species within the general Onshore Project Area (Table 4.3-2). However, disturbance of any habitat will be limited, and construction activities will be avoided at the landfall locations in the peak summer months (Memorial Day to Labor Day). By locating onshore Project activities in previously developed areas, away from sensitive ecological resources, most effects to State-listed bird species will be avoided.

Piping plovers breed in New Jersey, arriving in March and departing by October, with peak abundances between April and July (Appendix II-F2). Nesting could occur near the Export Cable Corridor (ECC) landfall sites. Exact nesting locations are not made public, but the birds have been documented to nest close to the Monmouth Landfall Area (Appendix II-F2). Red knots are observed in coastal New Jersey during migration, with abundance peaks in May and August–October during most years, and they are largely absent from December to April. Red knots do not breed in New Jersey. Cable landfall sites are not in areas being considered as critical habitat for red knots[12] (Appendix II-F2). Few roseate terns are observed in the onshore New Jersey region, and this species breeds on coastal islands from Long Island, New York, to Atlantic Canada (Gochfeld and Burger 2020).

[12] https://fws.gov/northeast/red-knot/

Table 4.3-2 List of Species Observed by eBird Users in the General Onshore Project Area

Common Name	Scientific Name	Primary Habitat	General Breeding Habitat	Conservation Status	Site
American Black Duck	*Anas rubripes*	Freshwater	Wetland	SGCN	C, L
Northern Pintail	*Anas acuta*	Freshwater, Coastal	Wetland	SGCN	C, L
Common Eider	*Somateria mollissima*	Marine	Intertidal, Wetland	SGCN	C, L
Hooded Merganser	*Lophodytes cucullatus*	Freshwater	Forest, Wetland	STE	C, L
Pied-billed Grebe	*Podilymbus podiceps*	Freshwater, Marine	Wetland	STE, F-SGCN	C, L
Black-billed Cuckoo	*Coccyzus erythropthalmus*	Terrestrial	Forest, Shrubland	STE, SGCN	C, L
Common Nighthawk	*Chordeiles minor*	Terrestrial	Grassland, Forest, Wetland	STE, SGCN	C, L
Chuck-will's-widow	*Antrostomus carolinensis*	Terrestrial	Forest, Grassland, Shrubland	SGCN	C
Chimney Swift	*Chaetura pelagica*	Terrestrial	Forest	SGCN	C, L
King Rail	*Rallus elegans*	Freshwater	Wetland	STE, SGCN	C
Clapper Rail	*Rallus crepitans*	Freshwater	Wetland, Forest	SGCN	C, L
Virginia Rail	*Rallus limicola*	Freshwater	Wetland	STE	C
Sora	*Porzana carolina*	Freshwater	Wetland	STE, SGCN	C
Common Gallinule	*Gallinula galeata*	Freshwater	Wetland	STE	C
American Oystercatcher	*Haematopus palliatus*	Marine	Intertidal, Beach	STE, F-SGCN	C, L
Piping Plover	***Charadrius melodus***	**Marine**	**Intertidal, Beach**	**FTE, STE, F-SGCN**	**C, L**
Whimbrel	*Numenius phaeopus*	Terrestrial, Coastal	Forest, Grassland, Shrubland	STE, SGCN	C
Marbled Godwit	*Limosa fedoa*	Terrestrial, Coastal	Grassland, Wetland	SGCN	C
Ruddy Turnstone	*Arenaria interpres*	Terrestrial, Coastal	Grassland, Wetland	F-SGCN	C, L
Red Knot	***Calidris canutus***	**Terrestrial, Coastal**	**Grassland, Wetland**	**FTE, STE, F-SGCN**	**C**
Sanderling	*Calidris alba*	Terrestrial, Coastal	Grassland, Wetland	STE, SGCN	C, L
Purple Sandpiper	*Calidris maritima*	Terrestrial, Coastal	Grassland, Wetland	SGCN	C, L
Semipalmated Sandpiper	*Calidris pusilla*	Terrestrial, Coastal	Grassland, Wetland	STE, SGCN	C, L
American Woodcock	*Scolopax minor*	Terrestrial	Forest	F-SGCN	C, L
Wilson's Phalarope	*Phalaropus tricolor*	Freshwater, Marine	Wetland, Grassland, Forest	SGCN	C
Spotted Sandpiper	*Actitis macularius*	Freshwater, Coastal	Wetland	STE	C, L
Willet	*Tringa semipalmata*	Terrestrial, Coastal	Intertidal, Wetland	SGCN	C, L
Least Tern	*Sternula antillarum*	Marine, Coastal	Intertidal	STE, F-SGCN	C, L
Gull-billed Tern	*Gelochelidon nilotica*	Marine, Coastal	Intertidal, Wetland	STE, SGCN	C

Table 4.3-2 List of Species Observed by eBird Users in the General Onshore Project Area (Continued)

Common Name	Scientific Name	Primary Habitat	General Breeding Habitat	Conservation Status	Site
Caspian Tern	*Hydroprogne caspia*	Marine, Coastal	Wetland, Intertidal	STE	C, L
Black Tern	*Chlidonias niger*	Marine, Coastal	Wetland	SGCN	C
Common Tern	*Sterna hirundo*	Marine, Coastal	Intertidal, Wetland	STE, F-SGCN	C, L
Forster's Tern	*Sterna forsteri*	Marine, Coastal	Wetland	F-SGCN	C, L
Black Skimmer	*Rynchops niger*	Marine, Coastal	Intertidal, Wetland	STE, F-SGCN	C, L
Common Loon	*Gavia immer*	Freshwater, Marine	Wetland	SGCN	C, L
American Bittern	*Botaurus lentiginosus*	Freshwater	Wetland	STE, SGCN	C
Least Bittern	*Ixobrychus exilis*	Freshwater	Wetland, Forest	STE, SGCN	C
Great Blue Heron	*Ardea herodias*	Freshwater, Marine	Wetland, Intertidal, Forest	STE	C, L
Snowy Egret	*Egretta thula*	Freshwater, Marine	Wetland, Intertidal	STE, F-SGCN	C, L
Little Blue Heron	*Egretta caerulea*	Freshwater, Marine	Wetland, Intertidal, Forest	STE, F-SGCN	C, L
Tricolored Heron	*Egretta tricolor*	Freshwater, Marine	Wetland, Intertidal, Forest	STE, F-SGCN	C
Cattle Egret	*Bubulcus ibis*	Freshwater	Grassland, Wetland	STE, SGCN	C
Black-crowned Night-Heron	*Nycticorax nycticorax*	Freshwater, Marine	Forest, Intertidal, Wetland	STE, SGCN	C, L
Yellow-crowned Night-Heron	*Nyctanassa violacea*	Freshwater, Marine	Forest, Intertidal, Wetland	STE, SGCN	C, L
Glossy Ibis	*Plegadis falcinellus*	Freshwater, Coastal	Wetland	STE	C, L
Osprey	*Pandion haliaetus*	Freshwater, Coastal	Forest, Wetland, Intertidal	STE, SGCN	C, L
Golden Eagle	*Aquila chrysaetos*	Terrestrial	Grassland, Forest, Shrubland	SGCN	C
Northern Harrier	*Circus hudsonius*	Terrestrial, Freshwater	Forest, Grassland, Shrubland, Wetland	STE, F-SGCN	C, L
Sharp-shinned Hawk	*Accipiter striatus*	Terrestrial	Forest, Shrubland	STE	C, L
Cooper's Hawk	*Accipiter cooperii*	Terrestrial	Forest	STE	C, L
Bald Eagle	*Haliaeetus leucocephalus*	Freshwater, Coastal	Wetland Forest, Intertidal	STE, SGCN	C, L
Red-shouldered Hawk	*Buteo lineatus*	Terrestrial	Forest	STE, SGCN	C, L
Broad-winged Hawk	*Buteo platypterus*	Terrestrial	Forest	STE, SGCN	C, L
Barred Owl	*Strix varia*	Terrestrial	Forest, Wetland	STE, SGCN	C, L
Short-eared Owl	*Asio flammeus*	Terrestrial	Grassland	STE, SGCN	C
Red-headed Woodpecker	*Melanerpes erythrocephalus*	Terrestrial	Forest, Grassland	STE, F-SGCN	C
American Kestrel	*Falco sparverius*	Terrestrial	Forest, Grassland, Shrubland	STE, SGCN	C, L

Table 4.3-2 List of Species Observed by eBird Users in the General Onshore Project Area (Continued)

Common Name	Scientific Name	Primary Habitat	General Breeding Habitat	Conservation Status	Site
Peregrine Falcon	*Falco peregrinus*	Terrestrial, Coastal	Forest, Grassland, Intertidal, Shrubland	STE, F-SGCN	C, L
Acadian Flycatcher	*Empidonax virescens*	Terrestrial	Forest, Wetland	SGCN	C, L
Willow Flycatcher	*Empidonax traillii*	Terrestrial	Shrubland, Wetland	SGCN	C, L
Least Flycatcher	*Empidonax minimus*	Terrestrial	Forest, Shrubland	STE	C, L
Yellow-throated Vireo	*Vireo flavifrons*	Terrestrial	Forest	SGCN	C, L
Blue-headed Vireo	*Vireo solitarius*	Terrestrial	Forest	STE	C, L
Horned Lark	*Eremophila alpestris*	Terrestrial	Grassland, Shrubland	STE, SGCN	C, L
Bank Swallow	*Riparia riparia*	Terrestrial, Freshwater	Grassland, Wetland	SGCN	C, L
Cliff Swallow	*Petrochelidon pyrrhonota*	Terrestrial, Freshwater	Forest, Grassland, Wetland	STE	C, L
Winter Wren	*Troglodytes hiemalis*	Terrestrial	Forest, Shrubland	STE	C, L
Marsh Wren	*Cistothorus palustris*	Terrestrial, Freshwater	Wetlands, Intertidal	SGCN	C, L
Brown Thrasher	*Toxostoma rufum*	Terrestrial	Shrubland, Forest	STE, SGCN	C, L
Veery	*Catharus fuscescens*	Terrestrial	Forest	STE, SGCN	C, L
Wood Thrush	*Hylocichla mustelina*	Terrestrial	Forest	STE, F-SGCN	C, L
Grasshopper Sparrow	*Ammodramus savannarum*	Terrestrial	Grassland, Shrubland	STE, F-SGCN	C, L
Field Sparrow	*Spizella pusilla*	Terrestrial	Forest, Grassland, Shrubland	SGCN	C, L
Vesper Sparrow	*Pooecetes gramineus*	Terrestrial	Grassland, Shrubland	STE, F-SGCN	C
Seaside Sparrow	*Ammospiza maritima*	Terrestrial	Intertidal	SGCN	C
Saltmarsh Sparrow	*Ammospiza caudacuta*	Terrestrial, Coastal	Intertidal	STE, SGCN	C
Savannah Sparrow	*Passerculus sandwichensis*	Terrestrial, Freshwater, Coastal	Grassland, Shrubland, Wetland	STE, SGCN	C, L
Eastern Towhee	*Pipilo erythrophthalmus*	Terrestrial	Forest, Shrubland	SGCN	C, L
Yellow-breasted Chat	*Icteria virens*	Terrestrial	Forest, Shrubland	STE, SGCN	C
Bobolink	*Dolichonyx oryzivorus*	Terrestrial	Grassland	STE, F-SGCN	C
Eastern Meadowlark	*Sturnella magna*	Terrestrial	Grassland, Shrubland	STE, F-SGCN	C, L
Rusty Blackbird	*Euphagus carolinus*	Terrestrial, Freshwater	Wetland	SGCN	C
Worm-eating Warbler	*Helmitheros vermivorum*	Terrestrial	Forest	STE, SGCN	C, L
Blue-winged Warbler	*Vermivora cyanoptera*	Terrestrial	Grassland, Shrubland	F-SGCN	C, L
Black-and-white Warbler	*Mniotilta varia*	Terrestrial	Forest	SGCN	C, L
Prothonotary Warbler	*Protonotaria citrea*	Terrestrial	Forest	F-SGCN	L

Table 4.3-2 List of Species Observed by eBird Users in the General Onshore Project Area (Continued)

Common Name	Scientific Name	Primary Habitat	General Breeding Habitat	Conservation Status	Site
Nashville Warbler	*Leiothlypis ruficapilla*	Terrestrial	Forest	STE	C, L
Hooded Warbler	*Setophaga citrina*	Terrestrial	Forest	STE, SGCN	C, L
Cape May Warbler	*Setophaga tigrina*	Terrestrial	Forest	SGCN	C, L
Northern Parula	*Setophaga americana*	Terrestrial	Forest	STE, SGCN	C, L
Bay-breasted Warbler	*Setophaga castanea*	Terrestrial	Forest	SGCN	C, L
Blackburnian Warbler	*Setophaga fusca*	Terrestrial	Forest	STE, SGCN	C, L
Black-throated Blue Warbler	*Setophaga caerulescens*	Terrestrial	Forest	STE, SGCN	C, L
Prairie Warbler	*Setophaga discolor*	Terrestrial	Shrubland, Forest	SGCN	C, L
Black-throated Green Warbler	*Setophaga virens*	Terrestrial	Forest, Wetland	STE, SGCN	C, L
Canada Warbler	*Cardellina canadensis*	Terrestrial	Forest	STE, SGCN	C, L
Scarlet Tanager	*Piranga olivacea*	Terrestrial	Forest	F-SGCN	C, L
Dickcissel	*Spiza americana*	Terrestrial	Grassland	SGCN	C

Note:
Species reported on at least 30 separate days over the last 10 years and designated as one or more of the following: SGCN = Species of Greatest Conservation Need for NJ, F-SGCN = focal Species of Greatest Conservation Need for NJ, STE = state-listed species, and FTE = federally listed species (bolded).

4.3.2 Potential Impacts and Proposed Environmental Protection Measures

There are several Impact-Producing Factors (IPFs) that may potentially affect bird species occurring in the Offshore and Onshore Project Areas during the construction, O&M, or decommissioning of the Projects (Table 4.3-3).

Table 4.3-3 Impact-Producing Factors for Birds

Impact-Producing Factors	Construction & Installation	Operation & Maintenance	Decommissioning
Presence of structures		●	●
Light	●	●	●
Vessel traffic	●	●	●
Noise	●	●	●
Installation and maintenance of new structures and cables	●	●	●

In addition, birds may also be affected by discharges from vessels and accidental releases. These potential effects are considered to have a low likelihood of occurrence and are discussed in Sections 9.2.3 and 9.2.4.

The maximum PDE analyzed for potential offshore effects to birds is the maximum offshore build-out of the Projects (as defined in Section 4.11 of Volume I). The PDE of WTG parameters are provided in Table 4.3-1 of Volume I, which serve as the basis for the discussion of potential collision and displacement effects. The rotor swept zone (RSZ[13]) for both Projects is 78 to 1,048.8 ft (23.8 to 319.7 m) above mean lower low water (Section 4.3 of Volume I). The maximum PDE analyzed for potential effects to birds onshore are the build-out scenarios discussed in Sections 4.8 and 4.9 of Volume I.

The potential effects associated with the Projects were evaluated using a risk assessment framework (see Appendix II-F2 for detailed methods and results). The framework uses a weight-of-evidence approach and combines an assessment of exposure and behavioral vulnerability within the context of the literature to establish potential risk. Exposure has both spatial and temporal components. Spatially, birds are exposed on the horizontal (i.e., habitat area) and vertical planes (i.e., flight altitude); temporally, bird exposure is dictated by a species' life history and may be limited to breeding, staging, migrating, or wintering. Therefore, to be at risk of potential effects,

13 The rotor swept zone, or RSZ, is the diameter the WTG blades cover (this diameter is shown in Figure 4.3-1 in Volume I).

a bird must be both *exposed* to an offshore wind development (i.e., overlapping in distribution) and be *vulnerable* to either displacement or collision (Goodale and Stenhouse 2016).

Exposure was evaluated based on the New Jersey Baseline Studies and version 2 of the Marine-life Data and Analysis Team (MDAT) marine bird relative density and distribution models (Curtice et al. 2016). Densities and fine scale distributions of species were calculated from Atlantic Shores digital aerial surveys (Appendix II-F2). Due to gaps in knowledge on the relationship between the number of turbines and risk, the assessment analyzed the exposure of birds to the total area of development, rather than to a specific number of turbines. Behavioral vulnerability was evaluated based on the literature (Furness et al. 2013, Wade et al. 2016), and vulnerability score (collision and displacement) for the WTG design envelope parameters adapted from a published scoring process (Furness et al. 2013, Wade et al. 2016, Fliessbach et al. 2019, Willmott et al. 2013). The vulnerability assessment also creates a population vulnerability score by using Partners in Flight data, a local state conservation status, and an adult survival score. The results are summarized in Table 4.3-4.

Table 4.3-4 Summary of the Assessment of Potential Exposure and Vulnerability of Marine Birds

Group	Exposure[1]	Relative Vulnerability to		
		Collision	Displacement	Population
Sea Ducks[2]	min–low	low	med–high	low–med
Auks	min–low	min–low	med–high	low–med
Jaegers & Gulls	min–low	low–med	low–med	min–med
Terns	min–low	low	med–high	low–high
Loons	min–med	low	high	low–med
Shearwaters, Petrels & Storm-Petrels	min–low	low	med	low–med
Gannets, Cormorants, & Pelicans	min–low	low–med	low–med	min–low

Note:
[1]Exposure scores represent the range for the species in each group. The individual species scores are derived from the rules in Table 4-5 in Appendix II_2, which account for varying exposure by season.
[2]Excluding Red-breasted Merganser.

4.3.2.1 Presence of Structures

Collision and displacement are the two primary potential effects to birds associated with the presence of offshore wind facility structures (Garthe and Hüppop 2004, Desholm 2009, Furness and Wade 2012, Furness et al. 2013, Robinson Willmott et al. 2013).

Bird collisions occur when an individual bird collides with a physical component of the Projects (i.e., a WTG) while in flight. Collisions can occur with both stationary and moving infrastructure (e.g., spinning WTG blades; Fox et al. 2006a). Collision risk increases when birds exhibit flight behaviors that increase exposure to blades (e.g., foraging), and spend a greater portion of their time at altitudes equivalent to a WTG RSZ. Environmental conditions, such as poor visibility from fog, low cloud ceilings, or day/night variability, can also contribute to increased collision risk (Fox and Peterson 2019, Johnston 1955, Crawford and Engstrom 2001). Collisions at onshore facilities are not expected given that cables will be buried in the Onshore Project Area and above-ground onshore substations will occupy a limited footprint.

Displacement occurs when birds show an avoidance response to a wind farm or WTG. While avoidance can reduce collision risk, it can also reduce access to foraging and resting habitat, and potentially increase energy expenditures (Fox and Peterson 2019). The offshore wind facilities may also cause migration disturbance (Dierschke et al. 2016, Vanermen et al. 2019). Of note, most displacement studies have been conducted at wind arrays with smaller turbines spaced closer together than Atlantic Shores' WTGs (for example one study in Belgium was at a wind array with 3 MW turbines spaced 1,640 to 2,132 ft [500 to 650 m]; Vanermen et al. 2015). While there is uncertainty on bird's avoidance response to larger WTGs, BOEM anticipates that for larger WTGs that there will be enough space between them for most migratory birds to fly through a wind array without changing course or only needing to make minor course corrections (relative to the entire migration) and that any "additional energy expenditure would not be expected to result in individual fitness or population-level impacts" (BOEM 2021).

The presence of offshore structures, such as foundations, scour protection, cable protection, and buoys during Project O&M, could have beneficial effects on local bird populations due to consequent increases in fish aggregations near structures, known as the reef effect. This reef effect creates habitat for structure-orientated and hard-bottom fish species, which has the potential to increase foraging opportunities for piscivorous birds (Taormina et al. 2018). Although increases in fish aggregations may provide more foraging opportunities for birds, this could also cause increases in bird exposure to turbine blades and concomitant increases in collision risk. Similar increases in exposure could also occur due to perching on the WTGs, specifically for some species groups, such as gulls and cormorants, although the Projects will utilize perch deterrents, where appropriate, to decrease the risks of these possible effects. The presence of structures may also cause limited entanglement hazards if lost line or fishing gear is caught on structures. There is some documentation that birds could become entangled in fishing line and lost nets wrapped around the WTG or OSS foundations (Ryan 2018, Schrey and Vauk 1987). These potential effects can be effectively managed by the Projects as Atlantic Shores commits to removing marine debris (e.g., derelict gear) from structures, when safe and practicable.

Collision

Collisions with WTGs has been identified as a potential effect on birds (Goodale and Milman 2016, Drewitt and Langston 2006, Fox et al. 2006). The exposure of non-marine migratory birds will be limited to migration, and marine bird exposure will vary by species and season.

Non-marine migratory birds: Wading bird and coastal waterbird populations are unlikely to be impacted by collision due to limited exposure, although some individuals may fly through the WTA. Some individual great blue herons (*Ardea herodias*) may pass through the WTA and have the potential to fly within the RSZ (Appendix II-F2). While shorebirds may fly through the Lease Area during migration (see tracking data provided by the USFWS in Appendix II-F2), they are likely to fly above the turbines (Loring et al. 2021). Among raptors, falcons are the most likely to be encountered offshore (Cochran 1985, DeSorbo et al. 2012, DeSorbo et al. 2018). Ospreys can make water crossings (Kerlinger 1985) and individuals will fly offshore (Bierregaard 2019), but satellite telemetry data indicated birds from New England and New York generally follow the coast during fall migration (Bierregaard et al. 2020), and that core use areas closest to the WTA are concentrated around Delaware Bay (Appendix II-F2). Eagles, *Buteo* hawks, and large *Accipiter* hawks (i.e., northern goshawks [*Accipiter gentilis*]) are rarely observed offshore (DeSorbo et al. 2012, DeSorbo et al. 2018). Falcons can fly offshore during migration (DeSorbo et al. 2019), and have been tracked adjacent to the WTA (Appendix II-F2); however, while falcons can be attracted to WTGs (Skov et al. 2016, Krijgsveld et al. 2011, Hill et al. 2014) peregrine falcon (*Falco peregrinus*) mortalities have not been documented at offshore wind projects in Europe. If exposed to the WTA, some songbirds may be vulnerable to collision. Songbirds may avoid colliding with offshore WTGs in some instances (Petersen et al. 2006), but they are documented to collide with illuminated marine and terrestrial structures (Fox et al. 2006)—low visibility periods generate the highest collision risk conditions (Hüppop et al. 2006). In summary, collisions with the WTGs could impact individual migratory birds, but population-level impacts are highly unlikely because the Projects' distance from shore limits population level exposure.

Marine birds: Of the marine birds, gulls are identified as having the highest vulnerability to collisions (Table 4.3-4; Wade et al. 2016; note, due to limited exposure pelicans are not discussed in detail but are included in analysis detailed in Appendix II_F2). Sea ducks, auks, loons, petrels (including black-capped petrels), shearwaters, and storm-petrels are generally not considered vulnerable to collision because they avoid WTGs (Furness et al. 2013). Some studies indicate that terns and northern gannets may have limited vulnerability to collision. Appendix II-F2 includes the supporting tables and maps for each species group exposure and vulnerability assessment.

- *Jaegers and Gulls*: These avian families are grouped here due to their general similarities in natural history. Gulls received a low to medium collision vulnerability score. Of the marine birds, they are identified as having higher collision vulnerability because they can fly at altitudes equivalent to the RSZ (Johnston et al. 2014), have been document to be attracted to WTGs (Vanermen et al. 2015), and individual birds have been documented to collide with WTGs (Skov et al. 2018). Recent studies suggest that for most large gulls there is a zero macro-avoidance rate, but the meso-avoidance rate is high, conservatively calculated as 99.59% for herring gulls (*Larus argentatus*) and 99.82% for lesser black-backed gulls (*L. fuscus*; Cook et al. 2018). For the three seasons surveyed during the Atlantic Shores digital aerial surveys in the WTA, gulls had the highest density in winter, and similar densities in the spring and fall. During winter, densities were slightly higher in the WTA than in the entire survey area. Within the Lease Area, distribution varied by species and season, although the proportion of medium and large gulls tended to be higher closer to shore in winter. These results should be interpreted within the context that species distribution will vary from year to year, depending upon food availability. As a group, jaegers and gulls have minimal to low exposure, although some species have medium exposure in specific seasons: the black-legged kittiwake (Rissa tridactyla; winter), parasitic jaeger (*Stercorarius parasiticus*; spring), Bonaparte's gull (*Chroicocephalus philadelphia*; spring), laughing gull (*Leucophaeus atricilla*; summer), ring-billed gull (*Larus delawarensis*; spring), and herring gull (winter).

- *Terns*: Terns have a low collision vulnerability score and may have some limited vulnerability to collision (Garthe and Hüppop 2004, Furness et al. 2013), but are expected to often fly below the RSZ (Loring et al. 2019), reducing the risk of colliding with WTGs. For the three seasons surveyed during the Atlantic Shores digital aerial surveys, there were not enough tern detections to model densities. However, terns were detected in the spring, summer, and fall during the NJDEP vessel-based surveys. Terns have minimal to low exposure overall, with the common tern (*Sterna hirundo*) having medium exposure in spring.

- *Gannet*: The northern gannet (*Morus bassanus*) has a low collision vulnerability score because they have been demonstrated to avoid WTGs (Garthe et al. 2017). Because individuals can enter wind arrays (Peschko *et al.* 2021), some may be vulnerable to collision because they have the potential to fly within the RSZ (Garthe et al. 2014, Cleasby et al. 2015, Furness et al. 2013). Northern gannets range widely within the offshore waters of the United States and a recent tracking study indicates moderate use of the Lease Area compared to surrounding areas (Stenhouse et al. 2020). For the three seasons surveyed during the Atlantic Shores digital aerial surveys in the WTA, gannets had the highest density in spring. During spring, densities were higher in the WTA than in the entire survey area. Within the Atlantic Shores Lease Area, distribution varied with the proportion of birds being higher closer to shore in the fall (this corresponds to tracking studies), to the north and offshore in winter (tracking indicated higher use closer to shore), and to the south in spring (tracking studies show broader use of the region). These results should be interpreted within the context that Northern Gannets range widely across the Atlantic OCS during the non-breeding season as they follow ephemeral prey, and that the NJDEP vessel-based surveys and MDAT models show lower relative use. Overall, northern gannets have minimal to low exposure.

- *Cormorants*: The double-crested cormorant (*Phalacrocorax auritus*) has a medium collision vulnerability score because it has been documented to be attracted to WTGs (Lindeboom et al. 2011, Krijgsveld et al. 2011), and may fly through the RSZ. For the three seasons surveyed during Atlantic Shores digital aerial surveys, there were not enough cormorant detections to model densities, indicating low use, which aligns with low detections (only in summer) during the NJDEP vessel-based surveys. Overall, cormorants have low exposure.

In summary, while collisions with WTGs may impact individual non-listed marine birds (i.e., gulls and cormorants), population-level impacts are not expected because the species vulnerable to collision have minimal to low exposure to the WTA. Furthermore, gulls and cormorants have minimal to medium overall population vulnerability. Atlantic Shores will implement measures to reduce attracting birds through lighting best management practices and perch deterrents.

Displacement

Habitat displacement due to the presence of WTGs may affect birds (Drewitt and Langston 2006, Fox et al. 2006, Goodale and Milman 2016), but impacts to populations is uncertain. Non-marine migratory birds are not expected to be particularly vulnerable to displacement because these species do not use the offshore environment as a primary foraging area. Jaegers and gulls generally rank low in vulnerability to displacement assessments (Furness et al. 2013), and there is little evidence that cormorants are displaced by offshore wind arrays (results of exposure and vulnerability assessment are detailed in Table 4.3-4). Appendix II-F2 includes the supporting tables and maps for each species group exposure and vulnerability assessment.

- *Sea ducks*: Sea ducks have a medium to high displacement score (medium was added to the range to account changes in displacement through time) as they have been identified as being vulnerable to habitat displacement (Furness *et al*. 2013), particularly scoters (MMO 2018). Avoidance of wind projects can lead to habitat displacement, resulting in effective habitat loss (Petersen and Fox 2007, Langston 2013, Percival 2010). However, for some species, this displacement may stop several years after construction (Petersen & Fox 2007, Leonhard et al. 2013) and avoidance of individual wind arrays is not expected to significantly increase energy expenditure (Masden et al. 2009). For the three seasons surveyed during the Atlantic Shores digital aerial surveys in the WTA, sea ducks had the highest density in winter, to few detections in the fall, and lower densities in spring. During winter, densities were much lower in the WTA than in the entire survey area. Within the Atlantic Shores Lease Area, the proportion of scoters was generally higher closer to shore in all three seasons, which corresponds to tracking data. As a group, sea ducks have minimal to low exposure.

- *Auks*: Auks have medium to high displacement score, due to a sensitivity to disturbance from boat traffic, a high habitat specialization, and vulnerability to displacement (Dierschke et al. 2016, Wade et al. 2016). The rates of displacement and reuse of a wind farm by Razorbills seems to vary by site. Two U.K. studies showed that auk displacement was most likely to occur during the summer breeding season (i.e., the period during which razorbills have not been recorded in the WTA; APEM 2016, 2017). In these two studies, auks showed significant declines between pre-construction and construction; however, their densities showed some recovery within the turbine array within 1-year post-construction (APEM 2016, 2017). Other studies have reported auk displacement between 61 and 75% from wind farms (Vanermen et al. 2015, Welcker and Nehls 2016, Peschko et al. 2020). For the three seasons surveyed during the Atlantic Shores digital aerial surveys, there were not enough auk detections to model densities at the species level; however, group models indicate variable use of the Lease Area with a greater proportion of murres in the north in spring. As a group, auks have minimal to low exposure, with razorbills and Atlantic puffins having medium exposure in winter.

- *Terns*: Terns receive a medium to high displacement score, but there is considerable uncertainty on tern avoidance responses (Wade et al. 2016). Tern avoidance has not been well studied, but terns have been shown to avoid smaller turbines at the Horns Rev facility (Cook et al. 2012, Petersen et al. 2006). Common terns typically forage within approximately 5.5 mi to 9.4 mi (9 to 15.2 km) of their nest sites (Perrow et al. 2011, Safina and Burger 1985, Duffy 1986, Thaxter et al. 2012, Nisbet et al. 2017) but are known to forage farther offshore during the post-breeding period (Goyert et al. 2014). For the three seasons surveyed during the Atlantic Shores digital aerial surveys, there were not enough tern detections to model species or group densities. However, terns were detected in the spring, summer, and fall during the NJDEP vessel-based surveys. Terns have minimal to low exposure, with common terns having medium exposure in spring.

- *Loons*: Loons have a high displacement score because they are consistently identified as being vulnerable to displacement (MMO 2018, Garthe and Hüppop 2004, Furness et al. 2013), due to a strong avoidance response by red-throated loons (*Gavia stellata*), which can be initiated from as far away as 10 mi (16 km) from a wind energy facility (Mendel et al. 2019). The distance and duration of loon displacement varies between sites (Allen et al. 2020), as does reuse of the site. Some monitoring data from wind farms in Europe indicate loons largely avoid offshore wind farms, leading to displacement from some offshore areas, with displacement effects seen out to 2.5 mi (4 km) from WTGs, especially during construction (Petersen et al. 2006, Percival 2010). Other studies indicate loons appear to avoid areas within 5.6 mi (9 km) of WTGs during construction (Petersen et al. 2006, Percival 2010, APEM 2016, Allen et al. 2020). While these birds are vulnerable to displacement, there is uncertainty about how displacement will affect individual fitness (e.g., changes in energy expenditure due to avoidance), and effective methodologies for assessing population-level displacement effects are lacking (Mendel et al. 2019, Fox and Petersen 2019). For the three seasons surveyed during the Atlantic Shores digital aerial surveys in the WTA, loons had the highest density in winter and lowest densities in the fall. During winter, densities were lower in the WTA than in the entire survey area. Within the Atlantic Shores Lease Area, distribution varied by season although proportion of loons tended to be higher closer to shore in the fall and spring. Tracking studies indicate red-throated loons use areas closer to shore in the winter and fall, and that in spring some migratory birds may pass through the WTA. Red-throated loons have minimal to low exposure, and common loons (*G. immer*) have low exposure for winter and summer, medium for fall, and high for spring.

- *Petrels and Shearwaters*: The petrel group has a medium displacement score; however, petrels, shearwaters, and storm-petrels are not generally considered vulnerable to habitat displacement (Furness et al. 2013), although displacement has not been well studied for this group. For the three seasons surveyed during the Atlantic Shores digital aerial surveys, there were not enough detections to model densities. However, species in the petrel group were detected in the summer and fall during the NJDEP vessel-based surveys. As a group, these birds have minimal to low exposure, with sooty shearwaters (*Ardenna grisea*) having medium exposure in summer, and Audubon's shearwaters (*Puffinus lherminieri*) having medium exposure in fall.

- *Gannet*: Northern gannets have a medium vulnerability score to displacement because studies indicate they actively avoid offshore wind developments (Hartman et al. 2012, Garthe et al. 2017, Vanermen et al. 2015, Cook et al. 2012, Dierschke et al. 2016, Krijgsveld et al. 2011). There is evidence that between 92 and 96% of northern gannets avoid turbine arrays (Welcker and Nehls 2016, Rehfisch et al. 2014), and Rehfisch et al. (2014) suggest they demonstrate an overall avoidance of 99.5%. While northern gannets were detected in the Atlantic Shores digital aerial surveys and were tracked through the area, gannets have minimal exposure, except for spring (low), indicating that they are unlikely to be displaced from important foraging areas.

In summary, displacement is unlikely to cause population-level impacts because most seabirds would have limited exposure to the WTA. Displacement effects, if they occur, are expected to be localized and concentrated during the construction and decommissioning periods. During O&M, some displacement may occur for certain species, while attraction to the WTA may increase due to improved foraging opportunities.

Potential Collision and Displacement Risk of Federally listed Threatened and Endangered Species

Based on the best available information, impacts to individual piping plovers and roseate terns are unlikely, due to low exposure. No roseate terns were recorded in the Lease Area in the Loring et al. (2019) studies, NJDEP Baseline Studies data, or Atlantic Shores digital aerial surveys, indicating that exposure to the WTA is rare. Furthermore, flight height estimates from Loring et al. (2019), and flight height records in the Northwest Atlantic Seabird Catalog from vessel-based surveys (can be biased low), suggest that roseate terns fly primarily below 82 ft (25 m), and thus have a low probability of flying within the RSZ.

Available data for piping plovers suggest that, while some individuals may cross the Lease Area (Loring et al. 2019), there is minimal overall use. Flight height estimates from Motus tags suggest that plovers generally fly relatively high in the WEAs (mean height 1,040 ft [317 m), and that plover migration peaks in early August, and on nights with high visibility, little to no precipitation, and high atmospheric pressure (Loring et al. 2019), further reducing the potential for collision. Plovers also have good visual acuity and maneuverability in the air (Burger et al. 2011), and there is little evidence to suggest that they are particularly vulnerable to collisions during migration.

For red knots, tracking data suggests that some individual long-distance south bound migratory knots may pass through the WTA. Three knots tagged with Motus tags were estimated to pass through the New Jersey WEAs (Loring et al. 2018). One out of 11 birds tagged in coastal New Jersey with GPS flew through the WTA, and the straight-line flight paths of six other birds suggests they may have flown through or near to the WTA (Appendix II-F3). Flight heights during long-distance migrations are thought to normally be 3,280 to 9,843 ft (1,000 to 3,000 m), except during takeoff and landing at terrestrial locations (Burger *et al.* 2011). However, Red Knots are likely to adjust their altitude to take advantage of local weather conditions, including flying at lower altitudes in headwinds (Baker et al. 2020), or during periods of poor weather and high winds (Burger et al. 2011). While flight height data from Motus studies have large error estimates (i.e., >656 ft [>200 m]), Loring et al. (2018) found red knots to have a wide range of flight heights from 72 ft (22 m) to 2,893 ft (882 m), indicating some potential exposure to the RSZ. These results align with the estimated flight heights of migratory shorebirds in federal waters, where the mean spring flight altitude is 2,999 ft (914 m) and the mean altitude in the fall is 1,788 (545 m; Loring et al. 2021). The bird carrying a GPS that passed through the WTA had an altitude of 1,886 ft (575 m), which is above the Project's RSZ. During fall migration, red knot flights across WEAs occurred under clear skies with little to no precipitation (Loring et al. 2018). Therefore, while red knots may pass through the WTA, they would be expected to fly during fair weather conditions when collision risk is likely lower.

Atlantic Shores is committed to continue supporting additional data gathering on these, and other, avian species and their potential use of the WTA. Specifically, Atlantic Shores is continuing a multi-year satellite tagging surveys of Red Knots and has affixed two Motus antennas on separate metocean buoys in the WTA in 2021. The red knot satellite tagging surveys will help Atlantic Shores and its research partners gain a better understanding of potential red knot movements offshore, calibrated for season, weather, and flight height.

4.3.2.2 Light

Artificial lighting to promote safe operation of the Projects onshore and offshore will be required during construction, O&M, and decommissioning. During construction and decommissioning, there will be a temporary increase in lighting from construction equipment and vessels that have navigational lights, deck lights, and interior lights. During O&M, vessel traffic and associated vessel lighting will also occur but at a lower frequency than during construction and decommissioning. In addition, operational WTGs will require lighting that complies with Federal Aviation Administration (FAA), U.S. Coast Guard (USCG), and BOEM guidelines. Other temporary lighting (e.g., helicopter hoist status lights) may be used for safety purposes, when necessary.

To minimize the offshore effects of lighting, Atlantic Shores is considering the use of an Aircraft Detection Lighting System (ADLS), subject to FAA and BOEM approval, which will substantially reduce the time the aviation obstruction lighting mounted on WTGs is illuminated. An assessment of the activation frequency of an ADLS indicates that it would be activated less than 11 hours per year (see Appendix II-M4). An ADLS automatically activates all aviation obstruction lighting (i.e., any FAA lighting on nacelles or towers) when aircraft approach the WTGs; at all other times, the lighting is off. The use of ADLS is expected to further reduce bird exposure to operational lighting. Yellow flashing marine navigation lights will be used on the WTGs instead of constant white light to reduce further bird attraction. As a result of these lighting modifications and precautions, only short-term, localized effects from artificial lighting on birds are likely. Further, lighting will be limited to Project vessels, vehicles, equipment, and structures, most of which will be associated with other activities that would deter birds. As practicable, down-lighting and down-shielded lighting will be used to avoid and minimize effects.

The Onshore Project Area is situated within and/or immediately adjacent to urbanized areas, thus effects from additional light emitted by the Projects' activities and installations (e.g., substations) are expected to be very limited. Artificial lighting will be needed onshore during construction to light vehicle pathways and construction activity. Like offshore, construction lighting will be temporary, localized to the work area, and downlighted/shielded to the maximum extent practicable. Effects from lighting during decommissioning are expected to be like those during construction and will be temporary. During decommissioning all artificial lighting will be removed.

4.3.2.3 Noise

Noise effects to birds may occur when intense sound interferes with normal breeding, foraging, and resting periods (Ortega 2012). Though the noise intensity of each source varies considerably, birds have the potential to be affected by noise in all phases of the Projects, from sources such as aircraft, impact pile-driving, vehicle and vessel traffic, and onshore and offshore construction equipment, in general. Aircraft may be used to transport construction/maintenance personnel and for wildlife surveys (Section 5.6 of Volume I). Low-flying aircraft could cause birds to flush and expend extra energy (Brown 1990); however, this effect would be temporary and limited to offshore areas near the aircraft flight path. Noise from vessel traffic is expected to be minimal and not to directly affect birds compared to actual vessel movements.

Impact pile-driving associated with the installation of piled foundation concepts (Section 8.0 In-Air Noise and Hydroacoustics) has the potential to produce noise that could disturb birds occurring within the WTA (Teachout 2012). Pile-driving creates noise above the water that could temporarily displace birds from the area of construction, as well as underwater that could temporarily displace diving birds and associated prey species. The extent of these potential effects on birds known to frequent the WTA largely depends on the equipment used, duration of activity, and noise levels. Displaced birds would have large areas of ocean to relocate to, away from pile-driving, and are expected to return post-disturbance.

Onshore construction noise from the operation of vehicles and equipment could temporarily displace birds from nearby habitats (Bottalico et al. 2015), although these effects are expected to be temporary and highly localized. As discussed in Section 4.2 Coastal and Terrestrial Habitat and Fauna, the Onshore Project Area consists predominantly of previously disturbed and developed areas, so birds in the area are expected to be habituated to ambient noises typical of urban areas or would move away from construction noise. During O&M, noise from onshore substations during operations is expected to be minimal and not to affect birds because they are habituated to the ambient sounds of the area (see Section 8.0 In-Air Noise and Hydroacoustics).

Onshore noise effects during decommissioning are expected to be similar to onshore construction. Offshore noise effects during decommissioning are expected to be less than offshore construction as some activities, such as pile-driving, will not occur.

4.3.2.4 Vessel Traffic

The potential effects of vessel-related noise and lighting were addressed in Section 4.3.2.2 and 4.3.2.3. Vessels operating in the ocean have the potential to disturb birds on the water, or in flight, during all phases of the Projects. These disturbances can cause incremental increased energy expenditure as birds take flight to avoid the vessel, and, among studied marine birds, loons are the most sensitive to ship traffic (Schwemmer et al. 2011). The greatest volume of vessel traffic would be anticipated during construction, and to a lesser extent decommissioning (Section 4.10 of Volume I); however, this traffic will be concentrated in the WTA or along segments of the ECC for relatively short periods of time. Movement of these vessels will be associated with other construction activities that will also temporarily disturb birds. Birds that are exposed to disturbing levels of activity, including vessel traffic, are likely to fly away to other areas to forage or roost, and are expected to return post-disturbance. Furthermore, vessel traffic associated with the Projects is estimated to be, on average, two to six vessel roundtrips per day collectively between construction staging port facilities under consideration and the offshore construction areas, which is low in comparison to existing commercial and recreational vessel traffic in these waters (see 7.6 Navigation and Vessel Traffic).

4.3.2.5 Installation and Maintenance of New Structures and Cables

The focus of this IPF discussion is the installation of offshore cables (i.e., export, inter-array, and inter-link cables), WTGs, and OSSs, and any localized, short-term disturbances of the seafloor (see Section 4.0 of Volume I) that could influence prey species for birds foraging offshore. Offshore cable and foundation installation may temporarily disrupt the foraging behavior of diving species groups (e.g., loons) within the area of disturbance, as described previously in Sections 4.3.2.3 and 4.3.2.4 on Project-related noise and vessel activity, respectively (BERR 2008; Niras Consulting 2015).

As addressed in Section 3.2 Water Quality, Section 4.5 Benthic Resources, and Section 4.6 Finfish, Invertebrates, and Essential Fish Habitat, seafloor disturbances, caused by seafloor preparation for foundations, pile-driving, offshore cable installation, and vessel anchoring, will result in localized, short-term suspension of sediment in the water column during construction. Increases in suspended sediment are likely to affect the turbidity lower in the water column, and not likely to reduce underwater visibility that birds rely on for foraging (Cezilly 1992). Effects on birds of this nature would be isolated events and expected to be temporary and highly localized. Once disturbance ceases, suspended sediment will settle back to the seafloor.

Installation of onshore interconnection cables is expected to largely occur in existing corridors (i.e., along existing roadway, utility rights-of-way [ROWs], and/or along bike paths). While most of the onshore interconnection cable routes will be installed via open trenching, Atlantic Shores will employ trenchless specialty installation techniques, such as jack-and-bore, pipe jacking, and HDD, where needed to avoid impacts to wetland habitats. Disturbance to bird habitat is expected to be minimal, including minor tree-clearing near the Cardiff and Larrabee substation and/or converter station sites. The contiguous forest to the north, west, and east of the Cardiff POI is documented Barred Owl (*Strix varia*) habitat, a State threatened species; however, tree clearing will be limited to the fragmented wooded areas proximate to the current substation. This limited tree clearing will be the minimum required to install facility components, will not include mature trees, and will be conducted during the winter months. Habitat disturbance could reduce foraging and nesting habitat for birds, in general; however, these effects will be highly localized, and birds can move to other undisturbed areas (Cook and Burton 2010).

During O&M, periodic maintenance of the onshore facilities may be required. Any necessary maintenance will be accessed through manholes, thereby avoiding and minimizing land disturbance. Land disturbance during the decommissioning phase is expected to be like construction, except that further land clearing is not expected. Heavy equipment used to remove infrastructure could disturb some land, but most of this activity is expected to occur in already disturbed areas and will be temporary.

The use of horizontal directional drilling (HDD) at the landfall site, and trenchless specialty techniques for wetland crossings, will avoid effects to wetland and shoreline habitats (including any potential shoreline nesting areas) that are important for the Federally Threatened Piping Plover and Red Knot (Baker et al. 2020, Elliott-Smith and Haig 2020).

4.3.2.6 Summary of Potential Effects and Proposed Environmental Protection Measures

Of the avian species known to occur in the Offshore Project Areas, the vast majority are at low risk of collision and displacement due to limited exposure in the WTA, primarily due to the distance of the Projects from shore and the lack of significant underwater structures (e.g., shoals). Federally listed piping plovers and roseate terns are expected to have limited exposure to the WTA during migration. If individuals pass through the WTA, roseate terns would generally be expected to fly below the RSZ, while piping plovers would be expected to fly above the RSZ. Individual red knots may fly over the WTA but are generally expected to fly during fair weather conditions and at altitudes above the RSZ, which would reduce collision risk. For the Onshore Project Area, impacts to bird habitat will largely be avoided because the onshore project components are nearly completely co-located with areas of existing development.

Atlantic Shores will continue to study avian activity in the Onshore and Offshore Project Areas and has already taken precautionary steps and commitments to avoid and minimize Project-related effects on birds during construction, O&M, and decommissioning. Furthermore, Atlantic Shores will develop and implement a post-construction monitoring plan and will document any dead or injured birds incidentally encountered on vessels or structures.

Additional avoidance and minimization measures and tools will be evaluated further as the Projects progress through development and permitting, in coordination with Federal and State jurisdictional agencies and other stakeholders. Atlantic Shores proposes to implement the following avoidance and minimization measures to reduce impacts to birds throughout the Onshore and Offshore Project Areas.

Offshore

- An Avian and Bat Survey Plan has been implemented, in conjunction with BOEM and the USFWS, that includes digital aerial surveys and a satellite telemetry study of the Federally protected red knot to further characterize the WTA and support consultations.
- Two Motus receiving antennas have been installed on separate metocean buoys to track the offshore movement of tagged bird species within the WTA.
- A Bird and Bat Monitoring Plan (BBMP) will be developed and implemented prior to the commencement of offshore construction in coordination with USFWS and other relevant regulatory agencies. Annual monitoring reports will be used to determine the need for adjustments to monitoring approaches, consideration of new monitoring technologies, and/or additional periods of monitoring.
- Lighting during operations will be limited to the minimum required by regulation and for safety, minimizing the potential for any light driven attraction of birds.
- Attraction to structures will be reduced by using perch deterrents to the maximum extent practicable.
- Red flashing FAA lights and yellow flashing marine navigation lights will be used on the WTGs, instead of constant white light, to reduce further bird attraction, and ADLS is being considered to significantly reduce the number hours FAA lighting will be illuminated.
- Down-lighting and down-shielding lighting will be used to the maximum extent practicable.
- Marine debris caught on offshore project structures will be removed, when safe and practicable, to reduce the risk of bird entanglement.
- An avian post-construction monitoring plan will be developed and implemented.
- Any dead or injured birds will be reported to BOEM on an annual basis. Any birds with USFWS bands will be reported to the USGS Bird Banding Lab.
- .
- Atlantic Shores will implement the following measures in accordance with the Offshore Renewable Energy Credit (OREC) allowance that the New Jersey Board of Public Utilities (NJBPU) awarded to Atlantic Shores on June 30, 2021:

- Maintain and update the Environmental Protection Plan (EPP) and Fisheries Protection Plan (FPP) at key Project milestones, including commencement of construction, completion of construction, and every 2 years thereafter, through decommissioning, or at other times as requested by NJDEP to ensure that impacts are being actively monitored and mitigated.
- Update the EPP and FPP to ensure New Jersey's natural resources, including finfish and shellfish, sea turtles, marine mammals, avian species, bats and benthic populations are protected throughout the life of the Project from pre-construction through decommissioning and to ensure that any impacts are being actively monitored and mitigated as required by law.
- Provide funding to the State of New Jersey for research initiatives and the regional monitoring of wildlife and fisheries related to the introduction of offshore wind projects. The funding will be administered by the New Jersey Department of Environmental Protection (NJDEP) and NJBPU, with stakeholder input to aid in the identification and prioritization of regional research and monitoring needs.
- Report annually in writing to BPU and NJDEP beginning June 30, 2022, on actions taken to ensure environmental protection, fisheries protection, mitigation of environmental and/or fishing impacts. This report will specifically address how Atlantic Shores is enacting its plans for environmental and fisheries protection and mitigation of impacts as articulated in its Application to BPU. An appendix to the report will indicate the data collected in the reporting period, and will include an accessibly written, narrative description(s) of the dataset(s), the associated findings made based upon these data, and reference(s) to the data portal(s) where these data can be publicly accessed. This appendix will be made public.
- Report annually in writing to BPU and NJDEP beginning June 30, 2022, on the policies and programs that may be adopted by BPU or NJDEP to help reduce future environmental or fisheries impacts or enhance the protection of natural resources. This report will detail any proposed future mitigation or protection measures that could be adopted, providing a description, proposed timeline, and expected outcomes of the recommended action.
- Make public through appropriate data portals, all data collected in the development of the Project from pre-construction activities through decommissioning activities. All collected information and scientific data not deemed confidential by statute or regulation will be made publicly available. Specifically, data with particular emphasis on natural resources including, but not limited to, finfish and shellfish, sea turtles, marine mammals, avian species, bat and benthic populations, as well as data regarding vessel strikes, avoidance, observations on habitat, and routine data collection on ocean conditions will be shared in a manner that is in keeping with best practices for the reporting of these types of data. Atlantic Shores will report annually to BPU and NJDEP beginning June 30, 2022, describing the type of data shared, and where the data is shared.

Should a common database for New Jersey-related, scientific data generated in association with offshore wind development be created, Atlantic Shores will archive all data collected with the development of the Project in that data repositor.

Onshore

- Onshore cables will be buried, thus avoiding collision risks to birds associated with overhead structures and conductors.
- HDD at the landfall site and trenchless cable installation techniques for wetland crossings will be used to avoid impacts to wetlands and shoreline habitats, including any potential shoreline nesting areas, such as those for the Federally listed threatened piping plover and red knot.
- Tree clearing will be minimized to the maximum extent practicable. This limited tree clearing will be the minimum required to install facility components, will not include mature trees, and will be conducted during the winter months.
- Onshore construction lighting will be temporary and localized to the work area.
- Lighting during operations will be limited to the minimum required by regulation and for safety, minimizing the potential for any light driven attraction of birds.

  The communication antenna, if built, will be designed in accordance with USFWS guidelines to the extent practicable, including lighting and support system characteristics.

4.4 Bats

This section describes bats that may be present in the Offshore and Onshore Project Areas, associated impact-producing factors (IPFs) and environmental protection measures to be considered during construction, operations and maintenance (O&M), and decommissioning. The Offshore Project Area includes the export cable corridors (ECC) and the Wind Turbine Area (WTA), which includes Project 1, Project 2 and the Overlap Area.

4.4.1 Affected Environment

This section synthesizes the state of the science on bat activity and focuses on the species with the potential to occur within the Offshore and Onshore Project Areas. This information includes scientific literature, publicly available data, and information provided by the NJDEP about known roosting locations of the Federal and State listed northern long-eared bat (*Myotis septentrionalis*). Published studies of offshore bat activity were reviewed, as well as data from Sjollema et al. (2014) made publicly available as part of the NJDEP Baseline Studies[14] (Geo-Marine, Inc. 2010), to investigate spatial relationships between bat observations and the WTA.

[14] Some figures in this document were developed using NJDEP Geographic Information Systems (GIS) digital data, but this secondary product has not been verified by NJDEP and is not State-authorized.

Atlantic Shores conducted a desktop assessment of onshore and offshore bat presence and has also implemented an offshore Avian and Bat Survey Plan (Survey Plan) that builds upon, and fills gaps, from previous survey efforts. The Survey Plan includes pre-construction vessel-based acoustic bat surveys throughout the WTA and was developed in consultation with the New Jersey Department of Environmental Protection (NJDEP), U.S. Fish and Wildlife Service (USFWS), and the Bureau of Ocean Energy Management (BOEM). This Survey Plan provides data to assess the spatial and temporal distributions of bat species throughout the WTA and will support characterizing bat exposure to the Projects Areas.

4.4.1.1 Offshore

Bat Presence Offshore

This section focuses on the potential for bat presence offshore and within the WTA. At its closest point, the WTA is located approximately 8.7 miles (mi) (14.0 kilometers [km]) offshore from the New Jersey coastline. Most scientific literature related to bats in the offshore environment are natural history accounts documenting species compositions, phenology, and observation locations of individuals (reviewed in Peterson et al. 2014). Older accounts of offshore bat activity were documented by natural historians with in-person encounters from ships or coastlines; however, recently researchers have used passive acoustic monitoring on offshore land masses, platforms, buoys, and/or boats. Some publications on offshore bat activity have concluded that the primary drivers of bat presence are seasonality, weather, and wind speeds (Johnson et al. 2011; Pelletier and Peterson 2013; Pelletier et al. 2013; Peterson 2016), echoing similar findings from onshore studies.

Within the eastern United States, long-distance (270–1,080 nm [500–2,000 km]; Fleming and Eby 2003) migratory tree bat species make up the majority of species observed offshore (Peterson 2016). The species identified offshore include eastern red bats (*Lasiurus borealis)*, hoary bats *(Lasiurus cinereus)*, and silver-haired bats *(Lasionycteris noctivagans)* (Peterson 2016), with the eastern red bat being the most prevalent offshore (see Appendix 1 in Peterson et al. 2014). Although less common, *Myotids* have also been detected offshore and on islands.

The following studies have detected bats as far offshore as the proposed WTA:

- Peterson et al. (2016) detected bats from 2.8 nm (5.3 km) to 70.1 nm (130 km) offshore with a mean distance from shore of 32.6 nm (60.3 km [n = 35]) over 52 nights of acoustic monitoring from mid-July through September 2014, none of which were confirmed as *Myotids*.

- Sjollema et al. (2014) found that on average bats were detected 4.7 nm (8.7 km) [n = 166] from shore after over 86 nights of acoustic monitoring throughout the Mid-Atlantic. Eastern red bats were the most widely distributed species in the Mid-Atlantic, being detected both nearest (0.6 nm [1.2 km]) and farthest from shore (11.8 nm [21.9 km]).

- Hatch et al. (2013) observed bats up to 22.6 nm (41.8 km) offshore during surveys in the Mid-Atlantic using vessel-based observers and digital imagery.

- New York State Energy Research Development Authority (NYSERDA) recorded silver-haired bats at an offshore bat monitoring buoy deployed 37.8 nm (70 km) from shore in the New York Bight (NYSERDA on remote.normandeau.com).

Additionally, although *Myotids* are less common in the offshore environment than long-distance migratory species, the following studies have detected *Myotids* offshore within the eastern United States:

- Sjollema et al. (2014) detected *Myotids* as far as 6.2 nm (11.5 km) from the Mid-Atlantic coast during vessel-based surveys.
- Peterson et al. (2014) detected *Myotids* using a stationary acoustic monitor located on a small island containing only a lighthouse 22.5 nm (41.6 km) from the coast of mainland Maine.
- Thompson et al. (2015) reports *Myotids* (most likely little brown bats *[Myotis lucifugus]*) using a commercial fishing vessel as a roost approximately 60 nm (110 km) from the nearest land in the Gulf of Maine.
- Peterson (2016) detected *Myotids* during a buoy-based survey in the Gulf of Maine, albeit in very low numbers (four passes over 1,609 detector nights).
- Dowling et al. (2017) reports tri-colored bats active throughout the maternity season on Martha's Vineyard, Massachusetts.

Bat Presence Within the WTA

To further investigate bats that may be in the WTA, the subset of data collected by Sjollema et al. (2014) during the NJDEP Baseline Studies (see Volume 1 Appendix B in Geo-Marine, Inc. 2010) was reanalyzed (see Table 4.4-1). The NJDEP Study Area extends from the 33 feet (ft) (10 meters [m]) isobath to its boundary, roughly 20 nm (37 km) from the New Jersey coastline. In the NJDEP Study Area there were 55 observations of bats (53 acoustic detections and two visual detections) with no detection occurring within the WTA (see Figure 4.4–1). Despite a lack of detections in the WTA, 41.8% of observations were collected beyond 7.6 nm (14.0 km), the westernmost edge of the WTA. As in the complete Sjollema et al. (2014) dataset, eastern red bats were the most abundant species and had the greatest frequency of occurrence beyond the westernmost edge of the WTA. One additional difference was found between the reanalysis and Sjollema et al. (2014): using the U.S. base layer (ESRI, USA) to estimate the distance from shore for each observation, one *Myotid* was recorded 8.5 nm (15.75 km) from shore (see Table 4.4– and Figure 4.4–1), 2.3 nm (4.25 km) farther than the maximum distance from shore reported in Sjollema et al. (2014). Finally, the dataset contains nine sets of observations occurring within 5 minutes of each other. This suggests that bats either passed the survey vessel in numbers greater than one, individuals were interested in the vessels and made multiple passes of investigation, or some combination of the two. There are no threatened and/or endangered bats that occurred in the records in the NJDEP Study Area (see Table 4.4-1).

In 2020 and 2021, Atlantic Shores conducted pre-construction vessel-based acoustic bat surveys throughout the Lease Area. The Avian and Bat Survey Plan (Appendix II-F1) was developed in consultation with the NJDEP, USFWS, and BOEM. Surveys were focused on the southern portion of the Lease Area in 2020, and in the central portion in 2021. In 2020, the detector was deployed from August 16 – November 18 for 65 nights; in 2021, the detector was deployed from June 30 – November 1 for 115 nights. Combining both years of data, detections included the eastern red bat (*n*=495), big brown/silver-haired bat group (*n*=478), silver-haired bat (*n*=80), hoary bat (*n*=37), big brown bat (*n*=26), and *Myotis* species (*n*=3). No federally listed northern long-eared bats or Indiana bats were detected. Bats were detected from July to October, with spikes of detections in late August and early September. The last detection was on November 1, 2020, and October 24, 2021. The Bat Monitoring Report is provided as Appendix II-F4.

Table 4.4–1 Offshore Bat Occurrence Records in the NJDEP Study Area

Common Name	Scientific Name	Federal Status (Endangered Species Act [ESA])	State Status (NJDEP Division of Fish and Wildlife)	Active Period	Peak Offshore Occurrence	Migratory Habitat	Max Distance Observed Offshore in NJDEP Study Area	Observations	
								<7.6 NM (14.0 KM)	>7.6 NM (14.0 KM)
Eastern Red Bat	Lasiurus borealis	Not Listed	Not Listed	Apr 31–Oct 15	Aug–Sep	Latitudinal: Up to 2,000 km	16.4 km	13	6
Hoary Bat	Lasiurus cinereus	Not Listed	Not Listed	Apr 31–Oct 15	Aug–Sep	Latitudinal: Up to 2,000 km	5.18 km	1	0
Silver-haired Bat	Lasionycteris noctivagans	Not Listed	Not Listed	Apr 31–Oct 15	Aug–Sep	Latitudinal: Up to 2,000 km	18.9 km**	4	1
Little Brown Bat	Myotis lucifigus	Not Listed	Not Listed	Apr 31–Oct 15	NA	Regional: Generally <500 km	NA	NA	NA
Eastern Small-footed Bat	Myotis leibii	Not Listed	Not Listed	Apr 31–Oct 15	NA	Regional: Generally <500 km	NA	NA	NA
Big Brown Bat	Eptesicus fucscus	Not Listed	Not Listed	Apr 31–Oct 15	NA	Regional: Generally <500 km	NA	NA	NA

Table 4.4–1 Offshore Bat Occurrence Records in the NJDEP Study Area (Continued)

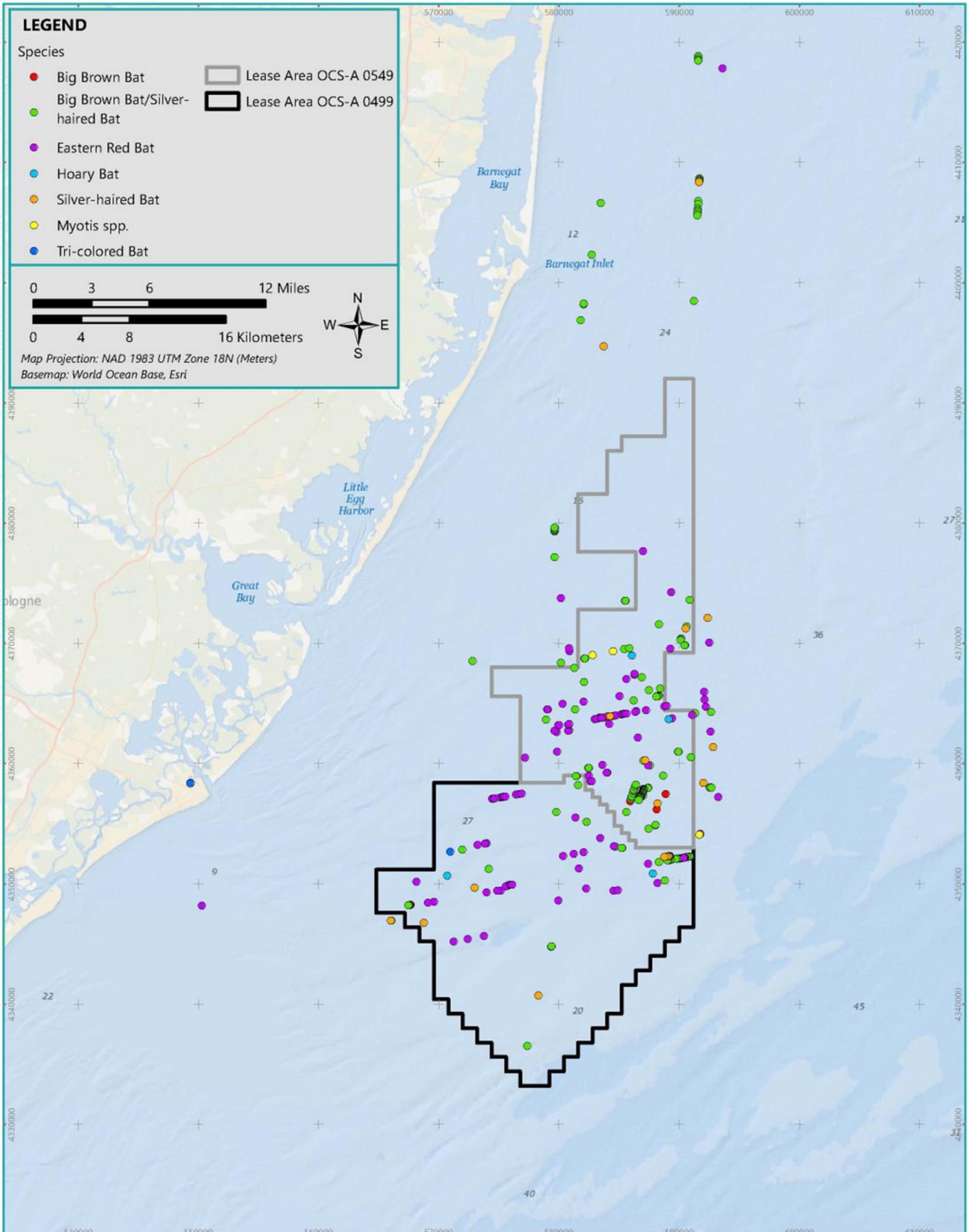
Common Name	Scientific Name	Federal Status (Endangered Species Act [ESA])	State Status (NJDEP Division of Fish and Wildlife)	Active Period	Peak Offshore Occurrence	Migratory Habitat	Max Distance Observed Offshore in NJDEP Study Area	Observations	
								<7.6 NM (14.0 KM)	>7.6 NM (14.0 KM)
Tri-colored Bat	Perimyotis subflavus	Not Listed	Not Listed	Apr 31–Oct 15	NA	Regional: Generally <500 km	NA	NA	NA
Myotis spp.	NA	NA	NA	Apr 31–Oct 15	Aug–Sep	Regional: Generally <500 km	15.7 km	2	1

Notes:

*Observations less than 7.6 nm (14.0 km) from shore represent records west of the WTA and observations greater than 7.6 nm (14.0 km) represent records east of the WTA westernmost boundary. Rows containing NA result from the species not being detected in the NJDEP Study Area despite having the potential of being observed in the area based on their known distributions.

**Silver-haired bats were classified as silver-haired bat/big brown bat because their acoustic calls are often ambiguous, though big brown bats have not been reported offshore elsewhere and silver-haired bats are one of the most common species offshore and we therefore concluded that the calls are likely silver-haired bats.

Source:
Geo-Marine, Inc. (2010).



ATLANTIC SHORES offshore wind

Figure 4.4-1

2020-2021 Bat Acoustic Detections Atlantic Shores Lease Areas OCS-A 0499 and OCS-A 0549

Acoustic monitoring efforts recorded bats at a maximum of 10.2 nm (18.9 km) from shore in the NJDEP Study Area. In addition, two eastern red bats were visually observed 9.5 nm (17.6 km) and 12.9 nm (23.9 km) from shore by human observers on the deck of the vessel conducting bird surveys (Geo-Marine 2010). Both bats were observed during daylight hours.

Patterns in Offshore Bat Activity

Bats have been detected offshore from April through November; however, offshore bat activity peaks significantly throughout the autumn migration period of August to October across all records (Peterson et al. 2014; Lagerveld 2015, 2017, 2020; Peterson 2016; Sjollema et al. 2014). The coincidence of offshore presence within the known migratory period suggests that the offshore environment is related to the migratory behavior of certain species. Individuals migrating long distances south from northeastern Canada and U.S. may achieve a rapid and energetically beneficial migration by traveling a more direct route between summering and wintering locales rather than following the coastline (Alerstam 2000, 2008; Gill et al. 2009; Hedenström 2009; Bauer et al. 2010). Bats may also be seen offshore in pursuit of other landmasses (Allen 1923; Van Gelder and Wingate 1961) or for foraging opportunities during migration. However, bats are more likely following foraging opportunities that begin on the coast and end up at various distances offshore where they take advantage of ephemeral pulses of high-quality prey (Shannon 1916; Russell et al. 1998; Wikelski et al. 2006; May 2013; Westbrook et al. 2016).

Bat activity offshore is consistently negatively correlated with wind speed (Ahlén et al. 2009; Cryan and Brown 2007; Sjollema et al. 2014; Peterson et al. 2014; Hüppop and Hill 2016; Peterson 2016). Peterson (2016) found that mean nightly wind speed had a negative effect on activity up to 22.4 miles per hour (mph) (10 meters per second [m/s]). Sjollema et al. (2014) found bats active up to 15.4 mph (6.9 m/s), and in Europe Ahlén et al. (2009) found that the majority of bat flights across the Baltic Sea took place at wind speeds less than 11.2 mph (5 m/s), although flights in winds of 22.4 mph (10 m/s) have been observed. In at least one study, ambient temperature was correlated with bat activity, finding that bat detection was greatest between a nightly range of 44.6 and 68°F (7–20°C) (Peterson 2016). During the 2020 and 2021 acoustic surveys aboard geophysical and geotechnical (G&G) vessels, the mean wind speed when bats were detected was 10.3 mph (4.6 m/s), ranging from 1–30 mph (0.5–12.5 m/s), but varied by species. The mean temperature when bats were detected was 74.6° F (23.7° C), ranging from 58.3–83.6° F (14.6–28.7° C); however, the temperature readings may have been influenced by heat generated by the survey vessel itself (see Appendix II-F4).

Reports of flight heights are mixed (Ahlén et al. 2009; Hatch et al. 2013). Ahlén et al. (2009) reports consistent flight heights less than 32.8 ft (10 m) and then rapidly increasing altitude in response to structures such as lighthouses, wind turbine generators (WTGs), and ships. However, Brabant *et al.* (2018) reported that offshore acoustic bat activity recorded at nacelle height is significantly less than at lower heights. Despite a maximum observed flight height of approximately 656 ft (approximately 200 m; Hatch et al. 2013) in the offshore environment, tree bats have been observed at much greater flight altitudes onshore. Peurach (2003) recorded a hoary bat being struck by an aircraft in October at 7,999 ft (2,438 m) above sea level. The incident was during the peak migratory period, suggesting that hoary bats can travel at altitudes many times greater than the Project's rotor swept zone (with a maximum height of 1,047 ft [319 m]) (see Figure 4.3-1 in Volume I). Furthermore, based on their conclusions that bats were using an offshore platform in the North Sea as a migratory refuge, Hüppop and Hill (2016) speculate that offshore migratory behavior may be associated with high altitude flights and low altitude activity may be associated with interruptions in those migratory flights.

4.4.1.2 Onshore

There are eight species of bats in New Jersey with ranges that overlap the Onshore Project Area (landfall sites, onshore interconnection cable routes, onshore substations and/or converter stations, and points of interconnection [POI]). These species are often classified as short-distance regional migrants (i.e., species that migrate less than 311 mi [500 km]) or long-distance migrants (i.e., species that migrate up to 1,243 mi [2,000 km]).

Short-distance regional migrants include the following:

- Big brown bat
- Eastern small-footed bat
- Little brown bat
- Northern long-eared bat
- Tri-colored bat

Long-distance migrants include the following:

- Eastern red bat
- Silver-haired bat
- Hoary bat

Of the species found in the Onshore Project Area, only northern long-eared bats are currently listed under the Endangered Species Act (ESA) of 1973 (U.S. Code 16 § 1531 et seq.). In New Jersey, northern long-eared bat and little brown bat are listed as a Focal Species of Greatest Conservation Concern (NJDEP 2018). Further, little brown bats and tri-colored bats are listed on the national work plan for ESA review (USFWS 2019).

Northern long-eared bats are considered regional migrants, as they travel from summering grounds back to thermally buffered hibernacula in caves, mines, and sometimes older buildings where they stay throughout the winter (Caceres and Barclay 2000, Henderson and Broders 2008). They spend the remainder of the year active in forested habitats (USFWS 2016). Between March and November, they have home ranges that can be up to 170 mi (275 km) from hibernation sites

(Griffin 1945). They have small foraging ranges of less than 25 acres (10.1 hectares) from day roost sites (Dowling et al. 2017). Maternity colonies are hard to identify as they are in trees and move every 2 to 14 days (Menzel et al. 2002). The young are volant by mid-July and both adults and young remain within their maternity colonies until mid-August before commencing return migrations to hibernacula (Carter and Feldhamer 2005; Menzel et al. 2002).

As detailed in Sections 4.7 to 4.9 of Volume I, the Projects include two landfall sites and associated onshore interconnection cable routes, substations and/or converter stations. Onshore interconnection cables will travel underground primarily along existing roadways, utility rights-of-way (ROWs), and/or along bike paths.

Northern long-eared bats occur throughout most townships and boroughs for each of the landfall sites, onshore interconnection cable routes, onshore substations and/or converter stations, and POIs. Records of summer foraging activity are in all townships and boroughs except Pleasantville City. Records of roost trees, including maternity colonies, exist in Howell Township but they are all within the confines of Earle Naval Weapons Station or further north (NJDEP, personal communication, October 2020). There are no records of roost trees, maternity colonies, or hibernacula in Absecon, Pleasantville City, or Wall. A maternity colony is located west of the Atlantic City Internship Airport near the Egg Harbor Township line, approximately 2.88 mi (4.64 km) away from the proposed Cardiff onshore interconnection cable route. Currently there are no records of northern long-eared bat hibernacula within 10 mi (16 km) of the Onshore Project Area (NJDEP, personal communication, October 2020).

White-nose syndrome (WNS) is the primary threat to northern long-eared bat and the USFWS does not consider ROW development or expansion a significant threat to the species given the small portion of forested habitat that it affects (USFWS 2016). Furthermore, summer habitat is not a limiting factor for the species; thus, management priority should be placed on protecting hibernacula (USFWS 2016).

In 2016, the USFWS promulgated a Section 4(d) rule under the ESA that states incidental take of northern long-eared bats is not prohibited within the WNS zone, which includes New Jersey, if the following two conservation measures are followed:

- The application of a 0.25 mi (0.4 km) buffer around known occupied northern long-eared bat hibernacula. Hibernacula are defined as locations where one or more northern long-eared bat have been detected during hibernation or at the entrance during fall swarming or spring emergence.

- Tree removal activity must not cut or destroy known occupied maternity roost trees, or any other trees within a 150 ft (45 m) radius around the maternity roost tree, during the pup season (June 1 through July 31).

There are no known hibernacula within the designated buffer of the Onshore Project Area (NJDEP, personal communication, October 2020), and there are no known maternity roost trees within 150 ft (45 m) of any planned onshore activities (NJDEP, personal communication, October 2020). Therefore, while incidental take of northern long-eared bats is not anticipated to occur in connection with construction and O&M activities within the WNS zone, the USWFS Section 4(d) rule for northern long-eared bats would not prohibit any such incidental take.

4.4.2 Potential Impacts and Proposed Environmental Protection Measures

The potential IPFs which may affect bats during construction, O&M, or decommissioning of the Projects are presented in 4.4-2.

Table 4.4–2 Impact Producing Factors for Bats

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Presence of Structures		●	
Light	●	●	●
Noise	●	●	●
Land Disturbance: Onshore Construction	●	●	●

The maximum Project Design Envelope (PDE) analyzed for potential offshore effects to bats is the maximum offshore build-out of the Projects (see Sections 4.3.1. and 4.11 of Volume I). The maximum PDE analyzed for potential onshore effects to bats is the maximum onshore build-out of the Projects (see Section 4.11 of Volume I).

4.4.2.1 Presence of Structures

The presence of structures in the offshore environment may have direct and indirect impacts on bats via WTG collision and migration disturbances during the O&M phase (Arnett et al. 2008; Arnett and Baerwald 2013; Arnett et al. 2016; Zimmerling and Francis 2016; Frick et al. 2017). Although the diversity of species and density of bats in the WTA is lower relative to the onshore environment, structures may disrupt migration as bats use structures as potential roosting habitat and/or investigate the area for foraging resources or mating/social interactions (Cryan 2008; Cryan and Barclay 2009; Cryan et al. 2012; Cryan et al. 2014).

Bats will be most exposed to the WTA during the migratory period, particularly autumn (Peterson et al. 2014; Lagerveld 2015, 2017, 2020; Peterson 2016). The species with the highest mortality rates at onshore WTG arrays are the species with the greatest abundance offshore (eastern red bat, hoary bat, and silver-haired bat). However, these species are less abundant offshore, so, if collisions were to occur, only a limited number of individuals would be expected to be affected and population level effects are unlikely.

Although WTGs are proposed 7.6 nm [14 km] offshore, and there is significant uncertainty on bat movement and behavior offshore, it is possible that they may impede migratory flyways and interfere with other life history traits, such as migratory refueling, and potential mating behavior that occurs throughout migration (Drueker 1972; Cryan et al. 2012). However, the range at which bats are drawn to WTGs is currently unknown, and these indirect effects are largely unknown.

Recent evidence onshore suggests that insects may be attracted to WTG nacelles and could be used as swarming sites (Jansson et al. 2020). While information on whether this phenomenon occurs offshore is currently lacking, it may be possible that migrating or swarming insects could temporarily congregate near the WTA, briefly creating foraging opportunities for bats and increasing the chance of WTG collisions (Ahlén et al. 2009; Rydell et al. 2010a; Jansson et al. 2020). Although bats use offshore structures to opportunistically forage and temporarily roost (Ahlén et al. 2009), the frequency of such interactions is temporally and spatially isolated and relatively low compared to onshore WTG arrays.

In a meta-analysis investigating drivers of bat mortality at onshore wind farms, Thompson et al. (2017) showed that open landscapes (i.e., increased grasslands relative to more heterogeneous environments) had an inverse relationship with bat mortality. The authors suggest this may result from fewer individuals using massive open grasslands during migration translating into fewer encounters with wind energy facilities. Further, in heterogeneous landscapes there are features such as ridgelines that can concentrate migrating individuals into WTG arrays, resulting in increased exposure. Rydell et al. (2010b) echo these findings in northwestern Europe by showing that mortality rates associated with WTGs in open landscapes were significantly lower than WTGs within more complex habitat matrices. Given that bats are relatively uncommon offshore and that the offshore landscape is open (i.e., there are no landscape features), it is expected that mortality rates will be relatively low offshore and population level impacts are unlikely. There are no anticipated impacts associated with bats interacting with onshore structures such as substations.

4.4.2.2 Light

The effect of lights on bats is species-specific, depends on behavioral contexts, and may affect foraging (Haddock et al. 2019; Bailey et al. 2019; Russo et al. 2019), commuting (Stone 2015; Stone et al. 2009), emergence, roosting, and breeding (reviewed in Stone et al. 2015). Lighting can disrupt the composition and abundance of prey (Davies et al. 2012) and thus shift bat foraging strategies between lit and unlit sites (Cravens et al. 2018). Migratory species in Europe have a diverse set of responses to light-emitting diode light source (LED) lighting, exhibiting increased foraging when exposed to warm-white light and exhibiting phototaxis attraction when exposed to red and green LED light (Voigt et al. 2017, 2018). In the U.S., Cravens and Boyles (2019) found that of seven observed species, eastern red bats were the only species to prefer LED lit areas as they presumably gained some advantage in foraging success near lit areas. From light tolerance studies, *Myotids* appear to be the species most intolerant of intensely lit areas (Stone et al. 2009; Lacoeuilhe et al. 2014) perhaps from the reduced capacity to evade predators by these more slowly flying bats (Stone et al. 2015).

Offshore

Artificial lighting will be required during the construction, O&M, and decommissioning of the offshore Projects. During construction and decommissioning, there will be a temporary increase in lighting from construction equipment and vessels with navigational, deck, and interior lights. During O&M, WTGs will require lighting that complies with Federal Aviation Administration (FAA), U.S. Coast Guard (USCG), and BOEM guidelines. Vessel use and associated lighting will also occur, though at a lower frequency than during construction and decommissioning. Other temporary lighting (e.g., helicopter hoist status lights) may be used for safety when necessary. However, down-lighting and down-shielding lighting will be used where practicable, such as at offshore substations.

At WTG arrays, Bennett and Hale (2014) found that eastern red bat fatality rates are significantly reduced at WTGs with red flashing lights compared to WTGs with no lights, and mortality rates for all other species observed in the study did not correlate with lighting. This suggests that hoary bats are neither attracted nor repelled from red aviation lighting on WTGs, and eastern red bats are not attracted to aviation lights. Further, Arnett et al. (2008) showed that blinking red lights did not significantly influence the mortality rates of bats at onshore wind energy facilities. Red aviation lighting is less likely to attract invertebrate prey which may partly drive patterns of reduced attraction (Bennet and Hale 2014).

To minimize the offshore effects of lighting, Atlantic Shores is considering the use of an Aircraft Detection Lighting System (ADLS), subject to FAA and BOEM approval, which will substantially reduce the time the aviation obstruction lighting mounted on WTGs is illuminated. An ADLS automatically activates all aviation obstruction lighting (i.e., any FAA lighting on nacelles or towers) when aircraft approach the WTGs; at all other times, the lighting is off. The use of ADLS is expected to further reduce bat exposure to operational lighting. An assessment of the activation frequency of an ADLS indicates that it would be activated less than 11 hours per year (see Appendix II-M4). Marine navigation lighting will include yellow flashing lights, which are not expected to serve as an attractant for insects, upon which bats may prey.

Onshore

The Onshore Project Area occurs within and adjacent to urbanized and residential areas, thus additional light emitted by substations and/or converter stations is expected to be minimal. Atlantic Shores is not anticipating significant nighttime work, yet artificial lighting may be needed onshore during construction to light vehicle pathways and construction activity. Onshore construction lighting will be temporary and localized to the work area. During O&M, lighting may have an indirect effect on bats by disrupting commuting routes (Stone et al. 2009) and reducing overall foraging habitat (Cravens et al. 2019). Onshore lighting will be used on an as-needed basis and the lighting fixtures will be equipped with hoods for down-shielding to the maximum extent practicable to minimize effects to bats (see Section 4.9.2 of Volume I). Effects from lighting during decommissioning are expected to be similar to those during construction and will be temporary.

During decommissioning, all artificial lighting will be removed. Atlantic Shores will minimize onshore work at night where practicable.

4.4.2.3 Noise

This IPF section addresses sound generated during activities conducted both onshore and offshore in the Project Areas, including pile driving and secondary noise sources, and the potential effect on bats.

Offshore

Noise occurring offshore during any of the three Project phases is not expected to have any direct effects on bats offshore, and the likelihood of indirect effects such as avoidance behavior, caused by noise, is believed to be low as North American bat species are regularly observed navigating through and foraging within noisy urban areas (Schimpp and Kalcounis-Rueppell 2018). Most studies showing negative effects of noise on bats demonstrate a noise-induced reduction in foraging efficiency for gleaning species only (Shaub et al. 2008, Bunkley and Barber 2015). All species with the potential to occur in the WTA are aerial insectivores and are not known to rely on passive listening for prey.

Bunkley et al. (2015) found that bats that emit low frequency (<35 kilohertz [kHz]) echolocation calls (e.g., silver-haired bats and hoary bats) were recorded less frequently at sites with compressor stations associated with natural gas extraction that produce broadband noise compared to quiet sites. Pile driving could produce similar levels of noise offshore resulting in avoidance behavior for low frequency emitting species, however there is no evidence to suggest that offshore pile driving would otherwise interfere with directional migratory flights, and noise associated with O&M and decommissioning is not expected to affect bat behavior.

Onshore

Because the Onshore Project Area is almost entirely co-located with existing developed areas, noise disturbance of bat habitat will be limited. There are potential temporary and localized direct and indirect effects to bats arising from onshore construction noise. During the non-hibernation period, noise from equipment during construction and decommissioning has the potential to cause avoidance behavior (Bunkley et al. 2015) or disrupt day-roosting bats, which may cause a direct effect through fleeing during daylight hours, increasing predation risk (Rydell et al. 1996). Noise effects will be temporary and localized and not expected to cause any long-term fitness disadvantages as frequent roost switching is common among bats (Whitaker 1998). Atlantic Shores will make reasonable efforts to minimize noise as feasible, including between August and October when the vast majority of onshore bat activity occurs during the fall migratory period. Onshore construction hours will adhere to local noise ordinances (see Section 8.0 and Appendix II-U). The Onshore Project Area avoids known northern long-eared bat hibernacula (NJDEP, personal communication, October 2020) and therefore would not disturb any listed hibernating bats during construction during the wintering season.

4.4.2.4 Land Disturbance: Onshore Construction

The siting of onshore facilities has avoided impacting bat habitat by siting them in existing developed areas. The installation and maintenance of cable landings, substations, and underground cables may have limited affects to bat habitat through temporary direct disturbance.

The greatest risk of direct effects to bats onshore is during the construction phase when there is potential for removal of trees used by bats for roosting (USFWS 2016). Some tree clearing may occur at the onshore substation sites (see Section 4.9 of Volume I); however, tree clearing is not expected at the landfall sites or along the onshore interconnection cable routes, which are located along existing roadway, utility ROWs, and/or along bike paths.

The maternity season for all bats including northern long-eared bat is typically between June 1 and July 31, and during this period tree removal must not occur within a 150 ft (45 m) radius around the maternity roost tree of northern long-eared bats. Currently there are no known northern long-eared bat hibernacula or maternity roost trees within 150 ft (45 m) of any planned onshore activities (NJDEP, personal communication, October 2020). However, within the State of New Jersey, northern long-eared bat is also currently a candidate endangered species, so the NJDEP also advises that any tree removal be done outside of the "active season" for northern long-eared bat, which is defined as April 1 to September 30 if there are no known northern long-eared bat hibernacula within 10 mi (16 km) of a project (NJDEP, personal communication, March 2021). Currently there are no records of northern long-eared bat hibernacula, maternity roosts, or roost trees within 10 mi (16 km) of the Project Areas (NJDEP, personal communication, October 2020). To avoid impacts to all bat species and especially to northern long-eared bat, any tree removal will take place outside of the April 1 to September 30 time-period. Overall, onshore construction activities are expected to be short-term and localized and not affect population-level fitness.

O&M of the onshore components including the substations and/or converter stations, and onshore interconnection cable routes is not expected to affect bats. No tree clearing is anticipated during O&M. Necessary maintenance to new and existing infrastructure will largely occur through manholes, thereby avoiding and minimizing the need for tree clearing. Effects to bat species during decommissioning are expected to be similar to construction and decommissioning of the Projects is not expected to result in additional habitat loss, except for the unlikely event that trees are removed for equipment to access a location.

4.4.2.5 Summary of Proposed Environmental Protection Measures

Atlantic Shores will implement the following environmental protection measures to reduce effects to bats throughout the Project Areas. Atlantic Shores will also continue to work with NJDEP, BOEM, and USFWS to outline additional avoidance and minimization measures where appropriate.

Offshore

- Two years of preconstruction vessel-based acoustic surveys for bats has been implemented to build upon and fill knowledge gaps from previous survey efforts.
- A Bird and Bat Monitoring Plan (BBMP) will be developed and implemented prior to the commencement of offshore construction in coordination with USFWS and other relevant regulatory agencies. Annual monitoring reports will be used to determine the need for adjustments to monitoring approaches, consideration of new monitoring technologies, and/or additional periods of monitoring.
- Lighting during O&M will be limited to the minimum required by regulation and for safety, minimizing the potential for any light driven attraction of bats or their insect prey and therefore reducing the effects of light on potential collisions of bats at night.
- Red flashing FAA lights and yellow flashing marine navigation lights will be used on the WTGs instead of constant white light, which has been shown to reduce eastern red bat fatality rates, the most prevalent species observed offshore. Furthermore, ADLS is being considered to significantly reduce the number hours FAA lighting will be illuminated.
- Down-lighting and down-shielded lighting will be used to the maximum extent practicable.
- A post-construction bat monitoring plan will be developed and implemented.
- data collected during the development of the Projects from pre-construction activities through decommissioning activities (not deemed confidential by statute or regulation) will be made available to the public to the extent practical. Specifically, data with particular emphasis on natural resources including, but not limited to, finfish and shellfish, sea turtles, marine mammals, avian species, bat and benthic populations, as well as data regarding vessel strikes, avoidance, observations on habitat, and routine data collection on ocean conditions will be shared in a manner that is in keeping with best practices for the reporting of these types of data. Atlantic Shores will archive all data collected with the development of the Projects.
- Atlantic Shores will implement the following measures in accordance with the Offshore Renewable Energy Credit (OREC) allowance that the New Jersey Board of Public Utilities (NJBPU) awarded to Atlantic Shores on June 30, 2021:
    - Maintain and update the Environmental Protection Plan (EPP) and Fisheries Protection Plan (FPP) at key Project milestones, including commencement of construction, completion of construction, and every 2 years thereafter, through decommissioning, or at other times as requested by NJDEP to ensure that impacts are being actively monitored and mitigated.
    - Update the EPP and FPP to ensure New Jersey's natural resources, including finfish and shellfish, sea turtles, marine mammals, avian species, bats and benthic populations are protected throughout the life of the Project from pre-construction

through decommissioning and to ensure that any impacts are being actively monitored and mitigated as required by law.

- Provide funding to the State of New Jersey for research initiatives and the regional monitoring of wildlife and fisheries related to the introduction of offshore wind projects. The funding will be administered by the New Jersey Department of Environmental Protection (NJDEP) and NJBPU, with stakeholder input to aid in the identification and prioritization of regional research and monitoring needs.
- Report annually in writing to BPU and NJDEP beginning June 30, 2022, on actions taken to ensure environmental protection, fisheries protection, mitigation of environmental and/or fishing impacts. This report will specifically address how Atlantic Shores is enacting its plans for environmental and fisheries protection and mitigation of impacts as articulated in its Application to BPU. An appendix to the report will indicate the data collected in the reporting period, and will include an accessibly written, narrative description(s) of the dataset(s), the associated findings made based upon these data, and reference(s) to the data portal(s) where these data can be publicly accessed. This appendix will be made public.
- Report annually in writing to BPU and NJDEP beginning June 30, 2022, on the policies and programs that may be adopted by BPU or NJDEP to help reduce future environmental or fisheries impacts or enhance the protection of natural resources. This report will detail any proposed future mitigation or protection measures that could be adopted, providing a description, proposed timeline, and expected outcomes of the recommended action.
- Make public through appropriate data portals, all data collected in the development of the Project from pre-construction activities through decommissioning activities. All collected information and scientific data not deemed confidential by statute or regulation will be made publicly available. Specifically, data with particular emphasis on natural resources including, but not limited to, finfish and shellfish, sea turtles, marine mammals, avian species, bat and benthic populations, as well as data regarding vessel strikes, avoidance, observations on habitat, and routine data collection on ocean conditions will be shared in a manner that is in keeping with best practices for the reporting of these types of data. Atlantic Shores will report annually to BPU and NJDEP beginning June 30, 2022, describing the type of data shared, and where the data is shared. Should a common database for New Jersey-related, scientific data generated in association with offshore wind development be created, Atlantic Shores will archive all data collected with the development of the Project in that data repositor.

Onshore

- Onshore facilities have been sited to avoid bat habitat to the maximum extent practicable.
- Tree clearing will be minimized to the maximum extent practicable. While no tree clearing is anticipated to occur during O&M phase of the project. Atlantic Shores will coordinate with USFWS in the event that significant tree clearing should be required.
- No known northern long-eared or tri-colored bat maternity or roost trees are present in the Onshore Project Area; however, to avoid potential conflicts, any tree removal activities will take place outside of the "active season" for northern long-eared and tri-colored bats, which is defined as April 1 to September 30.
- Onshore construction lighting will be temporary and localized to the work area.
- Lighting during O&M will be limited to the minimum required by regulation and for safety, minimizing the potential for any light driven attraction or deterrence of bats affecting their foraging behavior and exposure to predation and collisions.
- Down-lighting and down-shielded lighting will be used to the maximum extent practicable.
- Reasonable efforts will be made to minimize onshore construction noise.
- Onshore work at night will be minimized to the maximum extent practicable.
- The communication antenna, if built, will be designed in accordance with USFWS guidelines, to the extent practicable, including lighting and support system characteristics.

4.5 Benthic Resources

This section describes benthic resources and habitats present in the Offshore Project Area, which includes Project 1, Project 2, the Overlap Area, and the export cable corridors (ECCs). This section also assesses the impact producing factors (IPFs) associated with Project activities and the anticipated measures to avoid and minimize the potential effects to these resources. Benthic resources are important components of any marine ecosystem. Benthic habitats serve essential and diverse purposes within the marine ecosystem, influencing biological and behavioral processes and providing breeding, nursery, shelter, refuge, and foraging opportunities for a variety of benthic invertebrate and finfish species. Benthic invertebrate species are an important link in marine trophic interactions, typically acting as food sources for larger invertebrate or finfish predators. In addition to the ecological importance of benthic habitats and species, many species are considered recreationally or commercially important (see Section 7.4 Commercial Fisheries and For-Hire Recreational Fishing).

Atlantic Shores understands the importance of benthic resources to marine ecosystems and to the other ocean users relying on those ecosystems. Atlantic Shores has implemented benthic habitat assessment surveys, approved and accepted by Federal and State agencies, that build upon and fill data gaps from previously completed Federal and State funded initiatives to map and study benthic resources. These studies have provided data to characterize the seafloor and benthic habitats and to identify species occupying these habitats in the Offshore Project Area. In addition, Atlantic Shores will implement a benthic habitat monitoring plan to measure and assess the disturbance and recovery of marine benthic habitats and communities as a result of Project construction and operation (see Appendix II-H). These efforts have and will continue to inform Atlantic Shores' Project design and construction planning to avoid or minimize Project-related impacts.

4.5.1 Affected Environment

The description of benthic resource conditions within the Offshore Project Area is based on available literature, online data portals and mapping databases, and the results of Atlantic Shores' site-specific surveys. The site-specific surveys used to characterize benthic habitat and resources in the Offshore Project Area include the following:

- **Benthic video and grab sampling surveys** (2019) conducted as part of the Site Assessment Plan (SAP) (Appendix II-G1)[15]
- **Benthic video and grab sampling surveys** (2020 and 2022) conducted as part of the geophysical and geotechnical surveys (Appendix II-G2)
- **Benthic towed video surveys** (2021) conducted as part of the geophysical and geotechnical surveys (Appendix II-G3).
- **Sediment profile and plan view surveys** (2020 and 2022) conducted as part of the benthic infauna and habitat assessment sampling (Appendix II-G4).

Please refer to the above-referenced data reports for specific detail describing the benthic resources encountered during the surveys.

The affected environment for benthic resources spans the entirety of the Offshore Project Area which is comprised of the Wind Turbine Area (WTA) and the Atlantic and Monmouth ECCs up to the landfall sites. The WTA includes Project 1, Project 2, and the Overlap Area (see Volume I, Figure 1.1-2). For the purposes of this section and the analysis of benthic resources, the Overlap Area is included in both the Project 1 WTA and Project 2 WTA. The Offshore Project Area is located off the coast of Atlantic City, New Jersey within the Mid-Atlantic Bight. The shelf of the Mid-Atlantic Bight, a small portion of which will contain the offshore reaches of the Offshore Project Area, is characterized by valleys, channels, shoal massifs, scarps, and swales (Stevenson et al. 2004; BOEM 2012). Though these topographic features exist within the Mid-Atlantic Bight, most of the Offshore Project Area is topographically flat, characterized by smaller features such as ripples, mega ripples, sand bedforms, and sand ridges (Steimle and Zetlin 2000, Stevenson et al. 2004, BOEM 2012).

One distinct oceanographic feature of the Mid-Atlantic Bight is the Cold Pool. The Cold Pool is an oceanographic phenomenon referring to a bottom-trapped, cold, nutrient-rich pool that extends from Cape Cod, Massachusetts to Cape Hatteras, North Carolina, located over the mid- and outer-

[15] Benthic grab samples were conducted across the Lease Area as part of the 2019 SAP and 2020 Benthic Assessment Report, and along the ECCs in the 2020 Benthic Assessment Report. For the purposes of this report, only results within the Offshore Project Area will be discussed.

shelf of the Mid-Atlantic Bight (Chen 2018, Ganim 2019). The formation of the Cold Pool is driven by seasonal patterns in solar heating and wind (Ganim 2019) and is not spatially uniform (Lentz 2017). It forms at the start of spring when wind mixing is reduced, and surface heat fluxes increase causing the water column to become stratified (Ganim 2019, Lentz 2017). Freshwater runoff in the spring can further intensify stratification (Castelao et al. 2010). The Cold Pool, located along the seafloor, is isolated from warming surface waters by the seasonal thermocline and creates habitat conditions that provide thermal refuge to colder water species in the Mid-Atlantic Bight ecosystem (Lentz 2017). Cold Pool waters are nutrient-enriched and when upwelled toward the surface, can drive phytoplankton growth and high concentrations of particulate organic matter in the water column (Voynova et al. 2013). The timing of the formation and breakdown of the Cold Pool, as well as its spatial extent, varies significantly each year but generally develops annually between spring and fall (Chen and Curchitser 2020). The Cold Pool dissipates in the fall due to enhanced vertical mixing from an increase in the frequency of strong wind events and the cooling of surface temperatures (Ganim 2019). The timing of Cold Pool formation and breakdown has been linked to biological processes of marine invertebrates (e.g., surf clam growth and ocean quahog spawning) (Narvaez et al. 2015, Toupoint et al. 2012).

4.5.1.1 Benthic Habitat

Desktop Studies

Existing literature and data portals were reviewed to classify benthic habitat and determine the types of benthic habitat that may be present in the Offshore Project Area. There are approximately nine habitat types in the Offshore Project Area according to a classification and mapping study based on bathymetry, sediment grain size, and seafloor topography data conducted by Greene et al. (2010). The four most prevalent habitat types include: (1) depressions and mid-position flats[16] in 0 to 148 foot (ft) (0 to 45 meter [m]) water depths with coarse to fine sand; (2) mid-position flats and depressions in 82 to 148 ft (25 to 45 m) water depths with medium to coarse substrate; (3) mid-position flats in 82 to 148 ft (25 to 45 m) water depths on coarse to medium sand; and (4) depressions at moderate depths (15 to 82 m) on fine to coarse sand. Sediment types in the dominant habitats classified by Greene et al. (2010) support sediment classification efforts by The Nature Conservancy as part of the Northwest Atlantic Marine Ecoregional Assessment (NAM ERA) mapping[17] which shows that the Offshore Project Area is dominated by medium, coarse, and fine sands (see Figure 4.5-1). Specifically, the WTA is largely dominated by medium sand (0.01 to 0.02 in) (0.25 to 0.5 mm) and coarse sand (0.01 to 0.04 in) (0.5-1.0 mm), with smaller areas of fine sand (0.005 to 0.01 inch [in]) (0.125 to 0.25 millimeter [mm]). The Atlantic ECC consists of similar sediment sizes, dominated by medium sand to coarse sand in the central and southeastern portion of the route, and fine sand nearshore. The Monmouth ECC largely consists of coarse and medium sand, with medium and fine sand present in the nearshore portion.

[16] Mid-position flat refers to a broad, flat plain that is at an elevation and relative slope similar to the surrounding area (Greene et al. 2010).

[17] The NAM ERA uses grain-size data from the U.S. Geological Survey (USGS) and Woods Hole Coastal and Marine Science Center.

In addition to soft sediment, hardened structures created by shipwrecks, obstructions, or artificial reefs contribute to the benthic habitat available for marine species. These features represent areas of hard substrate projecting above the seabed that attract benthic resources and fish species in areas where reef habitat is sparse like the Mid-Atlantic Bight (Ross et al. 2015). Multiple shipwrecks are located in and along the borders of the Offshore Project Area. Additionally, two artificial reefs are located along the outer boundary of the Monmouth ECC, and one is located proximal to the southwestern corner of the WTA.

Living bottoms, such as corals (Phylum Cnidaria) and sponges (Phylum Porifera), could also provide habitat to benthic species; however, no corals were identified during site-specific benthic characterization surveys conducted between 2019 and 2021. Additionally, coral habitat suitability is low throughout the Offshore Project Area according to NOAA's Deep Sea Coral Research and Technology modeling (Kinlan et al. 2016). The Monmouth ECC is the only portion of the Offshore Project Area that could provide some habitat for non-gorgonian, coral species; however, habitat suitability in this area is classified as low to medium (Kinlan et al. 2016). Some sponge species were observed in the WTA, Atlantic ECC, and Monmouth ECC, during towed video surveys (see Appendix II-G3).

Site-Specific Surveys

To validate seabed and habitat conditions described in published literature and available data portals, Atlantic Shores initiated site-specific high-resolution geophysical (HRG), geotechnical, and benthic surveys to characterize benthic habitat in the Offshore Project Area. Site-specific surveys conducted by Atlantic Shores (see Appendices II-A1, II-A2, and II-G1 through G4) included side-scan sonar, backscatter, benthic grab, SPI camera – plan view video (PV), and towed video surveys. These surveys were conducted in accordance with BOEM's 2019 guidelines for benthic habitat mapping and were used to characterize seafloor morphology, sediment composition, and biogenic features that make up the benthic habitat of the Offshore Project Area. The sediment survey data were characterized in accordance with the Coastal and Marine Ecological Classifications Standards (CMECS). CMECS is a hierarchical system with classification thresholds based on sediment grain size and the relative percent composition of mud, sand, and gravel-sized components (FGDC 2012). In the CMECS classification system, grain size and composition is used to describe benthic habitats and define complex and potentially valuable fish habitats. According to NMFS, sediment containing at least 5% gravel content is considered complex habitat. Classifying to a standard allows for analysis of habitats and comparison both within and between regions, and the CMECS classification system was applied as recommended by NMFS in their guidelines for mapping Essential Fish Habitat (EFH) (NMFS 2021).

Results of the site-specific surveys are provided below for the WTA, Atlantic ECC, and Monmouth ECC.

WTA

Using side-scan sonar, bathymetry, backscatter, seafloor slope analyses, and SPI-PV surveys, Atlantic Shores was able to identify the following topographic features in the WTA: sand waves, ripples, mega ripples, depressional areas, and textured seafloor (i.e., dimpled, rugged, or uneven seafloor). Ripples were the most prevalent, mapped topographic feature in the WTA, comprising the entire surveyed area. In addition to ripples, sandwaves and mega ripples were the second most prevalent topographic features mapped in the WTA. These features are mapped in both the Project 1 WTA and Project 2 WTA. Though these topographic features are present, much of the WTA can be classified as largely flat given that a majority of the features present (e.g., ripples) offer limited relief. Additional information on these topographic features, including maps, can be found in Appendix II-A1.

Benthic grab samples collected within the WTA predominately consisted of unconsolidated, fine substrate sediments of geologic origin. Analysis of grab samples conducted in the WTA showed medium sand to be the most prevalent sediment type, making up 54% and 84% of the Project 1 WTA and Project 2 WTA, respectively (see Figures 4.5-2 and 4.5-3). Under NMFS' Recommendations for Mapping Fish Habitat (NMFS 2021), medium sand is considered soft bottom habitat. Other soft bottom CMECS-classified sediments identified in the WTA include fine/very fine sand, muddy sand, and very coarse/coarse sand. Some complex habitat was identified in the WTA including gravelly muddy sand and gravelly sand.

Approximately 2% and 15% of samples collected in the Project 1 WTA were identified as gravelly muddy sand and gravelly sand, both of which contain between 5% to less than 30% gravel content, respectively. Samples collected within the Project 2 WTA consisted of less complex habitat than samples collected in Project 1 WTA, accounting for only 8% of samples, all of which were limited to gravelly sand (see Figures 4.5-2 and 4.5-3). Results from the SPI-PV (see Appendix II-G4) and Towed Video report (see Appendix II-G3) largely support the findings of the benthic grab surveys. Analysis of the SPI-PV and Towed Video images showed the majority of the sample locations in the WTA to be dominated by medium and fine sands, with some coarse sand areas reported in the SPI-PV survey and some mud areas reported in the Towed Video survey. In addition to CMECS information, the Towed Video report documented biotic components present in the Offshore Project Area which can contribute to the benthic habitat present. According to results of the Towed Video survey, the most common benthic biogenic features observed in the WTA were sand dollar beds, clam beds, and infaunal structures (e.g., worm tubes) (see Appendix II-G3).

Atlantic ECC

Side-scan sonar, bathymetry, backscatter, seafloor slope analyses, and SPI-PV surveys have resulted in the identification of the following topographic features in the Atlantic ECC: ripples, mega ripples, sand waves, textured seafloor (i.e., rugged or uneven texture), and localized areas of relief. Ripples were the most prevalent topographic feature in the Atlantic ECC. Mega ripples, sandwaves, and textured seafloor were the second most predominant features. Small areas within the central portion of the Atlantic ECC were characterized as localized relief features, which refers to raised accumulations of sandy sediment. These areas of localized relief have the potential to provide habitat to a variety of organisms. Additional information on these topographic features, including maps, can be found in Appendix II-A1.

Benthic grab samples collected in the Atlantic ECC predominantly consisted of unconsolidated, fine substrate sediment of geologic origin. Analysis of the grab samples conducted in the Atlantic ECC showed fine/very fine and medium sand to be the most prevalent sediment types, making up 40% and 30% of the samples collected in the Atlantic ECC, respectively (see Figures 4.5-2 and 4.5-3). Both fine/very fine and medium sand are considered soft bottom habitat by NMFS (NMFS 2021). The remaining sediment types in the Atlantic ECC, each comprising 10% of the samples collected in the ECC, include muddy sand, very coarse/coarse sand, and gravelly sand. Muddy sand and very coarse/coarse sand are considered soft bottom habitat, while gravelly sand is considered complex habitat, containing between 5% and less than 30% gravel content. No grab samples collected in the Atlantic ECC contained gravel content greater than 30%. Results from the SPI-PV (Appendix II-G4) and Towed Video report (Appendix II-G3) largely support the findings of the benthic grab surveys, reporting sands and mud as the dominant sediment types. In addition to CMECS information, biotic features identified in the Atlantic ECC that contribute to the benthic habitat include polychaete worm tubes, decorator worms, and shell coverage (see Appendix II-G3).

Monmouth ECC

The Monmouth ECC contains more topographic diversity than the WTA and Atlantic ECC. Similar to the WTA and Atlantic ECC, ripples, mega ripples, and sandwaves were identified in the Monmouth ECC, with ripples being the most dominant topographic feature (see Appendix II-A1). Also, similar to the Atlantic ECC, the Monmouth ECC contains small, localized areas of relief in its central portion. However, unlike the WTA and Atlantic ECC, scarps and interbedded surficial sediments (characterized by terraced seafloor with steep slopes) were identified in the nearshore reaches of the Monmouth ECC, near the Monmouth Landfall Site. Features like scarps and interbedded surficial sediments have the potential to add habitat diversity for marine organisms.

Benthic grab samples collected in the Monmouth ECC predominately consisted of unconsolidated, coarse substrate of geologic origin. Analysis of benthic grab samples collected in the Monmouth ECC showed gravelly sand to be the most predominant sediment type, comprising approximately 48% of the samples collected in the ECC (see Figures 4.5-2 and 4.5-3). According to the NMFS' Recommendations for Mapping Fish Habitat (NMFS 2021), gravelly sand is considered complex habitat as it contains between 5% and less than 30% gravel content. Additional sediment types classified as complex habitat per NMFS' 2021 recommendations (NMFS 2021) in the Monmouth ECC include sandy gravel (approximately 8% of samples), gravelly muddy sand (approximately 8% of samples), and muddy sandy gravel (approximately 3% of samples). Both sandy gravel and muddy sandy gravel consist of 30% to less than 80% of gravel, while gravelly muddy sand consists of 5% to less than 30% gravel content. The remaining sediment types in the Monmouth ECC are classified as soft sediment and include medium sand (approximately 16% of samples), very coarse/coarse sand (approximately 11% of samples), fine/very fine sediment (approximately 3%

of samples), and sandy mud (approximately 3% of samples). Data collected by SPI-PV (Appendix II-G4) and Towed Video (Appendix II-G3) surveys largely agree with the benthic grab results and classify the majority of the sediment in the Monmouth ECC as gravels, gravel mixes, and sandy gravels. However, the Towed Video survey results depict a larger proportion of the Monmouth ECC being comprised of soft bottom habitat compared to the proportion of soft bottom habitat discussed in the SPI-PV and grab samples. The difference in proportion of soft bottom habitat between the Towed Video and benthic grab surveys is likely due to difference in sampling methods. The Towed Video Survey relies on still images of the seafloor, only capturing the surface of the sediment, while benthic grabs are obtained by taking a physical sample of the seafloor, up to a depth of 7.9 in (20 centimeters [cm]), followed by laboratory analyses. Images from the Towed Video report also helped identify and characterize biotic features that contribute to the benthic habitat of the Monmouth ECC. The most dominant biotic feature identified in the Monmouth ECC was sand dollar beds; however, numerous burrowing anemones, mussel beds, and decorator worm beds were also identified (see Appendix II-G3).

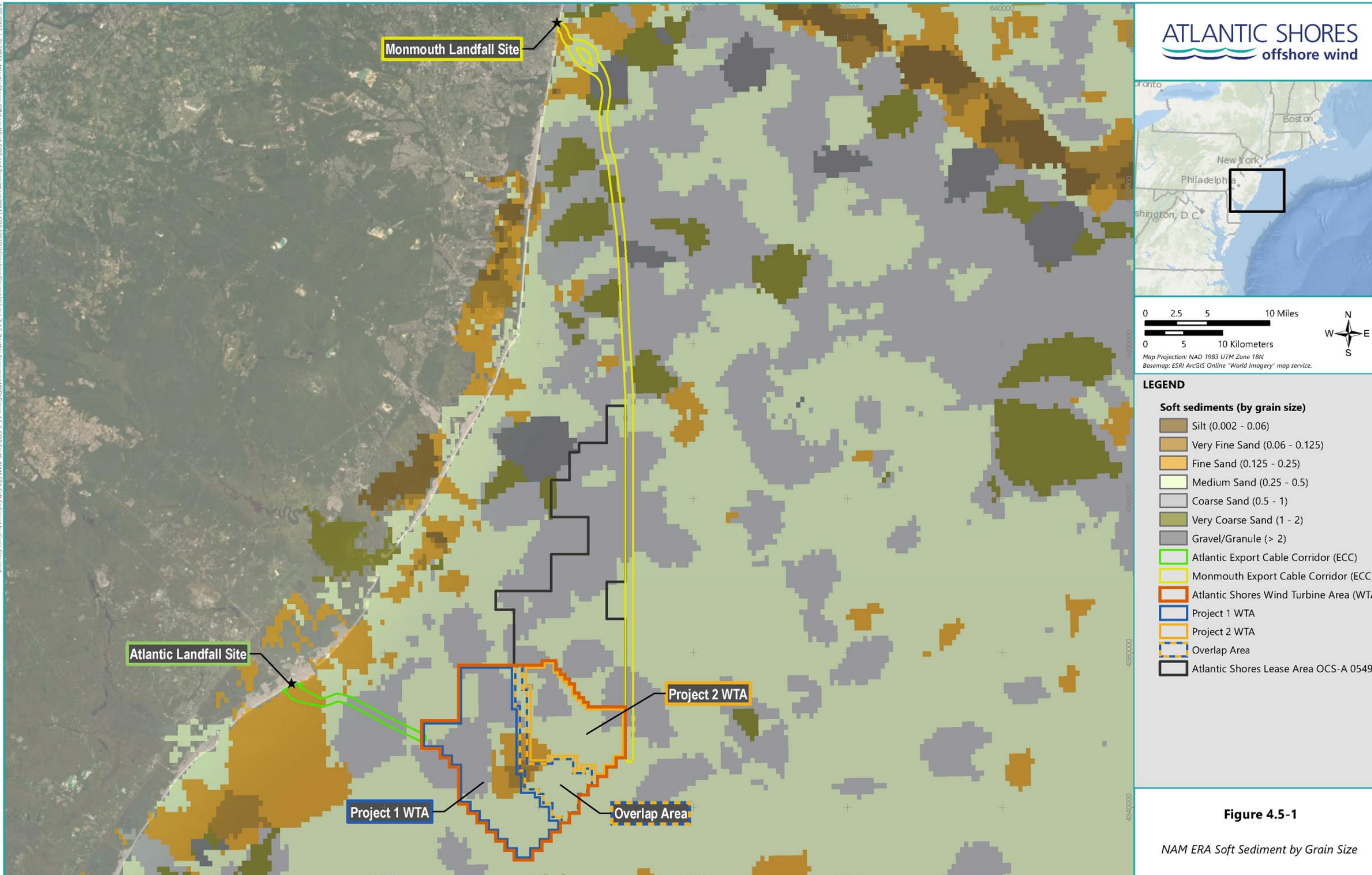


Figure 4.5-1

NAM ERA Soft Sediment by Grain Size

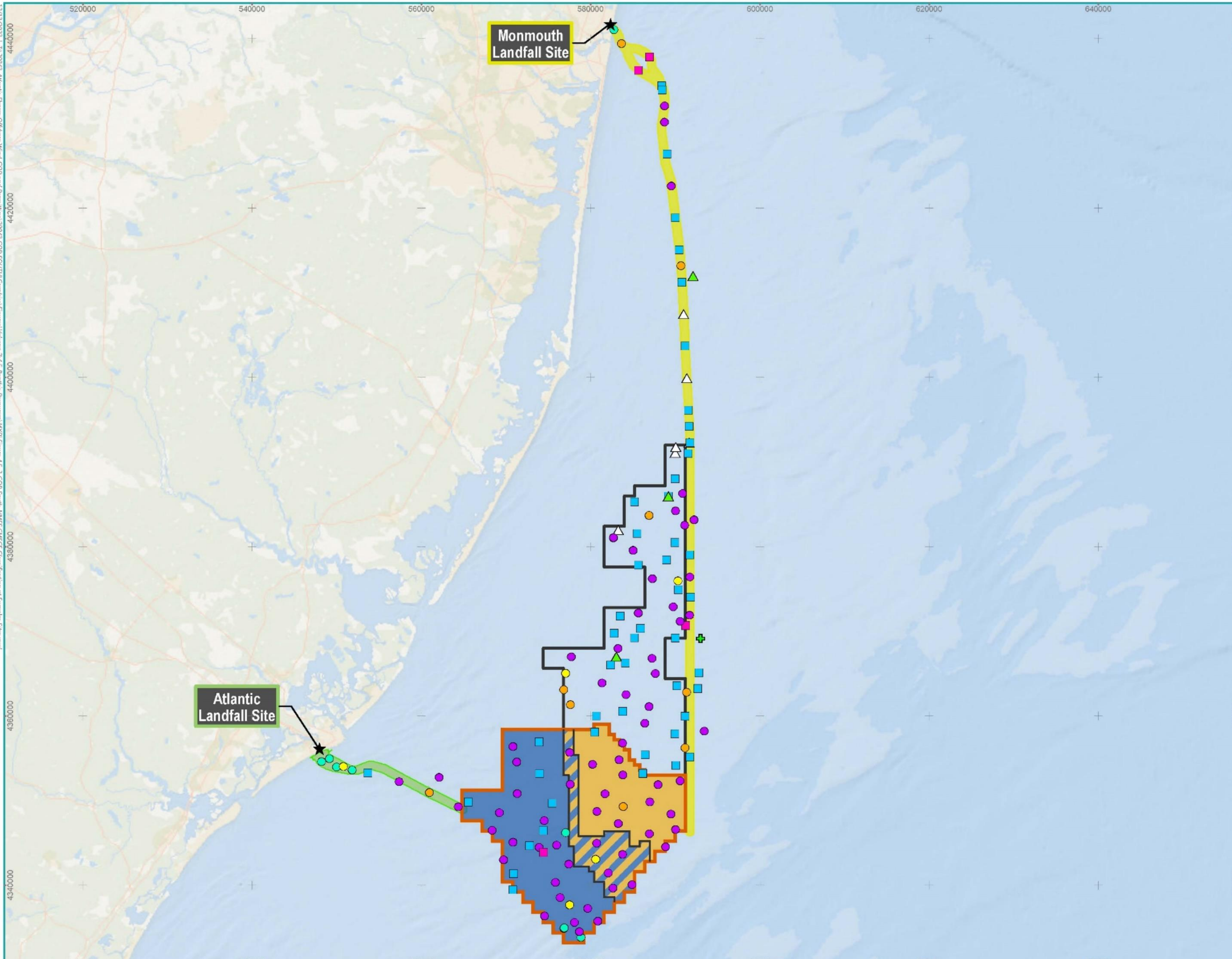
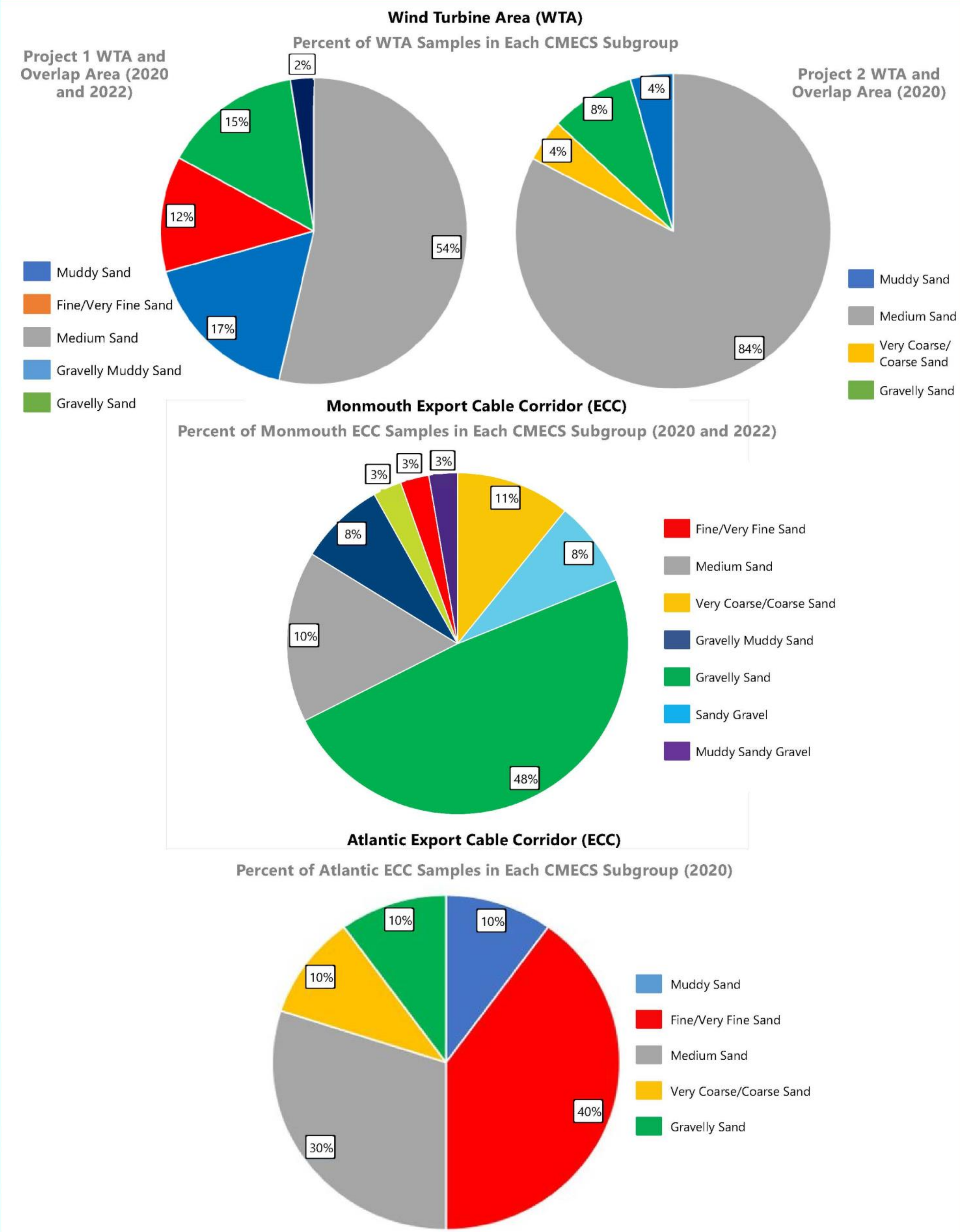


Figure 4.5-2

NMFS CMECS Classification of Grab Sample Sites (2020 and 2022)



12/11/2023 | T:\20043_Atlantic Shores Offshore Wind_COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\4.5_Benthic Resources\MXD\Figure 4.5-3_COP South_Proportion of NMFS CMECS Sediments in the WTA Atlantic ECC and Monmouth ECC.mxd

ATLANTIC SHORES offshore wind

Figure 4.5-3

Proportion of NMFS CMECS Sediments in the WTA, Atlantic ECC, and Monmouth ECC

Data Source: Atlantic Shores 2020 & 2022 Benthic Assessment Report (Appendix II-G2)

4.5.1.2 Benthic Community of the Offshore Project Area

The benthic organism community of the Offshore Project Area includes infauna and epibenthic organisms such as echinoderms, bivalves, gastropods, polychaetes, oligochaetes, amphipods, crustaceans, and cnidarians (Guida et al. 2017, SMAST 2016, Greene et al. 2010). The following sections discuss data from existing literature, public data portals, and site-specific surveys sources to clearly characterize the benthic community in the affected environment.

Existing literature and data portals were used as baseline sources to classify benthic community composition in the Offshore Project Area. Benthic community mapping conducted by Greene et al. (2010) and data assimilated into the Northeast Regional Ocean Council's (NROC) Northeast Ocean Data Portal (NROC 2009) connects physical habitat features (e.g., sediment, depth, and topographic features) with species composition. Four habitat types (depressions and mid-position flats in 0 to 148 ft (0 to 45 m) water depths with coarse to fine sand; mid-position flats and depressions in 82 to 148 ft (25 to 45 m) water depths with medium to coarse substrate; mid-position flats in 82 to 148 ft (25 to 45 m) water depths on coarse to medium sand; and (4) depressions at moderate depths 49 to 269 ft (15 to 82 m) on fine to coarse sand) are most prevalent in the Offshore Project Area. Based on these habitat types, Greene et al. (2010) predicted the presence of the following phyla and representative organisms: Annelida (e.g., polychaetes and oligochaetes), Arthropoda (e.g., amphipods and mysid shrimp (*Neomysis americana*)), Cnidaria (e.g., anemone), Echinodermata (e.g., common sea star), and Mollusca (e.g., chestnut astarte (*Astarte castanea*) and moon snail (*Natica clausa*)). Many of these benthic species or groups were collected during benthic grab samples and the State and Federal trawl/dredge surveys, which are discussed in further detail below.

Additional data derived from University of Dartmouth School of Marine Science and Technology (SMAST) 2003 to 2012 video surveys and mapped by NROC, show average presence and abundance[18] of species in the North Atlantic (see Figures 4.5-4 and 4.5-5). These data showed low to moderate average presence of bryozoans (Phylum Bryozoa), hydrozoans (Phylum Cnidaria), and sponges, and moderate to high average presence of sand dollars (Phylum Echinodermata) in the WTA and Monmouth ECC (see Figure 4.5-4). Data obtained from NROC also determined low abundance of moon snails (Phylum Mollusca), hermit crabs (Phylum Arthropoda), and sea stars (Phylum Echinodermata) in the WTA and Monmouth ECC (see Figure 4.5-5). These datasets did not cover areas in the Atlantic ECC.

[18] Average presence and abundance for identified species were calculated using University of Dartmouth SMAST video data and the New England Fishery Management Council Swept Area Seabed Impact (SASI) model. Average presence represents the average number of quadrats per SMAST survey station with a given species present within a larger SASI model grid. Average abundance represents the average number of species counted at the SMAST sampling stations within a larger SASI model grid (SMAST, 2016).

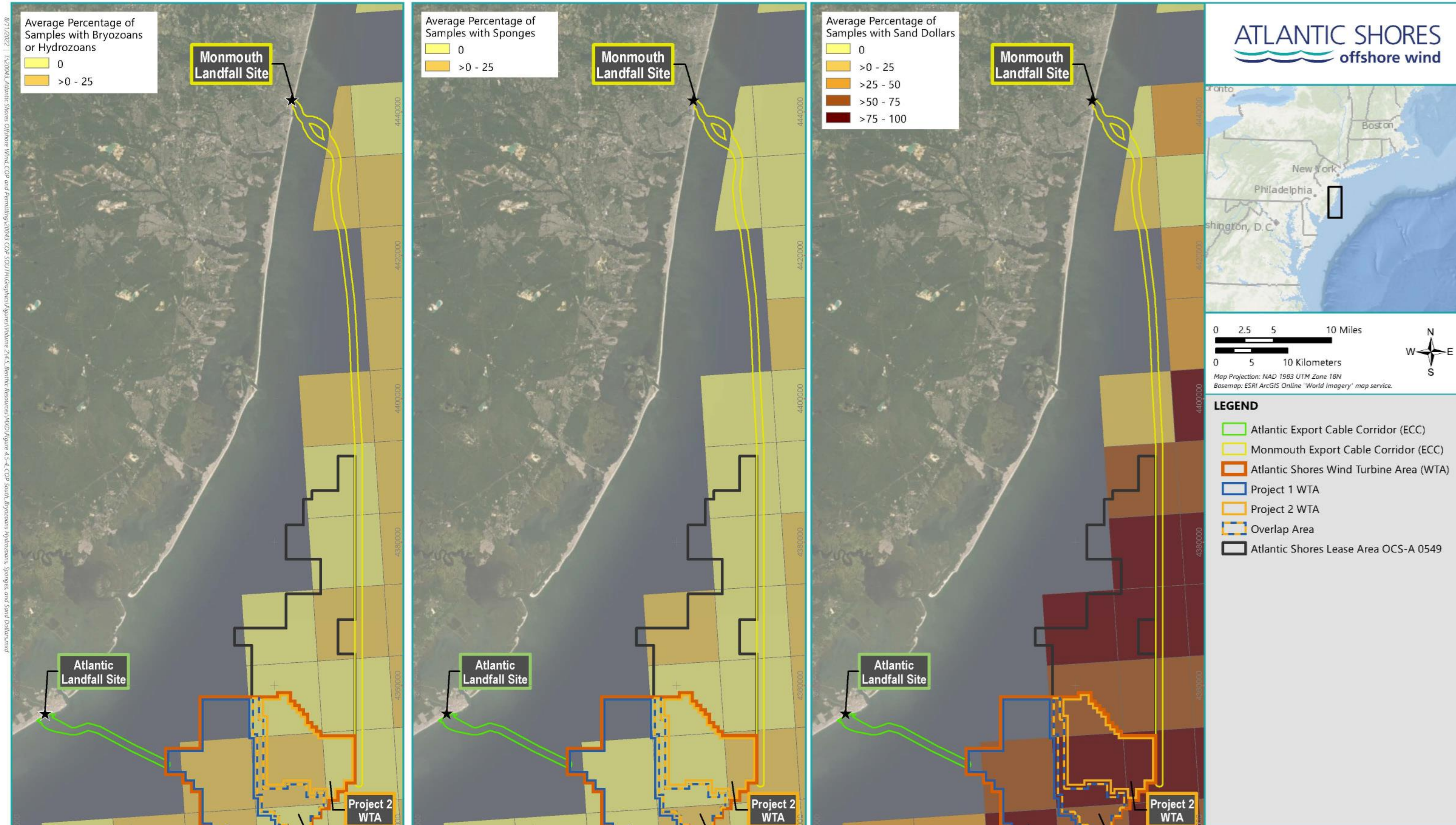


Figure 4.5-4

Average Presence of Bryozoans/Hydrozoans, Sponges, and Sand Dollars

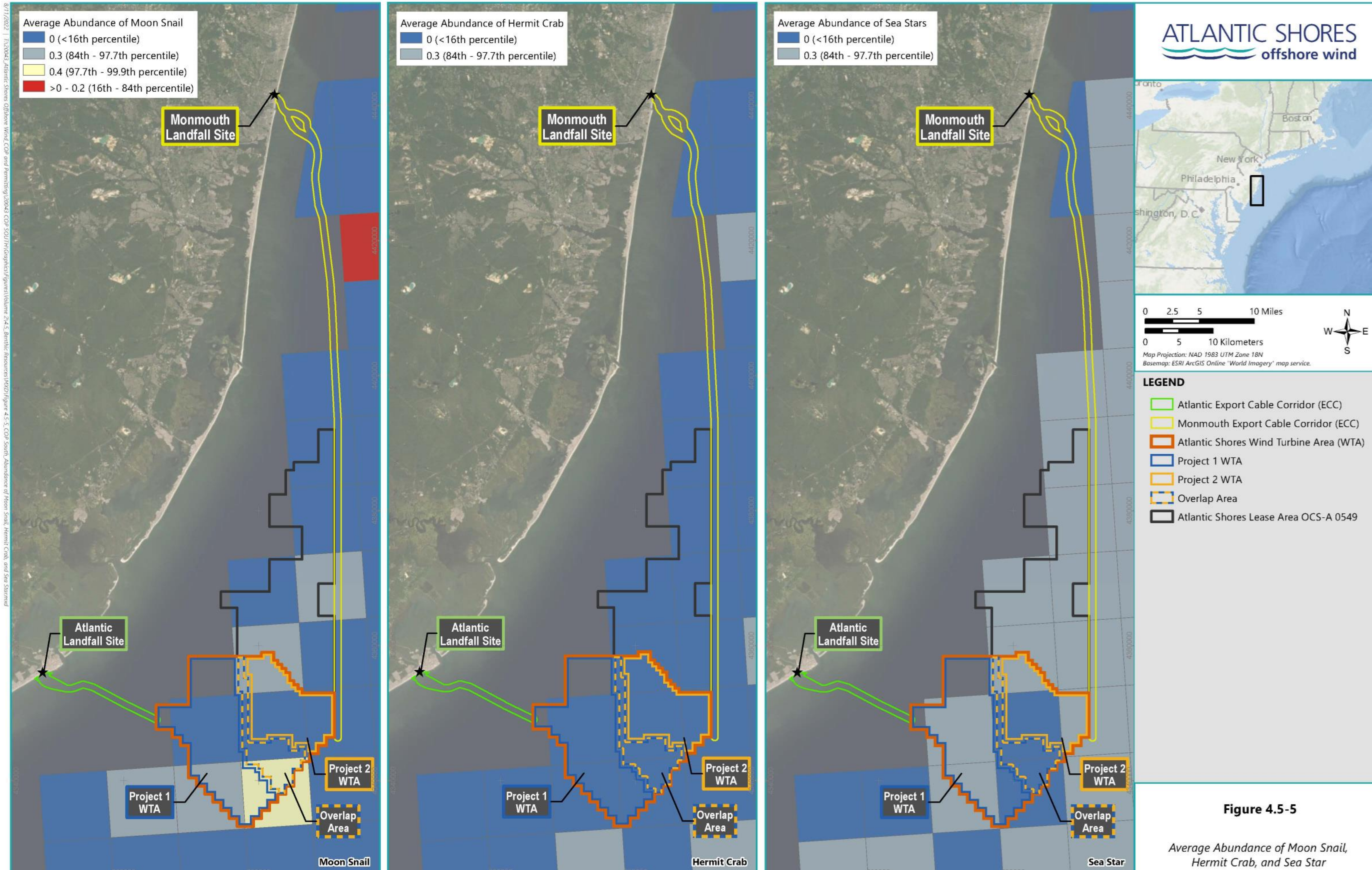


Figure 4.5-5

Average Abundance of Moon Snail, Hermit Crab, and Sea Star

To understand species composition in the Offshore Project Area, site-specific benthic grab surveys and towed video surveys (performed by Atlantic Shores in 2019, 2020, 2021, and 2022) were conducted throughout the WTA and ECCs. In addition to benthic grab surveys, data were obtained from the New Jersey Department of Environmental Protection (NJDEP) and Northeast Fisheries Science Center (NEFSC) State and Federal trawl and dredge surveys (P. Politis, NOAA 2020 personal communication; L. Barry, NJDEP 2020 personal communication) to contribute to benthic community characterization. Results of these surveys and datasets provide site-specific evidence of infauna and epibenthic fauna presence in the Offshore Project Area. Based on the results of the surveys, many phyla are represented in all three portions of the Offshore Project Area. Such phyla include Annelida, Arthropoda, Chordata, Cnidaria, Echinodermata, Mollusca, Nematoda, Nemertea, and Sipuncula. Table 4.5-1 shows the presence of different phyla in each portion of the Offshore Project Area and representative species.

Table 4.5-1 Phyla Presence in the Atlantic Shores Offshore Project Area Based on Site-Specific Benthic Grabs, Towed Video, and Federal and State Trawl and Dredge Surveys

Study	Phyla	Representative Groups or Species	Presence in WTA[1]	Presence in Atlantic ECC	Presence in Monmouth ECC
Atlantic Shores Benthic Community Analysis[2]	Annelida	Polychaetes, Oligochaetes	Y	Y	Y
	Arthropoda	Amphipods, Copepods, Ostracods	Y	Y	Y
	Chordata[4]	Tunicates	Y	Y	Y
	Cnidaria[4]	Hydroids	N	Y	Y
	Echinodermata	Sand Dollars, Sea Urchins, Sea Cucumber	Y	Y	Y
	Ectoprocta	Bryozoan	Y	Y	Y
	Foraminifera	Foram	Y	Y	Y
	Mollusca	Atlantic Surf Clam, Spoon Clam, Ocean Quahog	Y	Y	Y
	Nematoda	Nematode	Y	Y	Y
	Nemertea	Ribbon Worm	Y	Y	Y
	Platyhelminthes	Flatworm	Y	N	N
	Sipuncula	Peanut Worm	Y	Y	Y

Table 4.5-1 Phyla Presence in the Atlantic Shores Offshore Project Area Based on Site-Specific Benthic Grabs and Federal and State Trawl and Dredge Surveys (Continued)

Study	Phyla	Representative Groups or Species	Presence in WTA	Presence in Atlantic ECC	Presence in Monmouth ECC
Atlantic Shores Towed Video Report	Cnidaria	Burrowing Anemones	Y	Y	Y
	Arthropoda	Crabs, Lobsters	Y	Y	Y
	Mollusca	Snail, Astarte, Atlantic Sea Scallop, Whelks	Y	Y	Y
	Echinodermata	Sea Stars, Sea Urchins	Y	N	Y
NEFSC and NJDEP Trawl Surveys[3]	Arthropoda	Crabs, Lobster	Y	Y	Y
	Echinodermata	Common Starfish, Sea Urchins, Sand Dollar	Y	Y	Y
	Mollusca	Sea Scallop, Northern Moonshell, Ocean Quahog,	Y	Y	Y

[1] All phyla identified in the WTA were present in the Project 1 WTA and Project 2 WTA, with the exception of Phylum Sipuncula which was only found in the Project 1 WTA.

[2] Source: 2019 Benthic Assessment Report- Buoy Installation Areas and Sites of Interest (Appendix II-G1); 2020 and 2022 Benthic Assessment Report (Appendix II-G2).

[3] Source: NEFSC Multi-Species Bottom Trawl (2009-2019); NJDEP Ocean Stock Assessment Program (OSAP) (209-2019); NEFSC Atlantic Surfclam and Ocean Quahog dredge survey (2011-2015).

[4] No solitary hard coral (e.g., star corals) or invasive tunicates were observed during benthic site characterization surveys.

Site-specific benthic community composition metrics were calculated based on grab sample surveys conducted for Atlantic Shores in 2019, 2020, and 2022. These studies are included as Appendix II-G1 and Appendix II-G2. Based on the results of the benthic grabs (see Figure 4.5-6) from 2022 (Project 1 WTA and Monmouth ECC) and 2020 (Project 1 WTA, Project 2 WTA, Monmouth ECC, and Atlantic ECC), organisms from phyla Annelida, Arthropoda, and Mollusca, with the exclusion of Phylum Nematoda, were most commonly collected and had the highest densities in grab samples across all components of the Offshore Project Area when compared to other phyla. It should be noted that in 2022, organisms belonging to Phylum Nematoda were excluded from analysis as these were considered meiofauna and not part of the most recent BOEM (2019) or NMFS (2021) guidance for benthic community assessments. Additionally, the phyla with the greatest proportion of unique taxa were consistent across the Offshore Project Area. Those phyla included Annelida, Arthropoda, and Mollusca. These results are similar to those of the 2019 benthic grabs (see Appendix II-G1), with the exception of Nematoda dominance. Nematoda was present in the Offshore Project Area during 2019 surveys; however, not in large quantities. Proportion of unique taxa also differed slightly between the 2019 and 2020 surveys, with Phyla Annelida, Nematoda, and Arthropoda having the largest numbers of unique taxa. In the 2022 surveys, Phyla Annelida and Arthropoda had the highest proportions of unique taxa. The difference in phyla dominance and unique taxa between the 2022, 2020, and 2019 surveys could be attributed to the difference in sampling quantity. A total of nine samples were taken in 2019, all of which were limited to the WTA. In comparison, 74 samples were taken in the Offshore Project Area in 2020 with 45 in the WTA, 20 in the Monmouth ECC, and nine in the Atlantic ECC. In 2022, a total of 13 samples were taken in the Offshore Project Area with three in the WTA, and 10 in the Monmouth ECC.

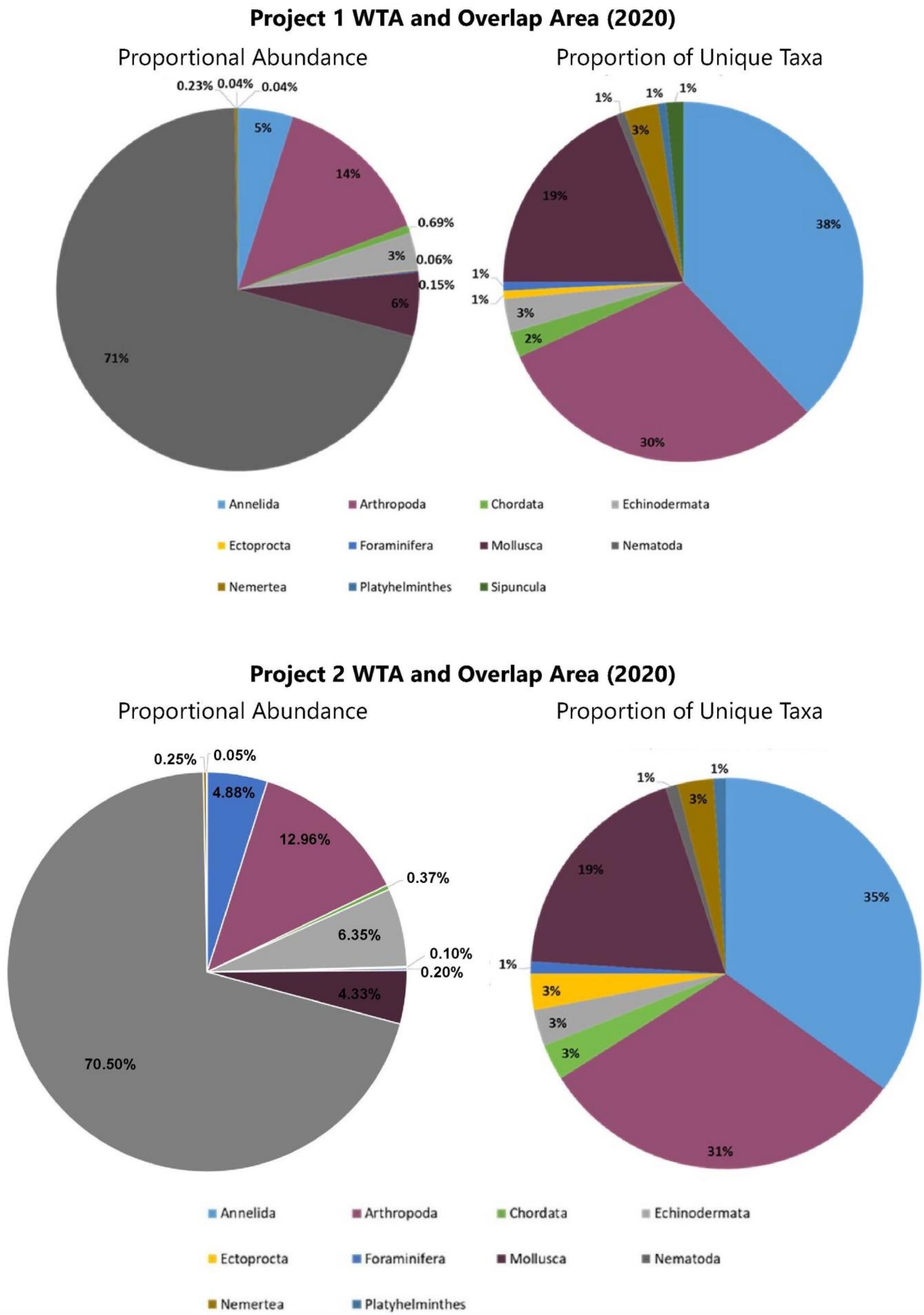
Species richness, diversity, and evenness were analyzed across the grab samples for the WTA, Atlantic ECC, and Monmouth ECC as part of the 2020 and 2022 Benthic Assessment Report and in the WTA as part of the 2019 Benthic Assessment Report. These results are provided in Table 4.5-2 and Appendices II-G1 and II-G2 for the entire WTA. Using the data provided in Appendices II-G1 and II-G2, average species richness, diversity, and evenness were calculated for the Project 1 and Project 2 WTAs. In 2020, the highest average species diversity and evenness occurred in the Atlantic ECC and the highest average species richness occurred in the Project 1 WTA. Average species diversity accounts for the number of unique taxa (i.e., species richness) and the abundance in each unique taxa (i.e., species evenness). Average species diversity increases as species richness and evenness increases. For additional information on benthic community sampling, see Appendices II-G1 and II-G2.

Table 4.5-2 Average Species Richness, Diversity and Evenness from 2019, 2020, and 2022 Benthic Grabs in the Offshore Project Area

Biodiversity Parameters[1]	Project 1 WTA[2]			Project 2 WTA[2]		Atlantic ECC	Monmouth ECC	
	2019	2020	2022	2019	2020	2020	2020	2022
Average Species Richness	3.91	3.68	5.33	4.80	3.41	2.97	3.25	3.44
Average Species Diversity	2.19	1.52	2.71	2.52	1.41	1.56	1.21	1.80
Average Species Evenness	0.78	0.51	0.82	0.80	0.48	0.57	0.41	0.63

[1] Biodiversity parameters were averaged across the samples taken in the WTA, Atlantic ECC, and Monmouth ECC. In 2019, nine grab samples were taken in the Offshore Project Area, each of which sampled an area of 0.05 square miles (mi^2) (0.13 square kilometer [km^2]). In 2020, 77 grab samples were taken in the Offshore Project Area, each of which sampled an area of 0.04 mi^2 (0.1 km^2).

[2] The Project Overlap Area is included in the Project 1 WTA and Project 1 WTA analysis.



ATLANTIC SHORES offshore wind

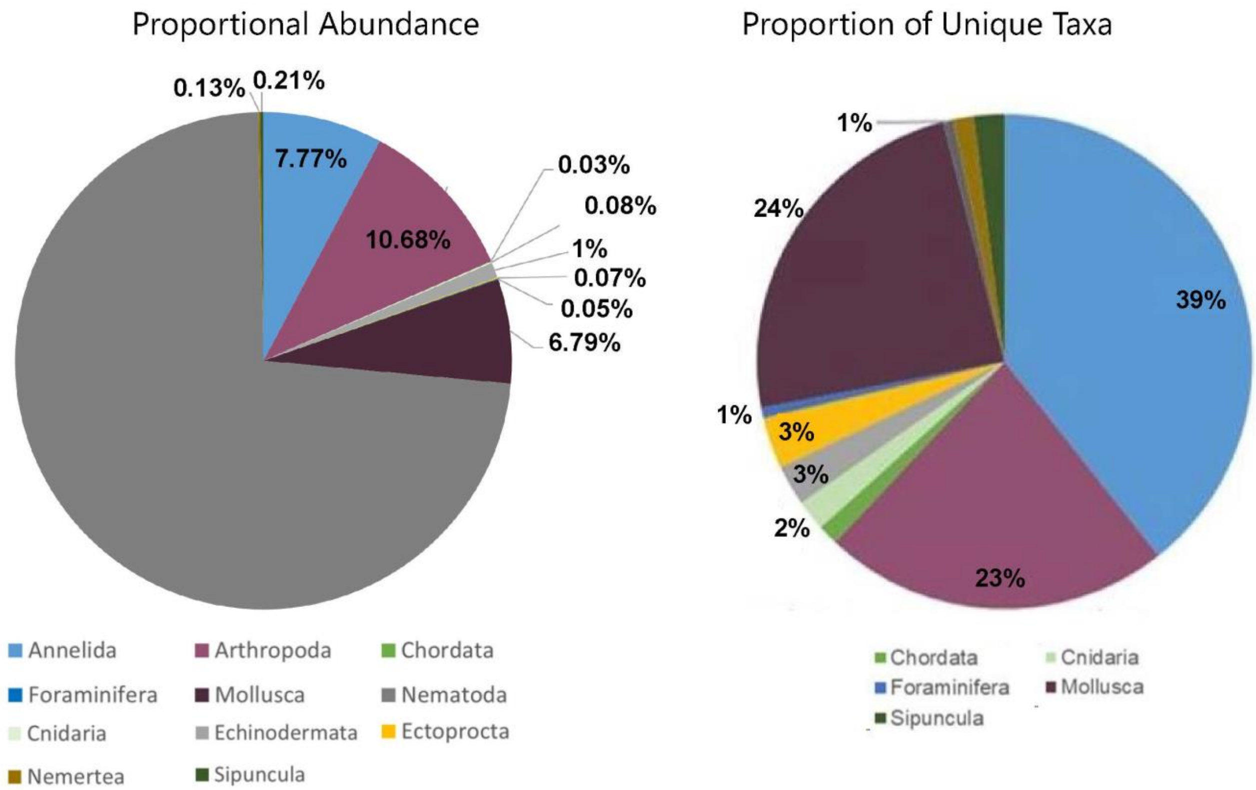
Figure 4.5-6 • *Sheet 1 of 3*

Proportional Abundance and Proportion of Unique Taxa based on Benthic Grabs Conducted in the WTA, Atlantic ECC, and Monmouth ECC

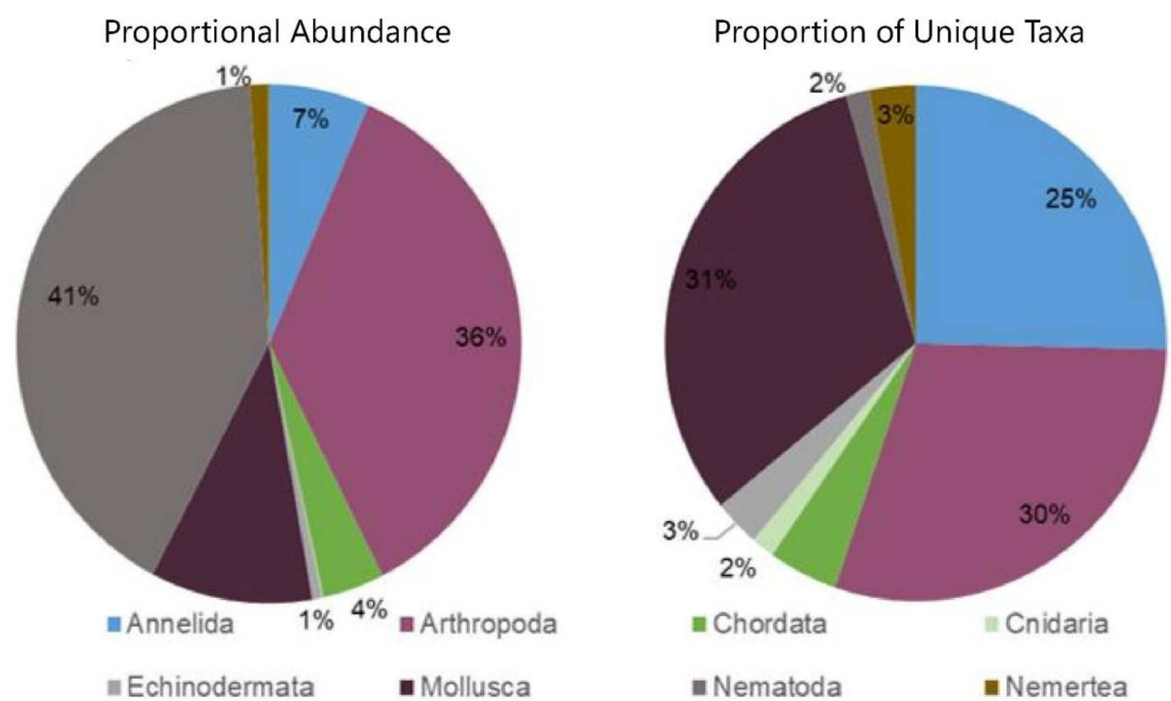
Data Source: Atlantic Shores 2020 & 2022 Benthic Assessment Report (Appendix II-G2)

12/12/2023 | T.

Monmouth Export Cable Corridor (ECC) (2020)



Atlantic Export Cable Corridor (ECC) (2020)



XD\Figure 4.5-6_COP South_Proportional Abundance and Proportion of Unique Taxa based on Benthic Grabs Sheet 2.mxd

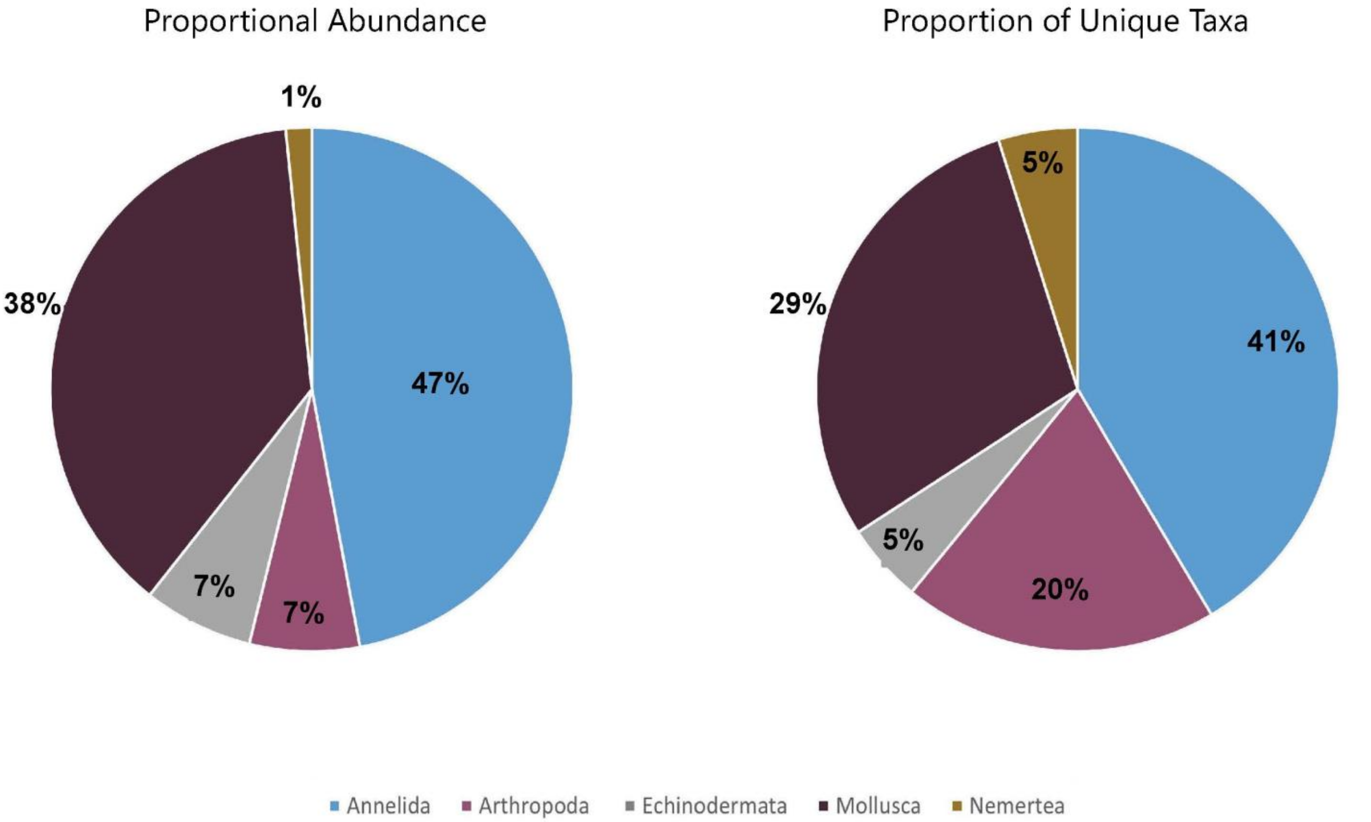
ATLANTIC SHORES offshore wind

Figure 4.5-6 • *Sheet 2 of 3*

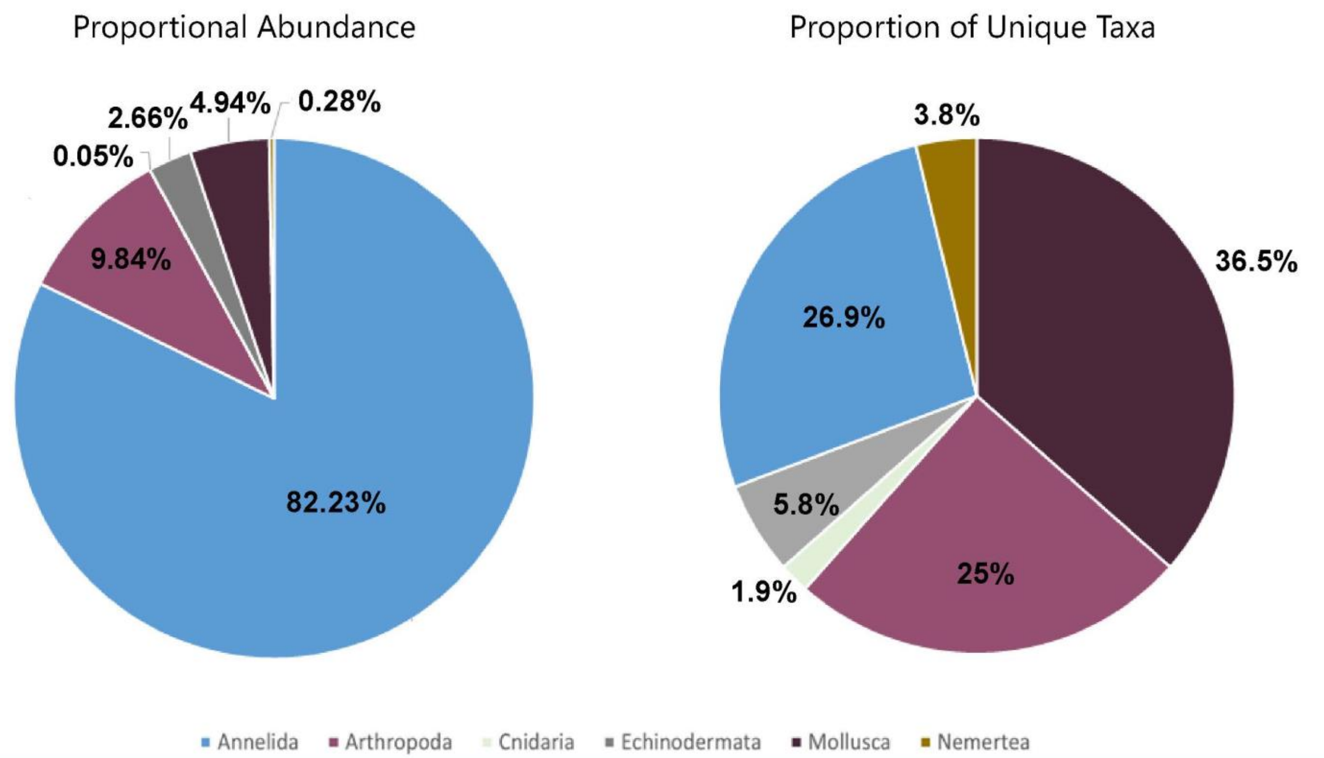
Proportional Abundance and Proportion of Unique Taxa based on Benthic Grabs Conducted in the WTA, Atlantic ECC, and Monmouth ECC

Data Source: Atlantic Shores 2020 & 2022 Benthic Assessment Report (Appendix II-G2)

Project 1 WTA (2022)



Monmouth Export Cable Corridor (ECC) (2022)



ATLANTIC SHORES offshore wind

Figure 4.5-6 • *Sheet 3 of 3*

Proportional Abundance and Proportion of Unique Taxa based on Benthic Grabs Conducted in the WTA, Atlantic ECC, and Monmouth ECC

Data Source: Atlantic Shores 2020 & 2022 Benthic Assessment Report (Appendix II-G2)

In addition to benthic grab samples, towed video surveys (see Appendix II-G3) were conducted in the Offshore Project Area in 2021 in order to gather data on the epifaunal and demersal biological communities, and ground-truth past surveying efforts. The towed video surveys allow for observation and enumeration of benthic megafauna, thereby providing Atlantic Shores with a greater understanding of the benthic community in the Offshore Project Area, beyond what can be surveyed using benthic grabs. Similar to the benthic surveys, the following phyla were observed during towed video surveys: Arthropoda, Chordata, Cnidaria, Mollusca, and Echinodermata. The most dominant phyla in the WTA, Atlantic ECC, and Monmouth ECC were Chordata, Mollusca, and Cnidaria, respectively.

Invertebrates identified in the WTA belonged to the following classes: Anthozoa, Asteroidea, Bivalvia, Gastropoda, and Malacostraca. Of these classes, class Malacostraca had the highest percent composition of enumerated invertebrates (28%), while class Asteroidea composed the lowest percent composition (2%). Within the Atlantic ECC, four taxonomic classes of invertebrates were identified: Anthozoa, Bivalvia, Gastropoda, and Malacostraca. The largest percentage of enumerated individuals belonged to class Gastropoda (67%), while the lowest percentage of composition belonged to Bivalvia (2%). Within the Monmouth ECC, seven classes of invertebrates were identified: Anthozoa, Asteroidea, Bivalvia, Cephalopoda, Echinoidea, Gastropoda, and Malacostraca. Of these classes, Anthozoa had the highest percent composition of enumerated individuals (72%), while Cephalopoda had the lowest (0.4%).

The towed video survey also analyzed presence of colonial species which develop large mats or beds that contribute to the benthic environment (e.g., sponge, tube worms). Benthic invertebrates identified in the WTA, Atlantic, and Monmouth ECC that provide or contribute to the benthic habitat of the Offshore Project Area include sand dollars, sponge/tunicates, decorator worms and worm tubes. Additionally, blue mussels were identified in the Atlantic and Monmouth ECCs and slipper shells were identified in the Monmouth ECC (see Appendix II-G3).

In order to gather additional evidence for the types of species found in the Offshore Project Area, particularly larger, more mobile species that were not collected in grab samples or captured in towed video surveys, data were obtained from NEFSC and NJDEP for the Offshore Project Area between 2009 and 2019. Federal and State surveys conducted in the Offshore Project Area include the NEFSC Multi-Species Bottom Trawl, NEFSC Atlantic Surf Clam (*Spisula solidissima*) and Ocean Quahog (*Arctica islandica*) Dredge, and NJDEP Ocean Stock Assessment Program (OSAP) Trawl surveys. The most commonly collected species during the surveys included sand dollars (*Echinoidae* spp.), lady crab (*Ovalipes ocellatus*), gulf shrimp (*Penaeus* spp), Atlantic Rock crab (*Cancer irroratus*), and Atlantic surfclam. Figure 4.5-7 illustrates the location of trawl surveys in the Offshore Project Area. Results of the surveys are included in Table 4.5-3.

Some results from the Federal and State trawl surveys conducted in the Offshore Project Area support the information from the NROC-provided presence and abundance data. Specifically, the data mapped by NROC showed moderate to high presence of sand dollars in the Offshore Project Area (NROC, 2009). According to Table 4.5-3, sand dollars were collected in all three portions of the Offshore Project Area, which could indicate moderate to high presence. However, NROC-provided data of northern moon snail and sea star (i.e., starfish) abundance differs from trawl results. According to the NROC-provided data, northern moonsnail and sea stars (i.e., starfish) were predicted to have low abundance in the Offshore Project Area; however, northern moon snail was collected in the WTA and Monmouth ECC, and sea stars (i.e., starfish) were collected across all three portions of the Offshore Project Area. Therefore, though modeling and literature sources are useful, combining those sources with site-specific data is most beneficial when attempting to understand benthic communities in the Offshore Project Area.

Table 4.5-3 Identified Benthic Species in Federal and State Trawl and Dredge Surveys

Common Name	Scientific Name	WTA[1]		Collected in Atlantic ECC	Collected in Monmouth ECC
		Project 1	Project 2		
Atlantic Rock crab	*Cancer irroatus*	▲○	▲○	○	▲○
American lobster	*Homarus americanus*	▲○			▲○
Blue crab	*Callinectes sapidus*			○	▲○
Channeled Whelk	*Busycotypus canaliculatus*	■	■		
Chestnut Astarte	*Astarte castanea*	○	○		
Common spider crab	*Libinia emarginata*	▲○	▲○	○	▲○
Common starfish	*Asterias rubens*	■	■		
Gulf shrimp	*Penaeus* spp.	○		○	○
Horseshoe crab	*Limulus polyphemus*	▲○	▲○	○	○
Jonah crab	*Cancer borealis*	○	▲		○
Knobbed Whelk	*Busycon carica*			○	
Lady crab	*Ovalipes ocellatus*	▲○	○	○	○
Mantis Shrimp	*Stomatopoda spp.*			○	
Northern moon snail	*Polinices heros*	○	○		○
Ocean Quahog	*Arctica islandica*	■	■		
Pastel swimming crab	*Portunus armatus*	○			○
Sea scallop	*Placopecten magelanicus*	▲○			▲○

Table 4.5-3 Identified Benthic Species in Federal and State Trawl and Dredge Surveys (Cont.)

Common Name	Scientific Name	WTA[1]			
		Project 1	Project 2	Collected in Atlantic ECC	Collected in Monmouth ECC
Sea snail	*Liparis atlanticus*				○
Shark's eye/lobed moonshell	*Polinices duplicatus*			○	○
Surf clam	*Spisula solidissima*	■○	■	■	○
Unclassified calico crab	*Hepatus epheliticus*	○	○		
Unclassified cancer crab	*Cancridae spp*				○
Unclassified sand dollar	*Echinoidae sp*		○	○	○
Unclassified sea urchin	*Echinoidae spp*				○
Unclassified starfish	*Asteriidae sp.*		○	○	○
Unclassified swimming crab	*Portunidae spp.*			○	

Notes:

▲- NEFSC Multi-Species Bottom Trawl; ■ – NEFSC Atlantic Surfclam and Ocean Quahog Dredge Surveys;
○ – NJDEP OSAP trawl Survey

[1] Both Project 1 and Project 2 contain the Overlap Area

Commercial, Recreational, and Ecologically Important Shellfish Species

Benthic community composition is of particular importance with respect to benthic invertebrate species of recreational or commercial fishing interest. Table 4.5-4 identifies species of commercial, recreational, or ecological importance based on NOAA landings data, as well as specific NOAA trust resources of ecological importance. NOAA trust resources included in Table 4.5-4 are based on a list provided by NOAA Fisheries Greater Atlantic Regional Fisheries Office (GARFO) during a virtual meeting held on May 20, 2020 (NOAA 2020, personal communication). Also included in Table 4.5-4 is the habitat requirements for those species and the potential occurrence in the Offshore Project Area based on data collected during NEFSC and NJDEP OSAP trawls.

Based on State and Federal trawl surveys and grab sample surveys conducted on behalf of Atlantic Shores, all species listed in Table 4.5-4 could occur in the Offshore Project Area. Though the Federal and State trawl surveys are useful tools to understanding the types of species present in the Offshore Project Area, limitations of the data exist. For example, analyses like species density cannot be easily conducted due to variabilities in sampling methodology (e.g., tow length variability, lack of consistent site sampling between years or seasons). However, combining the

Table 4.5-4 Benthic Invertebrate Species of Commercial, Recreational, or Ecological Importance

Species	Commercial/ Recreational Importance[1]	NOAA Trust Resource[2]	EFH	Habitat Requirements	Potential Occurrence in Offshore Project Area[3]
Atlantic Surfclam (*Spisula solidissima*)	C		X	Typically found in well-sorted, medium sand, but may also occur in fine or silty-fine sand (Cargnelli et al. 1999).	Potential occurrence of juveniles and adults throughout the Offshore Project Area.
Horseshoe Crab (*Limulus polyphemus*)		X		Utilizes inshore sandy substrates during spring spawning, then migrates to deeper estuarine and continental shelf habitats during fall (ASMFC 2015).	Potential occurrence throughout the Offshore Project Area.
Atlantic Sea Scallop (*Placopecten magellanicus*)	C		X	On sandy or gravel ocean floor at depths of 100 to 300 ft (30.4 to 91.4 m) (NOAA 2020).	Potential occurrence in the offshore reaches of the WTA and Monmouth ECC.
American Lobster (*Homarus Americanus*)	C			Rocky substrates, often utilizing shelters such as boulders and kelp (NOAA 2020).	Potential occurrence in the Offshore Project Area around artificial reefs, shipwrecks, and other hard structures/ substrates.
Jonah Crab (*Cancer borealis*)	C			Historically caught on hard and soft sediment habitats (e.g., rocks, clay, sand, mud), however limited information is available on habitat use (ASMFC 2018; Fisheries and Oceans Canada 2020).	Potential occurrence in the Offshore Project Area.
Ocean Quahog (*Arctica islandica*)			X	Burrow into a variety of substrates but are often associated with fine sand (MAFMC 2020).	Potential occurrence in the Offshore Project Area where fine, sandy sediment is present.

Table 4.5-4 Benthic Invertebrate Species of Commercial, Recreational, or Ecological Importance (Continued)

Species	Commercial/ Recreational Importance[1]	NOAA Trust Resource[2]	EFH	Habitat Requirements	Potential Occurrence in Offshore Project Area[3]
Blue Crab (*Callinectes sapidus*)	C	X		Underwater grasses and oyster reefs, ranging from shallow brackish water to deeper, saltier water (NOAA 2020)	Potential occurrence in the nearshore areas of the Offshore Project Area; however, there are no documented underwater grasses in the Offshore Project Area.
Blue Mussel (*Mytilus edulis*)		X		Intertidal shallow waters attached to rocks, pilings, shells, or other solid objects (URI 2020)	Potential occurrence in the Offshore Project Area, particularly in nearshore regions of the Atlantic and Monmouth ECCs, or around artificial reefs, shipwrecks and other hard structures/ substrates.
Channeled Whelk (*Busycotypus canaliculatus*)	C			Found in subtidal waters, less than 98 ft (30 m) deep, on sandy silt, shell hash or mud substrates (Nelson et al. 2018).	Occurrence most likely in the WTA and Atlantic ECC, where sandy sediments are more prevalent.
Eastern Oyster (*Crassostrea virginica*)		X		Brackish and salty waters between 8 to 35 ft (2.4 to 10.7 m) deep, often concentrated in beds and forming dense reefs (Chesapeake Bay Program 2020).	Potential occurrence in the nearshore reaches of the Atlantic and Monmouth ECC. Occurrence of eastern oyster is not expected in the WTA due to depth thresholds.
Knobbed Whelk (*Busycon carica*)	C			Shallow subtidal mud or sand flats during the spring and fall, and deeper waters offshore during winter (Barnegat Bay Partnership 2020)	Potential occurrence in the nearshore portions of the Atlantic and Monmouth ECCs in the spring and fall, and in the offshore reaches of the ECCs and WTA in the winter.

Table 4.5-4 Benthic Invertebrate Species of Commercial, Recreational, or Ecological Importance (Continued)

Species	Commercial/ Recreational Importance[1]	NOAA Trust Resource[2]	EFH	Habitat Requirements	Potential Occurrence in Offshore Project Area[3]
Soft-Shell Clam (*Mya arenaria*)		X		Sandy or muddy substrate in bays and estuaries (URI 2020).	Occurrence unlikely due to the absence of bays and estuaries in the Offshore Project Area.

[1] C- commercially important species; R – recreationally important species. Species with commercial landings values of $4,000 or greater in 2019 for the State of New Jersey as reported by NOAA Fisheries were considered a species of commercial importance. Species with confidential commercial landing values were not marked as a species of commercial importance in this table. None of the species in the table above were recorded in recreational landings in New Jersey.

[2] NOAA GARFO provided a list of Other NOAA Trust Resources to be evaluated in the EFH Assessment in a virtual meeting held on May 20, 2020.

[3] Presence in the Offshore Project Area is based on NEFSC and NJDEP OSAP trawl results and known habitat requirements.

trawl results with benthic habitat sampling can add confidence in the types of species that may be present in the Offshore Project Area and affected by Project activities.

4.5.2 Potential Impacts and Proposed Environmental Protection Measures

The potential IPFs which may affect benthic resources and habitat during Project construction, operations and maintenance (O&M), or decommissioning are presented in Table 4.5-5.

Table 4.5-5 Impact Producing Factors for Benthic Resources

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Installation and maintenance of new structures and cables	●	●	●
Anchoring and jack-up vessels	●	●	●
Noise	●	●	●
Electromagnetic fields		●	
Presence of structures and cables		●	●

The maximum Project Design Envelope (PDE) analyzed for impacts to benthic resources is the maximum offshore build-out of the Projects (as defined in Section 4.11 of Volume I), assuming the use of all piled foundations for the assessment of pile driving noise. Potential impacts from offshore spills, discharges, and accidental releases are not included in this section. Such impacts are considered to have a low likelihood of occurrence and are discussed in more detail in Section 9.2.3. Section 3.2 Water Quality provides further detail on measures to minimize the potential for drilling fluid release and frac-outs during horizontal directional drilling (HDD) installation at the landfall sites, including the development of an HDD Contingency Plan.

4.5.2.1 Installation and Maintenance of New Structures and Cables

The installation and maintenance of new foundation structures and offshore cables includes installation of associated scour and cable protection. These activities may affect benthic resources and habitat through direct seafloor disturbance and temporary increases in suspended sediment and deposition. This section focuses on the temporary direct and indirect disturbances that will primarily occur during the construction phase. Section 4.5.2.5 addresses permanent seafloor disturbance from the footprints of foundations, scour protection, and offshore cable protection that will result in habitat conversion of primarily sandy substrate to hard substrate. The O&M phase is expected to have significantly lower seafloor disturbance than Project construction. During O&M, Project components will be carefully monitored as described in Section 5.0 of Volume I. If portions of buried offshore cables require maintenance, the sediment cover may need to be removed for inspection and possible replacement of a portion of the cable. These activities would temporarily disturb the seafloor but would be short-term and extremely localized. The decommissioning phase is expected to have similar, but less expected seafloor disturbance than Project construction.

Direct Seafloor Disturbance

Benthic habitat will be temporarily disturbed during construction; however, as evidenced by the assessments and analyses conducted by Atlantic Shores to date, the area of disturbance is small relative to the total area of available surrounding habitat (Table 4.5-6) and benthic resources are expected to recover in the short-term.

Seafloor-disturbing activities during construction of the wind turbine generator (WTG) and offshore substation (OSS) foundations include jack-up vessel positioning and anchoring (see Section 4.5.2.2), seabed preparation, foundation placement, and scour protection installation. Seabed preparation may be required for gravity-based foundations or in areas with large sand bedforms. Seafloor-disturbing activities during installation of the offshore cables include anchoring, pre-installation activities (e.g., sand bedform removal, boulder relocation, and pre-lay grapnel run), offshore cable installation, cable protection installation, where needed, and excavation of the offshore HDD pit. Detailed methodologies for conducting these activities are described in Section 4.0 of Volume I.

The maximum area of seabed disturbance in the WTA and ECCs from construction of the Project is summarized in Table 4.5-6. The maximum total area of temporary seafloor disturbance (not including the area of the seafloor that will be permanently occupied by structures or cables) in the WTA is 4.41 square miles (mi^2) (11.42 square kilometers [km^2]), which represents only approximately 2.8% of the 160 mi^2 (413 km^2) WTA area. The total temporary seafloor disturbance in the Atlantic ECC is 0.83 mi^2 (2.14 km^2) and the total temporary seafloor disturbance in the Monmouth ECC is 2.26 mi^2 (5.86 km^2), for a total temporary disturbance of 3.09 mi^2 (8.00 km^2) for both ECCs combined (Table 4.5-6). This estimated area of disturbance represents approximately 6.3% of the entire ECC area. The area of temporary disturbance in the WTA and ECCs is small relative to the total area of available surrounding undisturbed habitat in the WTA and ECCs. Temporary direct seabed disturbance from the Project will be limited to these smaller areas.

Table 4.5-6 Maximum Total Seabed Disturbance

Offshore Project Area Component	Maximum Area of Seafloor Disturbance		
	Permanent Disturbance	Additional Temporary Disturbance	Total
Maximum Total Seabed Disturbance in the WTA[a,b]	1.01 mi^2 (2.60 km^2)	4.41 mi^2 (11.42 km^2)	5.42 mi^2 (14.02 km^2)
Maximum Total Seabed Disturbance in Project 1 WTA[a]	0.57 mi^2 (1.50 km^2)	2.32 mi^2 (5.99 km^2)	2.88 mi^2 (7.48 km^2)
Maximum Total Seabed Disturbance in Project 2 WTA[a]	0.49 mi^2 (1.25 km^2)	2.17 mi^2 (5.63 km^2)	2.66 mi^2 (6.87 km^2)
Maximum Total Seabed Disturbance in the ECCs	0.38 mi^2 (0.98 km^2)	3.09 mi^2 (8.00 km^2)	3.47 mi^2 (8.99 km^2)
Atlantic ECC	0.06 mi^2 (0.16 km^2)	0.83 mi^2 (2.14 km^2)	0.89 mi^2 (2.30 km^2)
Monmouth ECC	0.32 mi^2 (0.83 km^2)	2.26 mi^2 (5.86 km^2)	2.58 mi^2 (6.69 km^2)

Notes:

Basis of Calculations are described in detail in Section 4.11 of Volume I.

a. Seabed disturbance values within the WTA are reflective of a monopile-only scenario for WTG foundations due to monopiles resulting in the largest area of disturbance to the seabed. If piled jackets are used for Project 2 WTG foundations, the area of disturbance to the seafloor will be less. See Section 4.11 of Volume I for additional information about impacts from piled jackets.

b. Given that the Overlap Area could be incorporated into Project 1 or Project 2, disturbance associated with the Overlap Area is included in both the Project 1 WTA and Project 2 WTA disturbance calculations.

Based on side scan sonar data collected in the Offshore Project Area, the seabed is largely level and consistent across the WTA and ECCs. Benthic grabs indicate the majority of the Offshore Project Area consists of fine, medium, and gravelly sand. Predominant seafloor features in the Offshore Project Area include sandwaves and ripples (see Appendices II-A1 and II-J2 for benthic habitat mapping). Additionally, site-specific HRG and benthic survey images conducted for the Projects have shown this area to be dynamic in nature, exhibiting wide-spread bottom disturbance from existing marine uses (e.g., fishing and vessel activity) and mobile sediment. The species and habitat in the Offshore Project Area, including EFH, are adapted to disturbance and are expected to recover in the short-term. Therefore, impacts to benthic invertebrates and their habitat during installation and maintenance of structures and cables are expected to be temporary and localized.

Although immobile benthic invertebrate species in the direct footprint of foundation and associated scour protection or offshore cable installation may be subject to injury or mortality, the benthic community is expected to recover and benthic infauna and epifauna are expected to recolonize the area after physical disturbance from construction and maintenance activities cease in a given location (Brooks et al. 2006; Guarinello et al. 2017; Guida et al. 2017). A review of studies of recovery and recolonization along the U.S. East Coast by Brooks et al. (2004) reported that recovery of benthic assemblages to background levels following dredging disturbance can range from 3 months to 2.5 years with recovery time dependent on site-specific taxa, type of sediment disturbance, and environmental conditions. The Bureau of Ocean Energy Management (BOEM) (2021) reported that benthic assemblages subjected to physical disturbance in soft sediment communities typically recover in 6 to 18 months through dispersal from adjacent areas, assuming the affected area is not disturbed during the recolonization period. Guida et al. (2017) also supports benthic community recolonization, indicating that benthic infauna and epifauna that are adapted to sandy bottom habitats similar to the habitat in the Offshore Project Area, tend to recover quickly from disturbances and are considered resilient. Brooks et al. (2004) reported that polychaetas typically are the first to recolonize disturbed areas with crustaceans (amphipods) also reported to recolonize within weeks following disturbance activities. Based on documented cases of habitat recolonization and recovery after significant disturbances involving benthic communities like those found in the Offshore Project Area, and the expectation that the surrounding available habitat will not be disturbed, seafloor-disturbing Project activities are not expected to cause long-term population-level effects to the resident benthic organisms and communities. Similar to the conclusion in BOEM (2021), although mortality of some benthic invertebrates is anticipated, impacts are not expected to be significant at the population level and would not measurably alter the environmental baseline.

According to BOEM (2021), benthic invertebrate species associated with hard-substrate/complex habitat may take longer to recover from individual mortality events compared to species associated with soft-bottom habitats. Site-specific HRG and benthic assessments conducted to date (see Appendices II-A1, II-A2, and II-G1 through II-G4) in cooperation with NOAA, BOEM, and NJDEP, have indicated the presence of complex habitat, as defined by NMFS. Atlantic Shores is committed to minimizing the impacts to complex habitat to the maximum extent practicable by using tools and installation methods that minimize the potential disturbance. For example, in nearshore areas, HDD techniques will be employed to avoid seabed disturbance impacts to benthic habitat at the landfall sites. Any impacts caused by the construction, O&M, or decommissioning will be similar in nature to other human-induced activities occurring in the Offshore Project Area.

Suspended Sediment and Deposition

Various sediment-disturbing Project activities conducted during construction, O&M, and decommissioning have the potential to suspend sediments into the water column resulting in the transport and deposition of these sediments on the seafloor. As described in Section 2.1 Geology, sediments disturbed during Project activities are not expected to contain hazardous contaminants. Therefore, during all phases of the Projects, the benthic community will primarily be affected by the short-term, localized, and temporary physical suspension of sediments and resulting deposition.

The primary construction activities that will result in elevated suspended sediment concentrations and deposition include seabed preparation, sand bedform removal, offshore cable installation, and excavation at the offshore HDD pit. In order to determine the extent of suspended sediment and deposition produced by construction activities, a Sediment Transport Modeling study was conducted (see Appendix II-J3). This study examined the extent and duration of elevated total suspended solids (TSS) concentrations and sediment deposition as a result of offshore cable installation and HDD activities at the Monmouth and Atlantic Landfall Sites. Additional modeling of sandwave clearance[19] was performed to bound the potential effects of seabed preparation, prior to cable installation (Attachment A of Appendix II-J3).

Suspended Sediment Concentration Predictions

Model simulation results of above-ambient TSS concentrations stemming from cable installation for the inter-array cable, Monmouth ECC, and Atlantic ECC remained relatively close to the route centerline, were constrained to the bottom of the water column, and were short-lived. Table 4.5-7 summarizes the extent and duration of suspended sediment concentrations resulting from cable installation, HDD activities, and sandwave clearance. Simulations of several possible inter-array cable or offshore export cable installation methods using either jet trenching installation parameters (for inter-array cable and export cable installation) or mechanical trenching installation parameters (for inter-array cable installation only) predicted above-ambient TSS of ≥10 milligrams per liter (mg/L)[20] stayed relatively close to the route centerline. This is due to sediments being introduced to the water column closer to the seabed. TSS concentrations of ≥10 mg/L traveled a maximum distance of approximately 1.8 mi (2.9 km), 1.6 mi (2.6 km), and 1.1 mi (1.7 km) for inter-array, Monmouth ECC, and Atlantic ECC cable installation, respectively (see Table 4.5-7). For the landfall approach scenarios, use of an excavator was assumed and sediment was introduced at the surface. This resulted in a maximum distance for the predicted above-ambient TSS concentrations ≥10 mg/L of approximately 2.1 mi (3.3 km) and 1.2 mi (1.9 km) for the Monmouth and Atlantic HDD pits, respectively (see Table 4.5-7).

For the inter-array cable and Atlantic ECC model scenarios, above-ambient TSS concentrations substantially dissipated within 2 to 4 hours and fully dissipated in 6 or less hours. For the Monmouth ECC model scenarios, above-ambient TSS concentrations substantially dissipated within 2 to 6 hours but required up to 13 hours to fully dissipate, likely due to the relatively longer route (i.e., larger volume of suspended sediment), route orientation in relation to currents, and more frequent occurrence of fine sediment. For the landfall approach scenarios, the tails of the plumes, with concentrations ≥10 mg/L, were transported away from the source and were short-lived, while concentrations around the HDD pits dissipated within 12 hours for the Monmouth HDD pit and 11 hours for the Atlantic HDD pit. The larger areas of TSS concentrations above thresholds and the longer time for the plume to diminish to ambient conditions for the Monmouth HDD pit may be attributed to sediments being released in deeper water, the higher fraction of fine sediments taking longer to settle, and slightly stronger currents transporting the sediments parallel with the shore.

[19] Dredged material from sandwave removal will be discharged low in the water column within surveyed areas that contain sand bedforms, used for ballast in GBS foundations if those foundations are selected for the Projects, or transported a short distance to an agreed-upon disposal site outside the Lease Area.

[20] In the Mid-Atlantic Bight, 10 mg/L is considered within the range of ambient TSS concentration conditions (Balthis et al. 2009).

Predicted above-ambient TSS concentrations stemming from sandwave clearance activities also remained relatively close to the route centerline and were short-lived. The maximum distance for predicted above-ambient TSS concentrations of ≥10 mg/L was approximately 2.0 mi (3.2 km) (see Table 4.5-7). Above-ambient TSS concentrations were predicted to substantially dissipate within 4 to 6 hours and to fully dissipate in less than 12 hours for most areas.

Table 4.5-7 Suspended Sediment Modeling Results from Cable Installation and HDD Activities

Scenario	Maximum Duration of TSS >10 mg/L (hrs)	Maximum Extent of TSS ≥10 mg/L (km)	Maximum Duration of TSS >100 mg/L (hrs)	Maximum Extent of TSS ≥100 mg/L (km)
Offshore Cable Installation				
Inter-array Cable - Jet Trencher	5.7	2.6	2.5	1.5
Inter-array Cable - Mechanical Trencher	6.3	2.9	2.7	0.9
Monmouth Export Cable -Jet Trencher	12.8	2.6	6.0	1.5
Atlantic Export Cable - Jet Trencher	5.5	1.7	0.8	<0.1
HDD Activities at Landfall Site				
Monmouth Landfall Representative HDD Pit Excavator	12.3	3.3	11	0.4
Atlantic Landfall Representative HDD Pit Excavator	10.7	1.9	10.3	0.1
Sandwave clearance				
Representative Sandwave Clearance, Monmouth ECC	12.5	3.2	7.0	2.1

These model predictions agree with modeling results conducted for similar projects in similar sediment conditions (BOEM 2021; Elliot et al. 2017; West Point Partners, LLC 2013; ASA 2008). Actual suspended sediment concentrations and sediment transport during installation may be even lower given that environmental monitoring surveys conducted during installation of the Block Island Wind Farm submarine cable found that suspended sediment levels measured during jet plow installation were up to 100 times lower than those predicted by the modeling (Elliot et al. 2017).

Benthic invertebrates can experience negative effects from elevated suspended sediment concentrations, but typically the extent of effects are species-specific and observed at high concentrations. Effects from elevated suspended sediments on benthic invertebrates can include abrasion, respiration interference, feeding disruption, reduced growth rate, and in some cases, mortality (Johnson 2018; Wilber and Clarke 2001; Kjelland et al. 2015). A typical adult bivalve response to elevated suspended sediment reported by Wilber and Clarke (2001) is a reduction in net pumping rate and rejecting excess filtered material. Johnson (2018) reports that adult bivalves are relatively tolerant of TSS but could still exhibit reduced growth and survival rates; however, very high TSS concentrations would be required to induce mortality. Wilber and Clarke (2001) reported that adult bivalves exposed to TSS levels below 100,000 mg/L for shorter than 5 days did not experience mortality.

Results from the Sediment Transport Modeling report showed that suspended sediment concentrations greater than 100 mg/L are only anticipated to last up to 11 hours for HDD activities, 6 hours for cable installation, and 7 hours for sandwave clearance (Table 4.5-7), all of which are significantly less than the 5-day study cited by Wilber and Clark (2001). Additionally, concentrations greater than 100 mg/L are expected to be localized, extending up to a maximum distance of 0.9 mi (1.5 km), 0.2 mi (0.4 km), and 1.3 mi (2.1 km) from cable centerlines, HDD activities, and sandwave clearing respectively. Therefore, while effects could occur to sessile and less mobile benthic organisms and early life stages in the immediate vicinity of the cable and HDD activities, these effects are expected to be short-term and not result in high levels of mortality.

Sediment Deposition Predictions

Installation and maintenance of structures and cables will also result in the transport of sediment that will subsequently deposit over time as sediment particles settle through the water column to the seabed. Sediment deposition levels were modeled, as part of the Sediment Transport Modeling study, for the offshore installation of inter-array cables, the Monmouth ECC, Atlantic ECC, as well as HDD activities at the Monmouth and Atlantic Landfall Sites and sandwave clearance in a representative area of the Monmouth ECC.

Table 4.5-8 summarizes the areal extent and maximum distance of sediment deposition due to cable installation, sandwave clearance, and HDD activities. Two depositional thresholds are provided in the table below, 0.04 in (1 mm) and 0.4 in (10 mm). A threshold of 0.04 in (1 mm) is cited in literature as the level at which burial and mortality occurs in demersal eggs (Berry et al. 2011). A threshold of 0.4 in (10 mm) is cited in literature as the level at which sessile benthic invertebrates exhibit signs of sensitivity (Essink 1999). While both thresholds are provided in Table 4.5-8, the modeling results for the 0.4-in (10 mm) threshold are most likely to be of importance to benthic invertebrates. Deposition ≥ 0.4 in (10 mm) from offshore cable installation was limited to the Monmouth ECC which was modeled at 98 ft (30 m) from the ECC centerline (see Table 4.5-8). Deposition did not reach 0.4 in (10 mm) for the inter-array or Atlantic ECC. The maximum deposition associated with inter-array cable, Atlantic ECC, and Monmouth ECC model scenarios was less than 0.2 in (5 mm), less than 0.4 in (10 mm), and between 0.4 and 0.8 in (10 and 20 mm), respectively.

Deposition ≥0.4 in (≥10 mm) resulting from sandwave clearance was limited to 541 ft (165 m) from the route centerline and covered a maximum area of 0.9 mi^2 (2.34 km^2). The maximum deposition predicted for sandwave clearance was ≥3.9 in (100 mm) and predicted to extend a maximum distance of 66 ft (20 m) from the route centerline. For the Monmouth and Atlantic HDD pit excavations, deposition ≥0.4 in (10 mm) was predicted to extend a maximum distance of 334 ft (102 m) and 338 ft (103 m), respectively. The Atlantic landfall approach scenario was predicted to have higher areas of deposition due to a higher fraction of coarse sediment. In combination with the sediment type and the relatively more shore-perpendicular nature of the currents at the Atlantic HDD pit, more sediment remained close to the pit and settled to the bottom rather than lingering in the water column or being transported as a suspended sediment plume.

Table 4.5-8 Deposition Modeling Results from Cable Installation and HDD Activities

Scenario	Area of Deposition ≥0.04 in (1 mm) (km^2)[1]	Maximum Extent of Deposition ≥0.04 in (1 mm) (m)[1]	Area of Deposition ≥0.4 in (10 mm) (km^2)[2]	Maximum Extent of Deposition ≥0.4 in (10 mm) (m)[2]
Offshore Cable Installation				
Inter-array Cable - Jet Trencher[3]	0.6	110	N/A	N/A
Inter-array Cable – Mechanical Trencher[3]	0.4	50	N/A	N/A
Monmouth Export Cable – Jet Trencher	8.32	200	0.02	30
Atlantic Export Cable – Jet Trencher[4]	1.39	50	N/A	N/A
HDD Activities at Landfall Site				
Monmouth Landfall - Representative HDD Pit Excavator	0.09	479	0.01	102
Atlantic Landfall - Representative HDD Pit Excavator	0.04	200	0.02	103

Table 4.5-8 Deposition Modeling Results from Cable Installation and HDD Activities (Continued)

Scenario	Area of Deposition ≥0.04 in (1 mm) (km²)[1]	Maximum Extent of Deposition ≥0.04 in (1 mm) (m)[1]	Area of Deposition ≥0.4 in (10 mm) (km²)[2]	Maximum Extent of Deposition ≥0.4 in (10 mm) (m)[2]
Sandwave clearance				
Representative Sandwave Clearance, Monmouth ECC	5.20	855	2.34	165

[1] A depositional threshold of 0.04 in (1 mm) was used in the Sediment Transport Modeling report as it is the burial and mortality threshold for demersal eggs (Berry et al. 2011).
[2] Sensitivity in sessile benthic organisms has been observed 0.4 in (10 mm) (Essink 1999).
[3] Installation of inter-array cables resulted in deposition less than 0.2 in (5 mm) for both jet and mechanical trenching.
[4] Installation of the Atlantic ECC results in deposition less than 0.4 in (10 mm).

Sediment deposition has the potential to bury benthic organisms that are within the zone of deposition. Thresholds for lethal burial depths are species-dependent, with sessile organisms being most sensitive (Essink 1999). According to Essink (1999), sessile organisms such as oysters and mussels can survive in sediment deposition of 0.4 to 0.8 in (10 to 20 mm), while other macrozoobenthos can survive in deposition of 8.0 to 11.8 in (200 to 300 mm). One study, conducted by Colden and Lipcius (2015), showed deposition-caused mortality occurring in eastern oysters only when over 90% of the individual was covered in sediment. Results from the Sediment Transport Modeling report show that deposition ≥0.4 in (10 mm) will occupy a maximum area of 0.008 mi² (0.02 km²), 0.008 mi² (0.02 km²), and 0.9 mi² (2.34 km²) for cable installation, HDD activities, and sandwave clearing, respectively. Based on the modeling results, the area of deposition ≥ 0.4 in (10 mm) will be minimal compared to the surrounding available habitat.

With respect to sedimentation and deposition, it is important to note that benthic invertebrates that occupy the seafloor of the Mid-Atlantic Bight are generally adapted to periodic disturbance and deposition events. Therefore, sediment disturbing Project activities are not expected to result in population-level effects to benthic organisms, including EFH-designated species. Although sessile organisms could experience localized increases in physical abrasion, burial, or limited mortality, mobile species are expected to temporarily vacate the area during these activities and return shortly after sediment conditions return to ambient conditions, a phenomenon that has commonly been observed following dredging activities and other physical disturbance of seafloor conditions (Brooks et al. 2004; BOEM 2021; Guida et al. 2017).

The degree of suspended sediment and deposition will be significantly lower during O&M activities than during Project construction. Some sediment suspension and deposition may occur from maintenance of structures and cables if repairs are required, but impacts are expected to be short-term and temporary, due to the predominately sandy seafloor and shallow sediments in the Offshore Project Area. Decommissioning of structures and cables is expected to have similar limited impacts to those described for construction. During all Project phases, dynamically positioned vessels and jet plow embedment will be used to the maximum extent practicable to reduce sediment disturbance during cable laying processes.

4.5.2.2 Anchoring and Jack-Up Vessels

Temporary anchoring and use of jack-up vessels within the Offshore Project Area may occur during construction and decommissioning and to a lesser extent during O&M with variations in duration and extent according to the specific work activity. All vessel anchoring and jacking-up associated with Project activities will occur within surveyed areas of the WTA or ECCs. These activities may affect benthic resources through direct seafloor disturbance and temporary increases in suspended sediment and deposition and effects are expected to be similar to those described in Section 4.5.2.1.

Positioning of anchors and jack-up vessels is expected to result in temporary impacts in the immediate area where anchors, chains, or jack-up legs meet the seafloor. Potential effects to benthic habitat and resources during anchoring and jack-up vessel positioning include temporary surficial disturbances of the seafloor and increases in suspended sediments and deposition, which could cause mortality to benthic invertebrates or cause temporary habitat disruption in limited areas. The severity of impacts for each event would depend on the specific location and habitat type, with greater effects expected when seafloor-disturbing activities interact with sensitive habitats, early life stages (e.g., egg and larvae), and sessile species such as Atlantic surfclam and ocean quahog. Immobile and early life stages of benthic invertebrate species in the direct path of anchor or jack-up vessel disturbance may be subject to injury or mortality; however, as described in Section 4.5.2.1, the benthic community is expected to recover and benthic infauna and epifauna are expected to recolonize the area after physical disturbance ceases.

The maximum seabed disturbance in the WTA and ECCs resulting from jack-up or anchored vessel use is included in the temporary seafloor disturbance calculations presented in Table 4.5-6. Disturbance caused by anchoring and jack-up vessels will occur in small areas relative to the total available surrounding habitat in the WTA and ECCs as described in Section 4.5.2.1. Impacts would be temporary and localized, and any isolated mortality of benthic organisms is not expected to have population-level impacts since benthic macroinvertebrates are anticipated to recolonize the area after physical disturbance ceases as described in Section 4.5.2.1. HDR (2019a) as cited in BOEM (2021) reported that post-construction monitoring at the Block Island Wind Farm showed seabed scars from anchoring disturbance recovered to baseline conditions within 18 months to 2 years. Anchoring in sensitive habitat areas such as hard bottom habitats could have longer-term effects to the benthic community. As previously stated, Atlantic Shores is committed to minimizing the impacts to complex habitat to the maximum extent practicable by using tools and installation methods that minimize the potential disturbance. For example, Atlantic Shores proposes to use midline buoys on anchored construction vessels to minimize seabed disturbance and will develop an anchoring plan for areas where anchoring is required to avoid impacts to sensitive habitats to the maximum extent practicable, including hard bottom and structurally complex habitats, as identified in site-specific HRG and benthic assessments.

Vessels are not expected to anchor or use jack-up positioning during O&M activities unless the WTGs, OSSs, or offshore cables require major maintenance (e.g., component replacement or cable repair). Impacts associated with potential vessel positioning with anchors or jack-up legs during operation are expected to be similar, but less than those described for the construction phase. Impacts from anchoring and jack-up vessels during decommissioning are expected to be similar to those described for construction.

4.5.2.3 Noise

This section addresses underwater sound that may be generated during activities conducted in the Offshore Project Area, including impulsive pile driving and other noise sources (e.g., HRG surveys, vessels, cable installation, vibratory pile driving, operational WTGs, operational offshore cables, and decommissioning) and assesses the potential effect noise generated from these activities may have on benthic resources.

Noise, defined as unwanted sound, is detected by benthic species as oscillations in the water column and seafloor, with oscillations transmitted through the seafloor likely to be the primary exposure pathway for benthic organisms (Roberts and Elliott 2017). Noise generated during Project construction, O&M, and decommissioning has the potential to result in physiological stress and behavioral changes in benthic resources where and when the stimulus is present, with pile driving representing the greatest potential for effect. As described in the following sections, underwater noise will likely be limited to the spatial and temporal extent of the vibrational stimuli and is expected to pose low risk to benthic invertebrates.

4.5.2.3.1 Impact Pile Driving Noise

Impact pile driving may occur if piled foundation types (monopile and jackets) are chosen as the foundation type for the Projects. Impact pile driving creates stress waves that travel down the length of the pile and couple with the surrounding medium, radiating acoustic energy into the water and sediment. Noise levels produced by pile driving depend upon several interdependent factors such as pile size, hammer strike energy, and seabed characteristics. Impact pile driving primarily produces low-frequency sound with predominant acoustic energy <1 kilohertz (kHz) (Robinson et al. 2007, Tougaard et al. 2009a), though sound production can extend to much higher frequencies (MacGillivray 2018), perhaps >100 kHz (Tougaard et al. 2009a). Pile driving also generates multiple types of vibrational waves in the sediment and at the seabed interface that can be detected by benthic species (Roberts and Elliott 2017). The characteristics of impact pile driving noises are described in more detail in Appendix II-L.

Bivalves are known to respond to vibrational stimuli by closing their syphons and, in more active mollusks, moving away from the source (Mosher 1972, Ellers 1995). There are limited studies on the effects of pile driving on shellfish and crustaceans. One study investigated the clearance rate (the rate that filter-feeders remove suspended particles from water) of blue mussels (*Mytilus edulis*) and found significantly increased rates in study animals exposed to *in situ* pile driving versus ambient noise. The study concluded that the higher clearance rates were due to increased metabolic activity because of stress during pile driving (Spiga et al. 2016). Another study assessed physiological and behavioral responses of European green crabs (*Carcinus maenus*) to pile driving noise playback exposure and found no measurable physiological effects, but did find behavioral changes, including increased time spent immobile and decreased likelihood to feed (Corbett 2019).

Based upon these studies, the effects of intermittent and impulsive pile driving noise on benthic invertebrates will be limited to the spatial and temporal extent of the vibrational stimuli. As such, the risks of noise-related effects from pile driving on benthic invertebrates are expected to be low.

4.5.2.3.2 Other Noise Sources

There are several other potential anthropogenic sound sources associated with offshore Project construction, O&M, and decommissioning. These sources were not quantitatively modeled because the potential acoustic effects of these noise sources are expected to be much less than impulsive pile driving. A qualitative assessment of other noise sources generated by Project activities, including HRG surveys, vessels, cable installation, vibratory pile driving (if needed), operational WTGs, operational offshore cables, and decommissioning is summarized in this section.

As detailed in Sections 4.5.3 and 4.5.9 of Volume I, HRG surveys may be conducted to support pre-construction site clearance activities as well as post construction facilities surveys. The HRG survey equipment used for this type of survey work would be the same or similar to the equipment deployed during Atlantic Shores' 2019–2021 site characterization surveys including multibeam echosounders, side scan sonars, sub-bottom profilers, and high-resolution seismic equipment. Of this equipment, sub-bottom profilers and high-resolution seismic equipment emit acoustic signals vertically downwards into the water column, some of which will penetrate the seabed. Studies of stronger HRG survey equipment (not being deployed by Atlantic Shores, e.g., seismic airguns), have shown little evidence to suggest that the sound signals produced would have any substantial effect on invertebrate behavior (Hawkins et al. 2015). Given the results of these studies, the mobile and intermittent nature of HRG surveys, and the short-term and infrequent nature of surveying small areas of the seafloor relative to the overall area, noise from HRG surveys will not pose a risk to benthic invertebrates.

Vessel noise includes non-impulsive sounds that arise from a vessel's engines, propellers, and thrusters. Sound levels emitted from vessels depend on the vessel's operational state (e.g., idling, in-transit, etc.) and are strongly weather dependent. Zykov et al. (2013) and McPherson et al. (2019) report a maximum broadband source level of 192 decibel (dB) re 1 micropascal (μPa) for numerous vessels with varying propulsion power. The characteristics of these noises are described in more detail in Appendix II-L. Noise from the Projects' vessels is likely to be similar in frequency characteristics and sound levels to existing commercial traffic in the region. To date, there is no convincing evidence for any significant effects induced by non-impulsive noise in benthic invertebrates (Hawkins at al. 2015). Moreover, given the rapid attenuation of underwater vibrations with increasing distance from a sound source (Morley et al. 2014), it is unlikely that these stimuli will cause more than short-term behavioral effects (e.g., flight or retraction) or physiological (e.g., stress) responses. Overall, effects to benthic invertebrates from vessel noise are expected to be short-term and localized and are not anticipated to pose a risk to benthic invertebrates.

Noise generated from cable installation activities (e.g., from sand bedform removal [if needed], jet trenching, plowing/jet plowing, mechanical trenching, etc.) are expected to be similar to those described for vessel noise. A detailed modeling and measurement study conducted for construction activities associated with cable installations concluded that underwater sound generated by cable laying vessels was similar to that of other vessels already operating in the area and no significant acoustic impacts were identified (JASCO 2006). Therefore, noise associated with cable laying activities are not expected to pose a risk to benthic invertebrates.

Non-impulsive, vibratory pile driving could be an additional source of noise generated during construction. Vibratory pile driving may be used for a short period at the beginning of pile driving or to install the entire pile, depending on sediment conditions (see Section 4.2.1 of Volume I). Compared to noise generated from impulsive pile driving, which was determined to cause minimal effects to benthic invertebrates, non-impulsive pile installation is expected to result in even lower effects due to lower peak pressure levels and short duration. Comparisons of vibratory pile installation versus impulsive hammer pile installation indicate that vibratory pile installation typically produces lower amplitude sounds in the marine environment than impact hammer installation (Rausche and Beim 2012). Received peak sound pressure level (PK) and sound exposure levels (SEL) near impact hammer pile installation can exceed 200 dB, while studies of vibratory pile driving measured source levels ranging from 177 to 195 dB PK and 174.8 to 190.6 dB SEL (Hart Crowser and Illingworth and Rodkin 2009; Houghton et al. 2010). Therefore, exposure to non-impulsive vibratory hammer installation noise is unlikely to result in substantial impacts to benthic invertebrates because of its lower peak pressure levels and its relatively short duration.

During Project operation, WTGs will generate non-impulsive sound in the nacelle that will be transmitted down the WTG tower to the foundation and then radiated into the water. Underwater sound levels generated by an operational WTG are related to the WTG’s power and wind speed, with increased wind speeds creating increased underwater sound (Wahlberg and Westerberg 2005). Under normal conditions, the sound level that results from WTG operation is of low intensity (Madsen et al. 2006), with energy concentrated at low frequencies (below a few kHz) (Tougaard et al. 2008). Pangerc et al. (2016) recorded SPL measurements at approximately 164 ft (50 m) from two individual 3.6 megawatt (MW) monopile wind turbines over a 21-day operating period. The sound pressure level increased with wind speed up to an average value of 128 dB re 1 µPa at a wind speed of about 22.4 miles per hour (mph) (10 meters per second [m/s]), and then showed a general decrease. Additional studies conducted during operation of the Block Island Wind Farm measured sound levels below 120 dB SPL at wind speeds less than 29 mph (13 m/s) (HDR 2019b). These sound levels are expected to be similar to those reported for cable laying/trenching. Therefore, the effects of WTG noise on benthic invertebrates, while long-term, are not expected to be substantial and will not cause populations-level effects.

High-voltage alternating current (HVAC) offshore cables are expected to produce non-impulsive low-frequency tonal vibration sound in the water. Such low-frequency tonal vibrations are expected to be undetectable by benthic organisms. Direct current (DC) cables do not produce a similar tonal sound because the current is not alternating. Low level tonal sound from an existing 138 kilovolt (kV) transmission line was measured in Trincomali Channel, offshore Vancouver Island, British Columbia during a quiet period of recording. The SPL at approximately 328 ft (100 m) from the cable was below 80 dB. Assuming cylindrical spreading of sound, the source level of the submarine cable was approximately 100 dB SPL (JASCO 2006). Anticipated SPL arising from the vibration of AC cables during operation are significantly lower than SPL that may occur during cable installation (Meißner et al. 2006) and may be undetectable in the ambient soundscape of the WTA. Based on these studies, no effects to benthic invertebrates are expected during cable operation.

Sounds associated with decommissioning are reasonably assumed to be similar to, or less than, those produced during either the construction or O&M phases of the Projects. The methods used to decommission and remove the Projects' foundations will depend on the type of foundation (see Section 6.2.3 of Volume I); therefore, the level and duration of sounds emitted during decommissioning will depend on the type (e.g., gravity versus piled foundation), size, and location of the foundation. Piled foundations, if used, will be cut below the mudline, likely using underwater acetylene cutting torches, mechanical cutting, and/or a high-pressure water jet. Mechanical cutting tools and high-pressure water jetting will generate non-impulsive broadband sound (Topham and McMillan 2017). Regardless of the foundation type used, removal and transport of Project components (e.g., foundations, WTGs, OSSs, etc.), will require the use of vessels, which will also generate non-impulsive sound. Potential effects to benthic invertebrates from sound generated during decommissioning activities are expected to be similar or less than those encountered during the construction or O&M phases of the Projects.

The risk of noise-related effects to benthic invertebrates and associated behavioral responses from other sound sources such as HRG surveys, vessels, cable installation, vibratory pile driving, operational WTGs, operational offshore cables, and decommissioning is expected to be very low.

4.5.2.4 Electromagnetic Fields

This section addresses electromagnetic fields (EMF) generated during operation of the Projects and the localized effects on benthic resources. EMFs are invisible areas of electric and magnetic energy that occur both naturally and anthropogenically in the marine environment. Atlantic Shores conducted an EMF study to predict EMF levels from operation of the Projects' submarine electrical system which includes a combination of high-voltage direct current (HVDC) and HVAC cables and OSSs (see Appendix II-I). The modeling results show that EMF levels are predicted to decrease exponentially with increasing distance from the cables and are therefore expected to cause minimal risk to benthic invertebrates.

It is hypothesized that electric field detection by invertebrates is conducted through the use of chemical and mechanical sensory neurons (Normandeau et al. 2011). However, due to cable configuration and shielding, electric fields will not be released into the marine environment from Project cable operation, and therefore were not modeled in Appendix II-I and are not further discussed in this section.

Magnetic fields will however be generated by the offshore cable system, which includes HVAC and HVDC export cables, HVAC interlink cables, and HVAC inter-array cables. Multiple theories have been proposed for invertebrate detection of magnetic fields. The most supported theory proposes the use of a magnetite-based system which involves the presence of magnetic crystals (magnetite) that can detect differences in magnetic fields (CSA Ocean Sciences, Inc. and Exponent 2019; Normandeau et al. 2011). Magnetosensitivity has been observed in three invertebrate phyla: Mollusca (e.g., snails and bivalves), Echinodermata (e.g., sea urchins), and Arthropoda (e.g., lobsters) (Normandeau et al. 2011). It is hypothesized that species of these phyla that are magneto-sensitive utilize the earth's natural magnetic field for orientation, navigation, and homing (Normandeau et al. 2011). Of the marine invertebrate species studied with regards to responses to magnetic fields, the American lobster is the only species which may occur in the Offshore Project Area.

Magnetic fields generated from HVAC and HVDC export cables, HVAC inter-link cables, and HVAC inter-array cables used for the Projects will be minimized by cable burial (between approximately 5 to 6.6 ft [1.5 to 2 m]) and armoring (see Section 4.5.1 of Volume I). Table 4.5-9 summarizes the modeled peak magnetic field production anticipated for Project export and inter-array cables under maximum power generation scenarios for cable crossing and normal conditions.[21]

Though well-established magnetic field thresholds for benthic invertebrates are lacking, research suggests that marine species may be more likely to detect magnetic fields from DC cables than AC cables (Normandeau et al. 2011). In fact, studies have provided evidence that marine invertebrates may not be able to detect or respond to magnetic fields produced by AC cables that have a frequency of 60 hertz (Hz), especially at intensities below 50 milligauss (mG) (Normandeau et al. 2011). Modeling of Atlantic Shores' HVAC export cables and inter-array cables which will operate at 60 Hz, predicted magnetic fields ranging from 60.07 to 244.42 mG at the cable centerline. However, the field is predicted to drop to approximately 50 mG between 5.4 and 8.4 ft (1.6 to 2.6 m) in horizontal distance from the export cables and between 1.7 and 2.8 ft (0.52 to 0.85 m) in horizontal distance from the inter-array cables. Since the HVAC export and inter-array cables will operate at 60 Hz, and the magnetic fields are predicted to drop to approximately 50 mG at a maximum horizontal distance of 8.4 ft (2.6 m), it can reasonably be assumed that magnetic fields produced by Project HVAC offshore cables will result in minimal impacts to benthic invertebrate species in the Offshore Project Area.

[21] These predicted EMF levels assume cable shielding and burial. The model results are extremely conservative since the modeling assumed full load operation 100% of the time. The Projects will more reasonably operate at approximately 50% annual capacity factor with correspondingly reduced current.

Table 4.5-9 Peak Magnetic Fields Modeled under Maximum Power Generation for the Atlantic Shores Export and Inter-Array Cables

Cable Type	Peak Magnetic Field (mG) for Maximum Modeled Case
HVAC[1]	
Export Cable	107.82
Export Cable (at cable crossing)	244.42
Inter-array Cable	60.07
HVDC	
Export Cable	152.68
Export Cable (at cable crossing)	349.22

[1]HVAC inter-link cables are part of the larger OSS electrical system, and were not analyzed as isolated, individual cables. However, due to the configuration of the inter-link cables, they are expected to operate in a similar fashion as either HVAC export cables or the HVAC inter-array cables.

As previously stated, marine invertebrates that rely on magnetic fields for orientation, navigation, and homing behaviors may be more sensitive to magnetic fields produced by DC cables than AC cables Though precise magnetic field sensitivity thresholds for marine invertebrates do not exist, studies have been conducted to identify behavioral effects from DC sources. These studies have found impacts to be minor. Hutchison et al. (2018) conducted a field study which used enclosures situated over an existing DC cable to examine American lobster response in the presence of a maximum magnetic field of 653 mG DC. Results of the field study showed that though subtle changes in behavior (e.g., exploration activity) and differences in spatial distribution (e.g., use of enclosure space, proximity to seabed) were observed, the magnetic field did not present a barrier to movement. Laboratory studies have also been conducted on marine invertebrates to determine potential effects of magnetic fields produced by a DC source on invertebrate behavior and movement. Studies conducted by Woodruff et al. (2012 and 2013) examined responses of Dungeness crab and American lobster in the presence of high DC magnetic fields and observed no statistically significant difference in behavior (e.g., feeding) or spatial use (e.g., distribution in tanks). Woodruff et al. (2012) also examined behavioral changes such as antennular flicking and feeding in Dungeness crabs when exposed to 30,000 mG DC. Results of the study showed no statistically significant differences between controlled (i.e., no DC field exposure) and experimental trials (i.e., 30,000 mG DC exposure). Woodruff et al. (2013) continued their study in 2012 and examined spatial distribution (e.g., location in tanks with respect to EMF source) and activity levels (e.g., time spent buried or active) of Dungeness crabs when exposed to 10,000 mG DC and found no statistical significance with respect to magnetic field strength. Woodruff et al. (2013) also studied changes in spatial use and behavior in American lobster when exposed to a maximum EMF level of 11,000 mG DC. Unlike the results of the Hutchison et al. (2018) field study, results from Woodruff et al. (2013) laboratory studies showed no correlation between EMF levels and spatial use (e.g., location in tank, time spent under shelter or buried) and behavior in American lobsters (e.g., activity levels). The magnetic DC fields used in both the Hutchison et al. (2018) and Woodruff et al. (2012 and 2013) studies are significantly greater than the modeled magnetic field levels expected to be generated by HVDC export cables for these Projects. Although some effects to the spatial distribution of American lobster were observed in the field studies conducted by Hutchison et al. (2018), the presence of the cable did not represent a barrier to crossing, meaning effects to orientation, navigation, and homing would be unlikely. Therefore, it is reasonable to assume that EMF generated from HVDC export cables from the Projects will not result in substantial impacts to benthic invertebrates.

Given the localized spatial extent of expected EMF emissions from the Projects, the reported lack of invertebrate impacts in available literature (BOEM 2020, Hutchison et al. 2018, Woodruff et al. 2012, 2013), and proposed mitigation measures, EMFs associated with Project operation are not expected to pose a risk to benthic invertebrates.

4.5.2.5 Presence of Structures and Cables

This section addresses the potential effect that the presence of structures and cables in the Offshore Project Area may have on benthic resources. The seafloor of the Offshore Project Area is predominately comprised of flat, sandy habitat with ripples, sandwaves, and areas of textured seafloor, occupied by benthic species such as crabs, clams, polychaetes, oligochaetes, and nematodes. Introduction of new foundations, scour protection, offshore cables, and offshore cable protection introduces habitat complexity and diversity in a largely homogenous environment. Within the Offshore Project Area, the presence of foundations, cable protection, and scour protection may result in habitat conversion/creation, increased food availability, facilitation of invasive species settlement, and hydrodynamic disturbances.

The presence of foundations and scour protection will result in localized habitat conversion of any sandy, soft bottom habitat to a coarser, complex habitat. The maximum total area of permanent seafloor disturbance in the WTA, using the foundation type with the maximum footprint, is 1.01 mi^2 (2.60 km^2) (Table 4.5-6), which represents approximately 0.6% of the 160 mi^2 (413 km^2) WTA area. The maximum total area of permanent seafloor disturbance in the Project 1 and Project 2 WTA is 0.57 mi^2 (1.50 km^2) and 0.49 mi^2 (1.25km^2), respectively. The maximum total permanent seafloor disturbance in the Atlantic and Monmouth ECCs from the placement of cable protection is 0.06 mi^2 (0.16 km^2) and 0.32 mi^2 (0.83 km^2), respectively (Table 4.5-6). The combined permanent seafloor disturbance for the Atlantic and Monmouth ECCs represents 0.8% of the total ECC area. This permanent habitat conversion of predominantly sandy benthic habitat to hard structure habitat will be localized and restricted to the foundation, cable protection, and scour protection footprints (ICF, 2020).

Even though the presence of foundations, cable, and scour protection will eliminate a small percentage of flat sandy habitat in the Offshore Project Area, the Projects are expected to produce ecological benefits by creating new, hard substrate habitat for benthic species, thereby potentially increasing species abundance of invertebrate species that prefer hard substrates such as mussels, crabs, sea anemone, encrusting worms and barnacles (English et al. 2017, Lüedeke 2015). In two different wind farms, the Block Island Wind Farm off Rhode Island and the Horns Rev Wind Farm in the North Sea, abundance of benthic invertebrates within soft-bottom communities largely remained the same between pre- and post-construction (ICF 2020). At the Block Island Wind Farm, abundance of small invertebrates (e.g., nematodes and polychaetes) in existing soft-bottom benthic communities increased after construction around some WTGs.

Colonization of foundations and scour protection will predominately include fouling benthic species (e.g., mussels) that were not present, or at least not abundant, prior to development (English et al. 2017). Post-construction monitoring at the Alpha Ventus Offshore Wind Farm, located in the North Sea, observed a 100-fold increase in the abundance of fouling species (e.g., mussels) on foundations when compared to the biomass observed in the former soft sediment, as well as increases brown crab abundance (*Cancer pagurus*) (English et al. 2017). Surveys at the Horns Rev and Nysted offshore windfarms, located off the coast of Denmark, measured a 50 to 150% increase in biomass, primarily of common mussel species (ICF 2020). In the U.S., monitoring at the Block Island Wind Farm during the first two years following construction found increased abundance of benthic invertebrate species when comparing the WTG locations to control areas surrounding the facility; however, no statistically significant difference was observed between the facility and control areas with regards to species composition (HDR 2019a).

The presence of structures and scour protection may also result in increased food availability for filter feeders (Raox et al. 2017; HDR 2019a). It is hypothesized that the foundations and scour protection will facilitate the colonization of various benthic species, as well as attract predators such as finfish and crustaceans, a phenomenon known as the "reef effect". This colonization and predator attraction could result in a greater influx of organic matter, a prime food source for benthic filter feeders and detritovores, from uneaten food particles, dead organisms, and other waste products (Raox et al. 2017). At the Block Island Wind Farm, the seafloor in the immediate vicinity of the WTGs were colonized by a dense blanket of mussels, where high levels of organic material were found (HDR 2019a). Increased food availability for benthic filter feeders and detritivores could lead to biomass increases of those species.

In addition to providing increased food availability for benthic species, the presence of structures and foundations could result in increased predation on benthic organisms. Hard structures such as WTG, OSS, and meteorological (met) tower foundations and scour protection could offer more diverse and abundant feeding opportunities for finfish or predatory macroinvertebrates in an area that is largely comprised of flat, sandy habitat with small topographic features (e.g., ripples) (ICF 2020). Attraction of finfish and predatory invertebrates could lead to increased predation rates on benthic species (Raox et al. 2017). At windfarms in the North and Baltic Sea, higher finfish diversity and abundance was observed in the vicinity of WTG foundations compared to surrounding areas (Leonhard et al. 2011; Wilhelmsson et al. 2006). Studies conducted around oil platforms in the U.S. have observed higher predation rates around the platforms compared to surrounding environments (Page et al. 2007). Similar effects could occur around foundations and scour protection in the Offshore Project Area.

The presence of foundations and scour and cable protection could result in the spread of non-indigenous invertebrate species (English et al. 2017). Examples of non-indigenous invertebrate species known to inhabit marine ecosystems off the coast of New Jersey include European green crab and Asian shore crab (*Hemigrapsus sanguineus*) (USGS 2021; USDA 2021). A study which examined the development and progression of fouling communities at numerous wind farms off the Belgian coast showed that foundations created new habitat for non-indigenous species previously absent from the area (e.g., Pacific oyster (*Crassostrea gigas*) and Japanese shore crab (*Hemigrapsus sanguineus*)) and offered habitat expansion to two existing non-indigenous species, a species of barnacle and species of limpet (Kerckhof et al. 2011). In the U.S., exotic invertebrate species have been observed around oil and gas platforms. One study which examined species composition around offshore oil and gas platforms off the coast of California found three exotic invertebrate species, the Japanese skeleton shrimp (*Caprella mutica*), red rust bryozoan (*Watersipora subtorquata*), and an anemone species (*Diadumene spp*) (Page et al. 2006). Colonization of non-indigenous species can lead to decreases in native biomass due to competition of resources and can alter trophic links and ecological processes (Page et al. 2006; Sellheim et al. 2010). However, the surrounding area is comprised primarily of soft sediment so it can reasonably be assumed that if the foundations and scour protection resulted in invasive species attraction or growth, it is unlikely to result in population-level impacts to native invertebrates which would be dominated by species inhabiting soft sediments (BOEM, 2021).

The presence of WTGs and other foundation structures in the WTA may affect currents and water movement within the WTA. Specifically, as water moving along a current approaches a turbine or foundation, it changes and accelerates around a structure, creating turbulence (ICF 2020). This phenomenon is known as the wake effect (ICF 2020). The magnitude of wake effect depends on the diameter of foundation structures, volume of impervious surface in the water column and seafloor, and current speed (ICF 2020; English et al. 2017). Wake effect from monopile foundations has been observed approximately 600 ft (200 m) down current of the structures (English et al. 2017). During peak tidal movements, turbulent wakes have been observed as far as 1,312 ft (400 m) from the monopile (English et al. 2017). These localized wake effects could influence larval settlement and primary productivity. In some cases changes in current and water movement could result in positive effects for certain species. Changes to currents and water movement have potential to result in increased food availability for filter feeders (e.g., Atlantic sea scallop (*Placopecten magellanicus*), Atlantic surfclam, ocean quahog) as well as influence larvae settlement, a phenomenon which has been observed with gravity-base structures (English et al. 2017; ICF 2020).

Monitoring the physical dynamics in the Mid-Atlantic Bight and Cold Pool are important to understanding how placement of wind turbines may affect ocean mixing. Changes to Cold Pool timing have been linked to disturbances in biological processes of marine invertebrates. Mortality events in surfclams and alterations of ocean quahog spawning timing has been observed during earlier seasonal breakdown of the Cold Pool (Narvaez et al. 2015; Toupoint et al. 2012). Modeling studies, considering varying sizes of wind projects and technology, have indicated that wind turbines may cause atmospheric disturbances to near-surface winds that influence ocean mixing

(Afsharian and Taylor, 2019). The extent of changes to ocean mixing at local and regional, or mesoscale, scales is not well known and can vary widely in magnitude as local mixing is dependent on atmospheric forcing, daily heating and cooling, wind, and changes in temperature and humidity associated with mesoscale weather and other processes (Paskyabi et al., 2015). Measuring and predicting any possible effects to ocean mixing is highly dependent on the characteristics of the wind project (e.g., spacing between turbines, size of turbines) and the local and regional atmospheric and oceanographic conditions (Moum and Smyth 2019), including conditions of benthic invertebrates in the local and regional areas.

Conditions and observations at local and regional scales are necessary to understand if effects to mixing may occur from the Projects and if so, whether effects may influence the Cold Pool dynamics. Drawing early conclusions from European or modeling studies have inherent differences, as the Mid-Atlantic Bight has weaker tidal currents and more intense stratification than the North Sea and is different from other western boundary currents or mesoscale circulation features in European waters. It has been suggested that slower ocean velocities in the southern Mid-Atlantic Bight would result in significantly less mixing than has been found in Europe (Carpenter et al., 2016). European studies are more representative of Mid-Atlantic Bight conditions during weaker stratification. Therefore, it is not likely that structure-induced mixing would be sufficient to overcome intense summer stratification to influence the Cold Pool and cause broader ocean mixing (Miles et al., 2020). As a result, substantial impacts to the Cold Pool and ocean mixing from the presence of Project WTGs is not expected. However, considering the seasonal, annual, and longer scale changes in the Cold Pool and Mid-Atlantic Bight, Atlantic Shores is supportive of contributing to regional collaborative science to study and monitor the Cold Pool and its influence on benthic invertebrates.

In 2019, Atlantic Shores, in collaboration with Rutgers University and MARACOOS, deployed a metocean buoy to contribute to the study of the Mid-Atlantic Cold Pool. This buoy contains sensors at the atmospheric-boundary layer and ocean floor that allow for continuous measurements of the Cold Pool, as well as support regional oceanographic and atmospheric modeling efforts. The data collected by this buoy is publicly accessible and can be accessed through MARACOOS' data portal at https://ioos.noaa.gov/regions/maracoos. Once operational, the Projects will also represent a living laboratory as they provide abundant opportunities for direct ocean and ecological observations, such as the anticipated beneficial effects of introducing structure to a homogenous sandy sea floor.

As stated, the presence of foundations and cable and scour protection could create a range of effects to benthic resources during the O&M phase of the Projects. Most of these effects will be permanent throughout the life of the Projects and mostly beneficial. Foundations and cable and scour protection are expected to produce ecologically beneficial effects that could outweigh the risk of introducing hard structure to a small area of the vast flat, sandy habitat found in the Mid-Atlantic Bight. Once the Projects are decommissioned, the local environmental and ecological features of the area are expected to revert to pre-construction conditions. Potential effects from decommissioning include the loss of Project-related hard structures, which are expected to be colonized at the time of decommissioning. Benthic resources that attach to foundations will be displaced during decommissioning as the foundations and scour protection are removed.

4.5.2.6 Summary of Proposed Environmental Protection Measures

The majority of potential effects to benthic resources are expected to be temporary and localized as described in the previous sections. Many of the permanent effects from the presence of structures, including cable and scour protection, are expected to be ecologically beneficial. Atlantic Shores has extensively studied the benthic habitat in the Offshore Project Area and has already taken precautionary steps and commitments to avoid, mitigate, and monitor Project effects on benthic communities and habitat during construction, O&M, and decommissioning. Additional avoidance and mitigation measures and tools will be evaluated further as the Projects progress through development and permitting and in cooperation and coordination with Federal and State jurisdictional agencies and other stakeholders. The following provides a summary of proposed environmental protection measures that Atlantic Shores will implement to reduce impacts to benthic resources within the Offshore Project Area:

- Comprehensive benthic habitat surveys (seafloor sampling, imaging, and mapping) have been conducted in consultation with BOEM and NOAA to support the identification of sensitive and complex habitats and the development of strategies for minimizing impacts to identified areas to the maximum extent practicable.
- HDD will be used to avoid seabed disturbance impacts to benthic habitat at the landfall sites. All HDD activities will be managed by an HDD Contingency Plan for the Inadvertent Releases of Drilling Fluid to ensure the protection of marine and inland surface waters from an accidental release of drilling fluid. All drilling fluids will be collected and recycled upon HDD completion.
- Inter-array, inter-link, and export cables will be buried to a target depth of 5 to 6.6 ft (1.5 to 2 m) which will allow the benthic community to recover and recolonize, avoid direct interaction with benthic invertebrates, and minimize impacts from EMF.
- Dynamically positioned vessels and jet plow embedment will be used to the maximum extent practicable to reduce sediment disturbance during cable laying processes.
- Vessels will operate in compliance with regulatory requirements related to the prevention and control of discharges and accidental spills.
- Accidental spill or release of oils or other hazardous materials will be managed through the OSRP (see Volume I Appendix I-D).
- Anchor midline buoys will be used on anchored construction vessels, where feasible, to minimize seabed disturbance.
- An anchoring plan will be employed for areas where anchoring is required to avoid impacts to sensitive habitats, to the maximum extent practicable, including hard bottom and structurally complex habitats, identified through the interpretation of site-specific HRG and benthic assessments.

- A benthic habitat monitoring plan will be implemented to measure and assess the disturbance and recovery of marine benthic habitats and communities as a result of Project construction and operation (see Appendix II-H).
- Atlantic Shores will implement the following measures in accordance with the Offshore Renewable Energy Credit (OREC) allowance that the New Jersey Board of Public Utilities (NJBPU) awarded to Atlantic Shores on June 30, 2021:
  - Maintain and update the Environmental Protection Plan (EPP) and Fisheries Protection Plan (FPP) at key Project milestones, including commencement of construction, completion of construction, and every 2 years thereafter, through decommissioning, or at other times as requested by NJDEP to ensure that impacts are being actively monitored and mitigated.
  - Update the EPP and FPP to ensure New Jersey's natural resources, including finfish and shellfish, sea turtles, marine mammals, avian species, bats and benthic populations are protected throughout the life of the Project from pre-construction through decommissioning and to ensure that any impacts are being actively monitored and mitigated as required by law.
  - Provide funding to the State of New Jersey for research initiatives and the regional monitoring of wildlife and fisheries related to the introduction of offshore wind projects. The funding will be administered by the New Jersey Department of Environmental Protection (NJDEP) and NJBPU, with stakeholder input to aid in the identification and prioritization of regional research and monitoring needs.
  - Report annually in writing to BPU and NJDEP beginning June 30, 2022, on actions taken to ensure environmental protection, fisheries protection, mitigation of environmental and/or fishing impacts. This report will specifically address how Atlantic Shores is enacting its plans for environmental and fisheries protection and mitigation of impacts as articulated in its Application to BPU. An appendix to the report will indicate the data collected in the reporting period, and will include an accessibly written, narrative description(s) of the dataset(s), the associated findings made based upon these data, and reference(s) to the data portal(s) where these data can be publicly accessed. This appendix will be made public.
  - Report annually in writing to BPU and NJDEP beginning June 30, 2022, on the policies and programs that may be adopted by BPU or NJDEP to help reduce future environmental or fisheries impacts or enhance the protection of natural resources. This report will detail any proposed future mitigation or protection measures that could be adopted, providing a description, proposed timeline, and expected outcomes of the recommended action.
  - Make public through appropriate data portals, all data collected in the development of the Project from pre-construction activities through decommissioning activities. All collected information and scientific data not deemed confidential by statute or regulation will be made publicly available.

Specifically, data with particular emphasis on natural resources including, but not limited to, finfish and shellfish, sea turtles, marine mammals, avian species, bat and benthic populations, as well as data regarding vessel strikes, avoidance, observations on habitat, and routine data collection on ocean conditions will be shared in a manner that is in keeping with best practices for the reporting of these types of data. Atlantic Shores will report annually to BPU and NJDEP beginning June 30, 2022, describing the type of data shared, and where the data is shared. Should a common database for New Jersey-related, scientific data generated in association with offshore wind development be created, Atlantic Shores will archive all data collected with the development of the Project in that data repositor.

4.6 Finfish, Invertebrates, and Essential Fish Habitat

This section describes finfish and pelagic invertebrate resources and associated habitat, including Essential Fish Habitat (EFH), present in the Offshore Project Area, which includes Project 1, Project 2, the Overlap Area, and the export cable corridors (ECCs). This section also assesses the impact producing factors (IPFs) associated with Project activities and the anticipated measures to avoid and minimize the potential effects to these resources. Finfish and pelagic invertebrates are essential components of a marine ecosystem, providing important trophic resources for both larger predator and smaller prey species. The benthic habitat that supports many demersal and benthic-oriented species is described in more detail in Section 4.5 Benthic Resources. In addition to ecological importance, many finfish and invertebrate species are considered commercially and recreationally important (see Section 7.4 Commercial Fisheries and For-Hire Recreational Fishing). In order to maintain a healthy habitat for these species of recreational and commercial importance, EFH was established through the Magnuson-Stevens Fishery Conservation and Management Act to conserve and protect habitats that provide spawning, breeding, feeding, and growth opportunities to designated species. A Revised EFH Assessment is included as Appendix II-J2.

Atlantic Shores understands the importance of finfish and pelagic invertebrates and their associated EFH from an ecological, recreational, and commercial perspective and is committed to understanding these resources in the Offshore Project Area. Atlantic Shores has implemented benthic habitat assessment surveys, approved and accepted by Federal and State agencies, that build upon and fill data gaps from previously completed Federal and State-funded research efforts. These studies have provided data to characterize the seafloor and benthic habitats, including EFH, and to identify species occupying these habitats in the Offshore Project Area. In addition, Atlantic Shores will implement a fisheries monitoring plan to monitor baseline environmental conditions relevant to fisheries and how these conditions may change throughout Project construction and operation. Proposed fisheries surveys detailed in the Fisheries Monitoring Plan (see Appendix II-K) include a demersal fish trawl survey, fish pot survey, and clam dredge survey. These efforts have and will continue to inform Atlantic Shores Project design and construction planning to avoid or minimize Project-related impacts with the ultimate goal of maintaining a healthy, functioning marine ecosystem.

4.6.1 Affected Environment

The description of finfish, pelagic invertebrates, and EFH is based on available literature, online data portals, mapping databases, and survey results from Federal and State agencies. Specific information on species composition, distribution, and abundance within the Offshore Project Area was obtained from the Northeast Ocean Data Portal, Northeast Fisheries Science Center (NEFSC) multispecies trawl surveys[22], New Jersey Department of Environmental Protection (NJDEP) Ocean Stock Assessment Program (OSAP) trawl surveys,[1] BOEM Habitat Mapping and Assessment of the

[22] Site-specific trawl data from 2009 to 2019 were obtained directly from NOAA Fisheries and NJDEP for trawl surveys that overlapped with the Offshore Project Area (WTA, Atlantic ECC, and Monmouth ECC).

Northeast Wind Energy Areas (Guida et al. 2017),[23] and NJDEP Ocean/Wind Power Ecological Baseline Studies (Geo-Marine 2010).[24]

The Offshore Project Area is located in the Mid-Atlantic Bight, a region known for diverse species assemblages, with fish and shellfish species of commercial and recreational importance (BOEM 2012). Diversity of the Mid-Atlantic Bight has been attributed to overlapping species ranges from the New England and South Atlantic regions (BOEM 2012). Fish community composition within the Mid-Atlantic Bight fluctuates seasonally and consists largely of tropical-subtropical and temperate species (BOEM 2012; Geo-Marine 2010). Approximately 336 marine fish species can be found along the coastline of New Jersey, many of which are likely to occur in the Offshore Project Area, and demonstrate seasonal migration patterns, moving offshore in the winter, and nearshore during the spring and summer (Geo-Marine 2010).

The seasonality of food sources in the Mid-Atlantic Bight could be an influencing factor for fish migration patterns (Sherman et al. 1983). Two important sources of nutrients for many finfish species are phytoplankton and zooplankton. Phytoplankton are small, photosynthetic microalgae. Distribution and abundance of phytoplankton is strongly dependent on water temperature, light, nutrient concentrations, pH, and salinity (Geo-Marine 2010). The phytoplankton community off the coast of New Jersey is dominated by diatoms (Geo-Marine 2010). Within the Mid-Atlantic Bight, phytoplankton abundance is strongly influenced by the seasonal stratification of the shelf. The highest abundance of phytoplankton is seen in coastal waters where stratification is weak or absent (Geo-Marine 2010). Offshore, phytoplankton are most abundant in the fall and winter when seasonal stratification diminishes (Geo-Marine 2010).

Zooplankton refers to small animals suspended in the water column that either drift with currents or have weak swimming abilities (NMFS 2021). The zooplankton community found along the shelf of the Mid-Atlantic Bight includes, but is not limited to, copepods (e.g., *Calanus finmarchicus*), mysids, euphausiids, amphipods, cnidaria, ctenophores, and larval fish species (e.g., Atlantic herring) (Kane 2005; NMFS 2021). Copepods are a key food source for larval and adult pelagic fish that reside or migrate through the Mid-Atlantic Bight (Kane 2005). Studies along the shelf of the Mid-Atlantic Bight have shown evidence of seasonal variability in zooplankton abundance, with the greatest abundance occurring in the spring and summer, and the lowest abundance occurring in the winter (NMFS 2021). Seasonal differences in zooplankton abundance have been linked to migration patterns of some migratory species (e.g., Atlantic mackerel, Atlantic menhaden) (Sherman et al. 1983).

One unique feature of the Mid-Atlantic Bight is known as the Cold Pool. The Cold Pool is an oceanographic phenomenon referring to a bottom-trapped, cold, nutrient-rich pool that extends

[23] Guida et al. (2017) evaluated NEFSC seasonal trawl data from 2003 to 2016 in the entire NJ WEA which includes areas outside of the Atlantic Shores WTA.

[24] Geo-Marine (2010) evaluated NJOSAP ocean trawl data from 2003 to 2008 in sampling strata that extended from Barnegat Bay (about 5 miles [mi] (8 kilometers [km]) south of the Monmouth Landfall Site) to Hereford Inlet (about 25 mi [40 km] south of the Atlantic Landfall Site), extending from the coastline out to the 98-foot (ft) (30-meter [m]) depth contour.

from Cape Cod, Massachusetts to Cape Hatteras, North Carolina, located over the mid- and outer-shelf of the Mid-Atlantic Bight (Chen 2018; Ganim 2019). The formation of the Cold Pool is driven by seasonal patterns in solar heating and wind (Ganim 2019) and is not spatially uniform (Lentz 2017). It forms at the start of spring when wind mixing is reduced, and surface heat fluxes increase causing the water column to become stratified (Ganim 2019; Lentz 2017). Freshwater runoff in the spring can further intensify stratification (Castelao et al. 2010). The Cold Pool, located along the seafloor, is isolated from warming surface waters by the seasonal thermocline and creates habitat conditions that provide thermal refuge to colder water species in the Mid-Atlantic Bight ecosystem (Lentz 2017). Recruitment and settlement of several cold-water species, such as yellow-tail flounder (*Pleuronectes ferruginea*) and red hake (*Urophycis chuss*), has been linked to the presence of the Cold Pool (Chen 2018; Lentz 2017; Sullivan et al. 2005; Miller et al. 2016). This feature also provides temporary habitat for some northern species, like haddock (*Melanogrammus aeglefinus*) and Atlantic cod (*Gadus morhua*), which thrive in colder temperatures (Steves et al. 1999; Kohut and Brodie 2019). Cold pool waters are also nutrient-enriched and when upwelled toward the surface, can drive phytoplankton growth and high concentrations of particulate organic matter in the water column (Voynova et al. 2013).

The timing of the formation and breakdown of the Cold Pool, as well as its spatial extent, varies significantly each year but generally develops annually between spring and fall (Chen and Curchitser 2020). The Cold Pool dissipates in the fall due to enhanced vertical mixing from an increase in the frequency of strong wind events and the cooling of surface temperatures (Ganim 2019). The breakdown of the stratified Cold Pool is known to influence the timing of migration for species such as winter flounder (*Pseudopleuronectes americanus*), summer flounder (*Paralichthys dentatus*), black sea bass (*Centropristis striata*), and Atlantic butterfish (*Peprilus triacanthus*) (Kohut and Brodie 2019).

The affected environment for finfish, invertebrates, and EFH spans the entirety of the Offshore Project Area which is comprised of the Wind Turbine Area (WTA) and the Atlantic and Monmouth ECCs up to the landfall sites. The WTA includes Project 1, Project 2, and the Overlap Area (see Volume I, Figure 1.1-2). For the purposes of this section and the analysis of finfish, invertebrates, and EFH resources, the Overlap Area is included in both the Project 1 WTA and Project 2 WTA.

The Offshore Project Area, which includes the nearshore areas at the landfall sites, contains tidal, nearshore, and offshore habitat, with water depths ranging from 62 to 121 ft (19 to 37 m) in the WTA, approximately 0 to 72 ft (0 to 22 m) in the Atlantic ECC, and approximately 0 to 98 ft (0 to 30 m) in the Monmouth ECC. The seabed in the Offshore Project Area and vicinity is predominantly flat and sandy with mobile bedform features (e.g., sandwaves), which are typical features of the Mid-Atlantic Bight. Hardened structures created by shipwrecks, obstructions, or artificial reefs also contribute to the benthic and demersal habitats available for marine species. These features represent areas of hard substrate projecting above the seabed that attract benthic resources and fish species in areas where reef habitat is sparse like the Mid-Atlantic Bight (Ross et al. 2015). Multiple shipwrecks are located in and along the borders of the Offshore Project Area.

Additionally, two artificial reefs are located along the outer boundary of the Monmouth ECC, and one is located proximal to the southwestern corner of the Project 1 WTA.

Based on seasonal trawl surveys, presented in more detail in Sections 4.6.1.1, 4.6.1.2, and 4.6.1.4, the most common fish and pelagic invertebrate species captured in the Offshore Project Area include: Atlantic butterfish, Atlantic croaker (*Micropogonias undulatus*), Atlantic herring (*Clupea harengus*), northern sand lance (*Ammodytes dubius*), bay anchovy (*Anchoa mitchilli*), longfin inshore squid (*Doryteuthis pealeii*), northern searobin (*Prionotus carolinus*), spiny dogfish (*Squalus acanthias*), scup (*Stenotomus chrysops*), spotted hake (*Urophycis regia*), silver hake (*Merluccius bilinearis*), round herring (*Etrumeus teres*), weakfish (*Cynoscion regalis*), Atlantic silverside (*Menidia menidia*), and windowpane (*Scophthalmus aquosus*).

Many fish species that have the potential to occur in the Offshore Project Area are migratory, traveling between offshore and nearshore habitats seasonally to spawn (Geo-Marine 2010; Guida et al. 2017). Species composition within the Offshore Project Area includes a variety of demersal and pelagic finfish and invertebrates[25]. A list of major demersal and pelagic finfish and pelagic invertebrate species potentially present within and surrounding the Offshore Project Area is presented in Table 4.6-1. This table focuses on species that are reported as either abundant in the literature or trawl surveys, commercially or recreationally important, forage species that serve as prey, EFH-designated species, or protected species. Habitat association (demersal, benthic, pelagic) is also provided for each species. Additional information about demersal and pelagic fish, highly migratory species, pelagic invertebrates, threatened and endangered species, and EFH-designated species is provided in Sections 4.6.1.1 through 4.6.1.6.

[25] Demersal species are those living close to the seafloor, while benthic species are those associated with or occurring on the seafloor (NOAA 2021b; NOAA, 2020d). Pelagic species are those that inhabit the water column (NOAA 2020e).

Table 4.6-1 Finfish and Pelagic Invertebrate Species Potentially Present in the Atlantic Shores Offshore Project Area

Species	Commercial/ Recreational Importance[1]	Forage Species	EFH[2]	Protected Species Status[3]	Habitat Association
Albacore Tuna (*Thunnus Alalunga*)	C, R		X		Juvenile - Pelagic
Alewife (*Alosa Pseudoharengus*) [4]	R	X			Pelagic
American Eel (*Anguilla Rostrata*) [4]	C, R				Demersal
American Shad (*Alosa Sapidissima*) [4]	C, R				Pelagic
Atlantic Bonito (*Sarda Sarda*)	C, R				Pelagic
Atlantic Butterfish (*Peprilus Triacanthus*)	C	X	X		Pelagic
Atlantic Chub Mackerel (*Scomber Colias*)	C, R				Pelagic
Atlantic Cod (*Gadus Morhua*)	R	X	X		Eggs And Larvae – Pelagic Adult – Benthic
Atlantic Croaker (Micropogonias undulatus)	R				Demersal
Atlantic Herring (*Clupea harengus*)		X	X		Juvenile and Adult – Pelagic
Atlantic Mackerel (*Scomber scombrus*)	C, R	X	X		Pelagic
Atlantic Menhaden (*Brevoortia tyrannus*) [4]	C, R	X			Pelagic
Atlantic Salmon (*Salmo salar*) [5]				E	Pelagic
Atlantic Silverside (*Menidia menidia*)		X			Pelagic
Atlantic Sturgeon (*Acipenser oxyrinchus*)				E, E(S)	Demersal
Atlantic Wahoo (*Acanthocybium solandri*)	R				Pelagic
Bay Anchovy (*Anchoa mitchilli*)		X			Pelagic
Big Eye Tuna (*Thunnus obesus*)	C, R				Pelagic

Table 4.6-1 Finfish and Pelagic Invertebrate Species Potentially Present in the Atlantic Shores Offshore Project Area (Continued)

Species	Commercial/ Recreational Importance[1]	Forage Species	EFH[2]	Protected Species Status[3]	Habitat Association
Black Drum (*Pogonia cromis*)	C, R				Demersal
Black Sea Bass (*Centropristis striata*)	C, R	X	X		Larvae– Pelagic Juvenile and Adult– Demersal
Blacktip Shark (*Carcharhinus limbatus*)	R				Pelagic
Blueback Herring (*Alosa aestivalis*) [4]	R	X			Pelagic
Bluefin Tuna (*Thunnus thynnus*)	C, R		X		Juvenile and Adult - Pelagic
Bluefish (*Pomatomus saltatrix*)	C, R	X	X		Pelagic
Blueline tilefish (*Caulolatilus microps*)	C, R				Benthic
Blue Shark (*Prionace glauca*)	R		X		Juvenile and Adult - Pelagic
Clearnose Skate (*Raja eglanteria*)	R		X		Juvenile and Adult - Benthic
Common Thresher Shark (*Alopias vulpinus*)	C, R		X		Pelagic
Conger eel (*Conger oceanicus*)	C				Benthic
Cownose Ray (*Rhinoptera bonasus*)	R				Demersal
Cunner (*Tautogolabrus adspersus*)	R				Demersal
Dolphinfish (*Coryphaena hippurus*)	C, R				Pelagic
Dusky Shark (*Carcharhinus obscurus*)			X		Neonate, Juvenile, Adult - Pelagic
Golden Tilefish (*Lopholatilus chamaeleonticeps*)	C, R		X		Benthic

Table 4.6-1 Finfish and Pelagic Invertebrate Species Potentially Present in the Atlantic Shores Offshore Project Area (Continued)

Species	Commercial/ Recreational Importance[1]	Forage Species	EFH[2]	Protected Species Status[3]	Habitat Association
Goosefish (*Lophius americanus*)	C, R				Demersal
Gray Triggerfish (*Balistes capriscus*)	R				Demersal
Haddock (*Melanogrammus aeglefinus*)	R	X	X		Juvenile – Benthic
Hickory Shad (*Alosa mediocris*)	R				Pelagic
Little Skate (*Leucoraja erinacea*)	C		X		Juvenile and Adult - Benthic
Little Tunny (*Euthynnus alletteratus*)	R				Pelagic
Longfin Inshore Squid (*Doryteuthis pealeii*)	C		X		Eggs – Benthic Juvenile and Adult - Pelagic
Monkfish (*Lophius americanus*)	R	X	X		Eggs and Larvae – Pelagic Adult– Benthic
Northern Kingfish (*Menticirrhus saxatilis*)	R				Demersal
Northern Puffer (*Sphoeroides maculatus*)	R				Demersal
Northern Shortfin Squid (*Illex illecebrosus*)	C		X		Juvenile - Pelagic
Northern Sand Lance (*Ammodytes americanus*)		X			Demersal
Northern Searobin (*Prionotus carolinus*)	R				Demersal
Ocean Pout (Macrozoarces americanus)		X	X		Eggs and Adult - Benthic
Ocean sunfish (*mola mola*)	R				Pelagic
Pollock (*Pollachius virens*)	R		X		Larvae – Pelagic
Porbeagle shark (*Lamna nasus*)	R				Pelagic

Table 4.6-1 Finfish and Pelagic Invertebrate Species Potentially Present in the Atlantic Shores Offshore Project Area (Continued)

Species	Commercial/ Recreational Importance[1]	Forage Species	EFH[2]	Protected Species Status[3]	Habitat Association
Red Hake (*Urophycis chuss*)	C, R	X	X		Eggs and Larvae – Pelagic Juvenile and Adult– Benthic
Round Herring (*Etrumeus teres*)		X			Pelagic
Sand Tiger Shark (*Carcharias taurus*)			X		Neonate and Juvenile–Demersal
Sandbar Shark (Carcharhinus plumbeus)			X		Neonate, Juvenile, and Adult - Demersal
Scup (*Stenotomus chrysops*)	C, R	X	X		Juvenile and Adult–Demersal
Sheepshead (*Archosargus probatocephalus*)	R				Demersal
Shortfin Mako Shark (*Isurus oxyrinchus*)	C, R		X		Pelagic
Shortnose sturgeon (*Acipenser brevirostrum*) [5]				E, E(S)	Demersal
Silver Hake (*Merluccius bilinearis*)	C		X		Eggs and Larvae – Pelagic Adult – Pelagic and Benthic
Silver Perch (*Bairdiella chrysoura*)					Demersal
Skipjack Tuna (*Katsuwonus pelamis*)	R		X		Juvenile and Adult - Pelagic
Smoothhound Shark Complex (Smooth Dogfish) (*Mustelus canis*)	R		X		Demersal

Table 4.6-1 Finfish and Pelagic Invertebrate Species Potentially Present in the Atlantic Shores Offshore Project Area (Continued)

Species	Commercial/ Recreational Importance[1]	Forage Species	EFH[2]	Protected Species Status[3]	Habitat Association
Southern Kingfish (*Menticirrhus americanus*)	R				Demersal
Spanish Mackerel (*Scomberomorus maculatus*)	R				Pelagic
Spiny Dogfish (*Squalus acanthias*)	C, R		X		Pelagic and epibenthic
Spot (*Leiostomus xanthurus*)	C, R	X			Demersal
Spotted Hake (*Urophycis regia*)					Demersal
Striped Bass (*Morone saxatilis*) [4]	R				Demersal
Striped Mullet (*Mugil cephalus*)	R	X			Demersal/Pelagic
Striped Searobin (*Prionotus evolans*)	R				Demersal
Summer Flounder (*Paralichthys dentatus*)	C, R	X	X		Eggs and Larvae – Pelagic Juvenile and Adult – Demersal
Swordfish (*Xiphias gladius*)	C, R		X		Pelagic
Tautog (*Tautoga onitis*) [4]	C, R				Demersal
Tiger Shark (*Galeocerdo cuvieri*)	R		X		Juvenile and Adult - Pelagic
Weakfish (*Cynoscion regalis*) [4]	C, R	X			Pelagic
White Hake (*Urophycis tenuis*)	R		X		Adult - Benthic
White Mullet (*Mugil curema*)	R	X			Pelagic
White Perch (*Morone americana*)	R				Demersal

Table 4.6-1 Finfish and Pelagic Invertebrate Species Potentially Present in the Atlantic Shores Offshore Project Area (Continued)

Species	Commercial/ Recreational Importance[1]	Forage Species	EFH[2]	Protected Species Status[3]	Habitat Association
White Shark (*Carcharodon carcharias*)			X		Neonate, Juvenile, and Adult - Pelagic
Windowpane Flounder (*Scophthalmus aquosus*)	R	X	X		Eggs and Larvae – Pelagic Juvenile and Adult - Benthic
Winter Flounder (*Pseudopleuronectes americanus*)	R	X	X		Eggs, Juvenile, and Adult – Benthic Larvae - Initially planktonic, then demersal
Winter Skate (*Leucoraja ocellate*)	C, R		X		Juvenile and Adult – Benthic
Witch Flounder (*Glyptocephalus cynoglossus*)		X	X		Eggs and Larvae – Pelagic Adult - Benthic
Yellowfin Tuna (*Thunnus albacares*)	C, R		X		Juvenile - Pelagic
Yellowtail Flounder (*Limanda ferruginea*)		X	X		Eggs and Larvae – Pelagic Juvenile and Adult- Benthic

[1] C- commercially important species; R – recreationally important species.
Species with commercial landings values of $4,000 or greater in 2019 for the State of New Jersey as reported by National Oceanic and Atmospheric Administration (NOAA) Fisheries were considered a species of commercial importance. Species with confidential commercial landing values were not marked as a species of commercial importance in this table. Species were deemed recreationally important if average recreational landings from 2015 to 2019 for New Jersey were greater than 10,000 pounds (4,536 kilograms [kg]). Although many highly migratory species landings are not tracked given the prevalence of catch and release, these species were considered recreationally important. These species were identified through EFH data for the Offshore Project Area and available literature for New Jersey and the Mid-Atlantic Bight.
[2] Habitat association for EFH species only includes life stages with designated EFH in the Offshore Project Area.
[3] E-Federally endangered species; T-Federally threatened species; E(S) – New Jersey State endangered species
[4] Other NOAA Trust Resource species requested to be described by NOAA GARFO.

[5] Unlikely to occur within the Offshore Project Area

Sources:

Atlantic State Marine Fisheries Commission (ASMFC). Fisheries Management 2020. Arlington (VA): ASMFC; [accessed 2020 November 13]. http://www.asmfc.org/fisheries-management/program-overview.

Bureau of Ocean Energy Management (BOEM). 2012. Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New Jersey, Delaware, Maryland, and Virginia Final Environmental Assessment. BOEM 2012-003.

Geo-Marine. 2010. Ocean/Wind Power Ecological Baseline Studies, Volume IV: Fish and Fisheries Studies. Plano, Texas: Geo-Marine, Inc.

National Oceanic Atmospheric Administration (NOAA). 2019. Habitat Conservation, Habitat Protection: EFH View Tool. Silver Springs (MD): National Marine Fisheries Service; [updated 2019 June 25; accessed 2020 November]. https://www.habitat.noaa.gov/protection/efh/efhmapper/.

National Oceanic Atmospheric Administration (NOAA). 2020c. Species Directory. Silver Springs (MD): NOAA; [accessed 2020 November 13]. https://www.fisheries.noaa.gov/species-directory.

National Oceanic Atmospheric Administration (NOAA). 2020d. Commercial and Recreational Landings Query. Silver Springs (MD): NOAA Fisheries Office of Science and Technology; [accessed 2020 November 16]. https://foss.nmfs.noaa.gov/apexfoss/f?p=215:200.

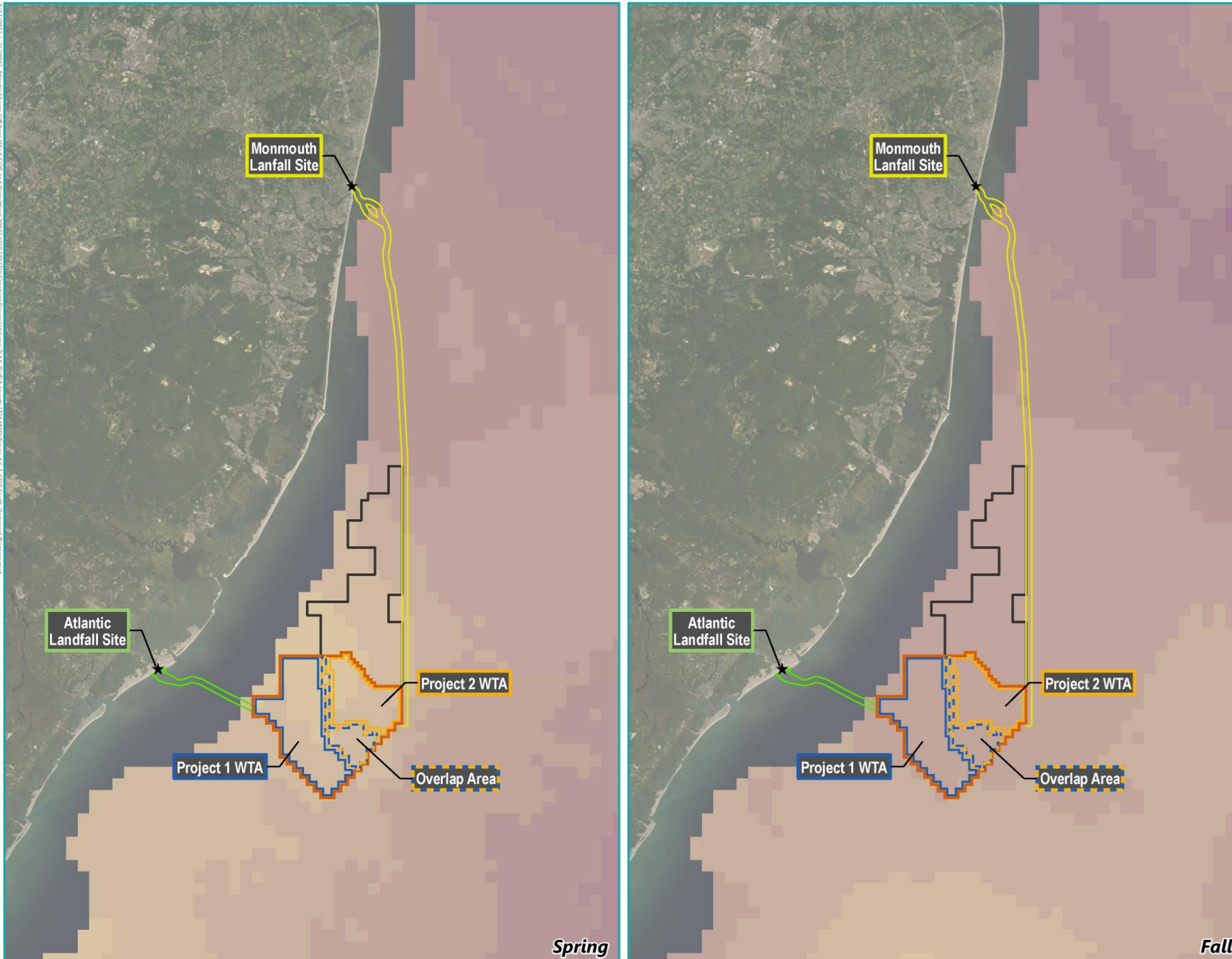
4.6.1.1 Demersal Fish

Demersal fish live or feed on, or close to, the seafloor. Seabed formations and substrate types can be influencing factors in demersal finfish distribution. Sediment within the Offshore Project Area largely consists of fine, medium, and gravelly sand (see Section 4.5 Benthic Resources and Appendices II-A1 and II-G1 through G4). Topographically, the Offshore Project Area is largely level, containing seafloor features that offer limited topographic relief (e.g., sandwaves and ripples) (Appendix II-A1). One study conducted by Slacum et al. (2010) examined species assemblage on sand shoals versus surrounding flat bottom habitat, similar to that found within the Offshore Project Area, and found that species abundance, diversity, and richness were greater in flat bottom habitats than sandy shoals (The Nature Conservancy 2015). In addition to seafloor bathymetry, there are shipwrecks within the Offshore Project Area, and two artificial reefs (Axel Carlson Reef and Atlantic City Reef) along the Monmouth ECC that could potentially create shelter, as well as foraging habitat for demersal fish and their prey (e.g., black sea bass, tautog (*Tautoga onitis)*) (Steimle and Figley 1996; NCDEQ 2021; SAFMC 2021). These reefs are depicted in Section 7.7, Figure 7.7.2. Another important ecological feature off the coast of New Jersey is the Carl Shuster Horseshoe Crab Reserve, which is located approximately 6 miles (mi) (9.7 kilometers[km]) south of the Offshore Project Area. As these ecological features are located outside of the Offshore Project Area, they will not be directly affected by Project activities. Other influencing factors of species distribution include temperature, presence of prey species, and shelter (Sogard et al. 1992, Steimle and Figley 1996, Stein et al. 2004a, Kohut and Brodie 2019).

Figure 4.6-1 represents the seasonal biomass of demersal fish species in the vicinity of the Offshore Project Area aggregated from 2010 to 2017. Data were obtained from the Northeast Ocean Data Portal which used NEFSC Multi-Species Bottom annual spring and fall trawl (NEFSC trawl) results to calculate and model seasonal biomass of demersal finfish (NROC, 2009). NEFSC trawl surveys were collected from the Gulf of Maine to Cape Hatteras, North Carolina. These data illustrate that demersal biomass off the coast of New Jersey fluctuates seasonally, with higher levels of biomass in the fall than in the spring.

In addition to changes in biomass, seasons influence species distribution, particularly those species that undergo seasonal migrations as shown in independent trawl survey data. Data were obtained directly from National Oceanic and Atmospheric Administration (NOAA) Fisheries and NJDEP from the NEFSC Multispecies Bottom Trawl and NJDEP OSAP Trawl surveys for the Offshore Project Area between 2009 and 2019 (P. Politis, NOAA Fisheries 2020 personal communication; L. Barry, NJDEP 2020 personal communication). The Federal and State trawl site locations within the Offshore Project Area are illustrated in Figure 4.6-2. Twenty NEFSC trawl sites from 2009 to 2019 are located within the WTA[26], one of which overlaps both the WTA and the southeastern corner

[26] Of the 20 NEFSC trawl sites located in the WTA, 14 occurred in Project 1 WTA, four in Project 2 WTA, and two in the Overlap Area.



ATLANTIC SHORES offshore wind

0 2.5 5 10 Miles

0 5 10 Kilometers

N W E S

Map Projection: NAD 1983 UTM Zone 18N (Meters)
Basemap: World Ocean Base, Esri

LEGEND

Demersal, Biomass, Fall 2010-2016, NEFSC
High
Low

Demersal, Biomass, Spring 2010-2017, NEFSC
High
Low

- Atlantic Shores Wind Turbine Area (WTA)
- Monmouth Export Cable Corridor (ECC)
- Atlantic Export Cable Corridor (ECC)
- Project 1 WTA
- Project 2 WTA
- Overlap Area
- Atlantic Shores Lease Area OCS-A 0549

Figure 4.6-1

Demersal Finfish Biomass

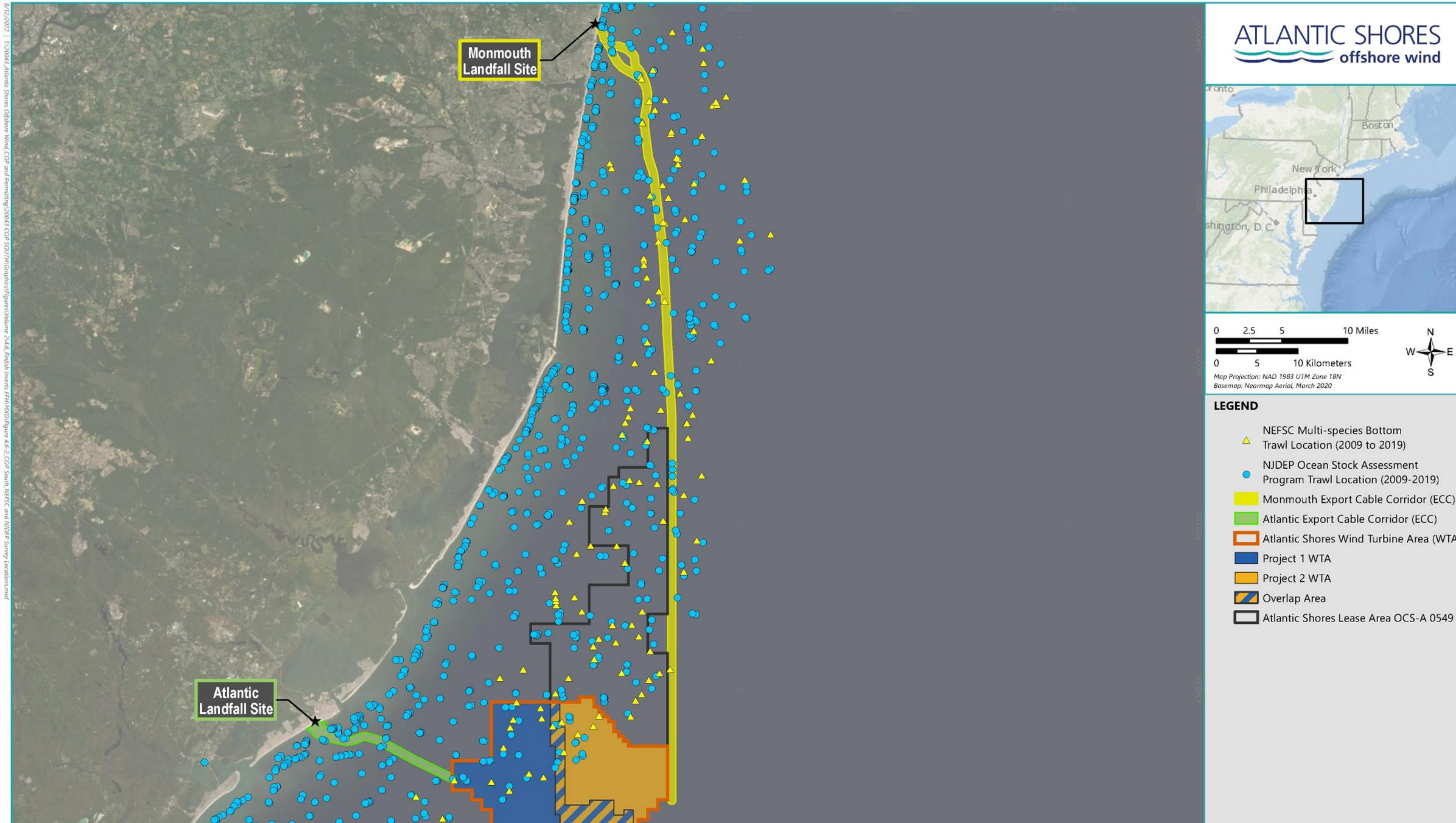


Figure 4.6-2

NEFSC and NJDEP Survey Locations

Table 4.6-2 Top Five Numerically Dominant Demersal Species from NEFSC and NJDEP OSAP trawl surveys (2009 to 2019).[1]

Project Area	Season[2]	Species				
NEFSC Trawl Surveys						
Project 1 WTA[3]	Fall	Northern Searobin	Atlantic Croaker	Spot	Weakfish	Black Sea Bass
	Spring	Little Skate	Spotted Hake	Windowpane	Winter Skate	Flounder spp.
Project 2 WTA[3]	Fall	Northern Searobin	Spot	Atlantic Croaker	Black Sea Bass	Atlantic Butterfish
	Spring	Little Skate	Summer Flounder	Windowpane	Northern Sand Lance	Flounder Spp.
Monmouth ECC	Fall	Scup	Northern Searobin	Flounder spp.	Little Skate	Atlantic Croaker
	Spring	Spotted Hake	Northern Sand Lance	Little Skate	Northern Searobin	Winter Flounder
NJDEP OSAP Trawl Surveys						
Project 1 WTA[3]	Fall	Little Skate	Scup	Windowpane	Northern Searobin	Summer Flounder
	Winter	American Sand Lance	Silver Hake	Windowpane	Little Skate	Winter Skate
	Spring	Silver Hake	Little Skate	Windowpane	Winter Flounder	Winter Skate
	Summer	Northern Searobin	Spotted Hake	Scup	Atlantic Croaker	Little Skate
Project 2 WTA[3]	Fall	Scup	Little Skate	Northern Searobin	Windowpane	Atlantic Croaker
	Winter	Silver Hake	Windowpane	Little Skate	Spotted Hake	Summer Flounder*
	Spring[4]	Little Skate	Windowpane	American Sand Lance*	Goosefish* Spotted Hake*	Northern Searobin* Striped Bass*
	Summer[4]	Northern Searobin	Atlantic Croaker	Smooth Dogfish	Windowpane	Little Skate Spotted Hake
Atlantic ECC	Fall	Silver Perch	Spotted Hake	Southern Kingfish	Little Skate	Spot

Table 4.6-2 Top Five Numerically Dominant Demersal Species from NEFSC and NJDEP OSAP trawl surveys (2009 to 2019).[1] (cont'd)

Project Area	Season[2]	Species				
NJDEP OSAP Trawl Surveys						
	Winter	Skate spp.	Windowpane	Little Skate	Winter Flounder	Silver Hake
	Summer	Spotted Hake	Little Skate	Smooth Dogfish	Scup	Haddock
Monmouth ECC	Fall	Scup	Little Skate	Spot	Spotted Hake	Silver Perch
	Winter	Little Skate	Windowpane	Spotted Hake	Winter Skate	Silver Hake
	Spring	Scup	Northern Searobin	Little Skate	Spotted Hake	American Sand Lance
	Summer	Atlantic Croaker	Northern Searobin	Clearnose Skate	Little Skate	Spotted Hake

* Species with average catch sizes less than 5 individuals per tow.

[1] Ranking is based on the average catch number per tow. The five species with the largest catch numbers per tow were included in the tables above. Calculations only accounted for the number of tows, not the length or duration of each tow.

[2] Fall – September, October, November; Winter – December, January, February; Spring – March, April, May; Summer – June, July, August

[3] The WTA is comprised of Project 1, Project 2, and the Overlap Area. For the purposes of this table, sampling stations located in the Overlap Area were incorporated into the analysis of both Project 1 and Project 2 WTAs.

[4] Cells with more than one species listed indicate equivalent average catch across all tows in a given season.

of the Atlantic ECC, and seven trawl sites are located within the Monmouth ECC (see Figure 4.6-2). Thirty-one NJOSAP trawl sites from 2009 to 2019 are located within the WTA,[27] one of which overlaps with both the Project 1 WTA and the southeastern corner of the Atlantic ECC, 24 trawls are exclusively located in the Monmouth ECC, and nine trawls are exclusively located in the Atlantic ECC. Table 4.6-2 represents the top five numerically dominant demersal species collected in the Offshore Project Area during State and Federal trawl surveys in each season. The most numerically dominant species typically differed between survey seasons, which could be attributed to seasonal migrations.

Overall, based on Federal and State trawl surveys conducted between 2009 and 2019 that overlap with the Offshore Project Area, the total number of individuals and total number of species collected were highest during fall and summer surveys. This could be attributed to migration patterns of many finfish and squid species in the Mid-Atlantic Bight that migrate offshore during winter to utilize warmer waters, then travel inshore during the spring and summer to spawn (Geo-Marine 2010).

4.6.1.2 Pelagic Fish

As previously stated, the Offshore Project Area, which includes the nearshore areas at the landfall sites, contains tidal, nearshore, and offshore habitats. Pelagic fish can be found in the nearshore and offshore environments of the Offshore Project Area. Distribution of pelagic fish varies based on availability of light, nutrients, dissolved oxygen, temperature, salinity, and water depth, as well as oceanographic phenomena like the presence of the Cold Pool and the Gulf Stream (NOAA, 2021a; Lentz 2017; Sullivan et al. 2005; Miller et al. 2016). Oceanographic features, such as the Cold Pool can influence migration and overall travel patterns in pelagic species like Atlantic butterfish (Kohut and Brodie 2019).

The distribution of many pelagic species changes seasonally with fluctuating water temperatures (Geo-Marine 2010). Many species that may occur in the Offshore Project Area migrate inshore during the spring and summer for spawning, and offshore for warmer water during late fall and winter (Geo-Marine 2010). Seasonal differences in species composition and abundance within the Offshore Project Area were observed during NEFSC and NJDEP OSAP surveys conducted between 2009 and 2019, with the largest catch numbers occurring in fall and summer (see Figure 4.6-2 for survey locations). Table 4.6-3 displays the top five numerically dominant pelagic species collected in the Offshore Project Area during State and Federal trawls for each season. Similar to demersal fish, the most numerically dominant pelagic fish species differed between survey seasons, which could be attributed to seasonal migrations.

[27] Of the 31 NJOSAP trawl sites located in the WTA, 17 occurred in Project 1 WTA, nine in Project 2 WTA, and five in the Overlap Area.

Table 4.6-3 Top Five Numerically Dominant Pelagic Species from NEFSC and NJDEP OSAP trawl surveys (2009 to 2019)[1]

Project Area	Season[2]	Species				
NEFSC Trawl Surveys						
Project 1 WTA[3]	Fall	Round Herring	Atlantic Butterfish	Bay Anchovy	Bluefish	Atlantic Moonfish
	Spring	Atlantic Herring	Spiny Dogfish	Blueback Herring	Atlantic Mackerel*	Atlantic Silverside*
Project 2 WTA[3]	Fall	Weakfish	Bay Anchovy	Atlantic Butterfish	Atlantic Moonfish*	
	Spring	Spiny Dogfish	Atlantic Herring	Atlantic Silverside	Blueback Herring	Alewife
Monmouth ECC	Fall	Round Herring	Bluefish	Butterfish	Weakfish	Atlantic Moonfish*
	Spring	Atlantic Herring	Spiny Dogfish*	Atlantic Silverside*		
NJDEP OSAP Trawl Surveys						
Project 1 WTA[3]	Fall	Bay Anchovy	Round Herring	Butterfish	Spiny Dogfish	Weakfish
	Winter	Atlantic Herring	Blueback Herring	Atlantic Silverside	Spiny Dogfish	Alewife
	Spring	Atlantic Herring	Spiny Dogfish	Butterfish	Blueback Herring	Alewife
	Summer	Atlantic Butterfish	Weakfish	Spiny Dogfish	Bay Anchovy	Bluefish
Project 2 WTA[3]	Fall	Spiny Dogfish	Round Herring	Atlantic Butterfish	Bluefish	Weakfish
	Winter	Atlantic Herring	Blueback Herring	Spiny Dogfish	American Shad	
	Spring	Blueback Herring	Atlantic Butterfish	Spiny Dogfish	Atlantic Mackerel*	Alewife*
	Summer	Round Herring	Atlantic Butterfish	Weakfish	Bluefish	Hickory Shad*
Atlantic ECC	Fall	Bay Anchovy	Weakfish	Butterfish	Atlantic Moonfish	Atlantic Croaker

Table 4.6-3 Top Five Numerically Dominant Pelagic Species from NEFSC and NJDEP OSAP trawl surveys (2009 to 2019)[1] (continued)

Project Area	Season[2]	Species				
NJDEP OSAP Trawl Surveys						
	Winter	Atlantic Herring*	American Shad*	Atlantic Silverside*	Threespine Stickleback*	Striped Mullet*
	Summer	Butterfish*	Spiny Dogfish*			
Monmouth ECC	Fall	Bay Anchovy	Weakfish	Butterfish	Atlantic Moonfish	Atlantic Croaker
	Winter	Atlantic Herring	Spiny Dogfish	Butterfish	Atlantic Mackerel	
	Spring	Butterfish	Bay Anchovy	Atlantic Herring	Spiny Dogfish	Alewife
	Summer	Bay Anchovy	Butterfish	Spiny Dogfish	Round Herring*	Weakfish*

* Species with average catch sizes less than five individuals per tow. Low catch numbers for pelagic fish species could be attributed to the sampling method used in the NEFSC and NJDEP surveys, both of which utilize bottom trawls. Bottom trawls will likely result in higher catches of demersal fish inhabiting the seafloor than pelagic fish in the water column.

[1] Ranking is based on the average catch number per tow. The five species with the largest catch numbers per tow were included in the tables above. Calculations only accounted for the number of tows, not the length or duration of each tow.

[2] Fall – September, October, November; Winter – December, January, February; Spring – March, April, May; Summer – June, July, August

[3] The WTA is comprised of Project 1, Project 2, and the Overlap Area. For the purposes of this table, sampling stations located in the Overlap Area were incorporated into the analysis of both Project 1 and Project 2 WTAs.

Overall, based on Federal and State trawl surveys conducted between 2009 and 2019 that overlap with the Offshore Project Area, the total number of individuals and total number of species collected were highest during fall and summer surveys. This could be attributed to migration patterns of many finfish and squid species in the Mid-Atlantic Bight that migrate offshore during winter to utilize warmer waters, then travel inshore during the spring and summer to spawn (Geo-Marine 2010).

4.6.1.3 Highly Migratory Fish

Highly migratory fish species are extremely mobile pelagic species that travel long distances both horizontally and vertically in the water column and live in the open ocean. Highly migratory species presence is not typically correlated with geological or biological features such as bottom substrate and submerged aquatic vegetation (Geo-Marine 2010). Instead, their presence is often linked to physiographic or hydrographic features such as ocean fronts, currents, the continental shelf, or seamounts (Geo-Marine, 2010). Given their mobility, and that they often cross domestic and international boundaries, species management occurs at a State, Federal, and sometimes international level. Highly migratory fish species that have the potential to occur within or transit the Offshore Project Area include tunas, sharks, and swordfish (see Table 4.6-1). Within the Offshore Project Area, 13 highly migratory species have EFH designated in the Offshore Project Area, indicating the potential presence of suitable habitat for foraging, spawning, breeding, and maturation (see Appendix II-J2). EFH is important for maintaining healthy habitat for these species which are highly sought after by both commercial and recreational fishermen (see Section 7.4 Commercial Fisheries and For-Hire Recreational Fishing).

4.6.1.4 Pelagic Invertebrates (Squid)

Important pelagic invertebrates with ranges that overlap the Offshore Project Area include longfin inshore squid (*Doryteuthis pealeii*), Northern shortfin squid (*Illex illecebrosus*), and Atlantic brief squid (*Lolliguncula brevis*). As reported by Geo-Marine (2010) and Guida et al. (2017), squid were one of the dominant groups caught in NJOSAP and NEFSC independent trawl surveys for a larger area off of New Jersey that also includes the Offshore Project Area. However, commercial squid vessel activity from the smaller Offshore Project Area indicates that squid may be less prevalent in the Offshore Project Area than in other parts of New Jersey.

All three species of squid were collected to various degrees in either the NEFSC or NJDEP OSAP trawl surveys within the Offshore Project Area between 2009 and 2019 (P. Politis, NOAA Fisheries 2020 personal communication; L. Barry, NJDEP 2020 personal communication).[28] Longfin squid were collected in both the NEFSC and NJOSAP trawl surveys within the Offshore Project Area and were numerically more abundant during fall and summer surveys. Shortfin squid were collected in NJOSAP trawl surveys within the Offshore Project Area, but not in NEFSC trawl surveys. All shortfin squid recorded in NJOSAP trawls were collected during summer surveys. Both longfin

[28] Site-specific trawl data from 2009 to 2019 were obtained directly from NOAA and NJDEP for trawl surveys that overlapped with the Offshore Project Area (WTA, Atlantic ECC, and Monmouth ECC).

inshore squid and Northern shortfin squid undergo seasonal migrations, moving offshore during late autumn to overwinter along the edge of the continental shelf and returning inshore during the spring and early summer (Cargnelli et al. 1999; Hendrickson and Homes 2004). Longfin and shortfin squid species have designated EFH in the Offshore Project Area (see Section 4.6.1.6 and Appendix II-J2).

Atlantic brief squid were collected in NJOSAP trawl surveys in the ECCs, but not in NEFSC trawl surveys. All brief squid recorded in NJOSAP trawls were collected during fall surveys. This species of squid, however, is more commonly found in waters south of Maryland (Chesapeake Bay Program 2020). NOAA has not established EFH for brief squid.

Although squid have the potential to be present in the Offshore Project Area, based on vessel monitoring system (VMS) data used for monitoring commercial squid vessel activity as well as vessel trip report (VTR) data for the WTA and ECCS, very little squid vessel effort occurs in the Offshore Project Area except for a small area of high vessel density along the Monmouth ECC offshore of the Manasquan Inlet (see Section 7.4 Commercial Fisheries and For-Hire Recreational Fishing)[29]. Given this lower level of commercial fishing activity for a lucrative species, squid may be more abundant in surrounding waters outside of the Offshore Project Area.

4.6.1.5 Threatened and Endangered Fish

Five Federally listed threatened or endangered fish species are listed by NOAA as occurring in the New England/Mid-Atlantic region: Atlantic salmon (*Salmo salar)*, Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), giant manta ray (*Manta birostris*), oceanic whitetip shark (*Carcharhinus longimanus*), and shortnose sturgeon (*Acipenser brevirostrum*) (NOAA 2021a). Oceanic whitetip sharks are not known to occur in the Offshore Project Area and are reported to live in the open ocean in water depths greater than 600 ft (183 m) (NOAA 2021a), which is deeper than the water depth range in the Offshore Project Area. Atlantic salmon are also not expected to occur in the Offshore Project Area. According to the NOAA ESA Section 7 Mapper, the spatial range of Atlantic salmon does not extend south of the coast of New Hampshire (NOAA 2020b). Since the Offshore Project Area is outside the habitat range of the oceanic whitetip shark and the distribution range of the Atlantic salmon, and no critical habitat is identified within the Offshore Project Area, further evaluation of these two species in this section is not warranted. The remaining three species are evaluated for potential occurrence in the Offshore Project Area in Table 4.6-4 and the following sections.

The likelihood of occurrence of Atlantic sturgeon, giant manta ray, and shortnose sturgeon within the Offshore Project Area is based on NOAA-published sources and literature reviews. The definitions for likelihood are as follows:

[29] VMS data presented in Section 7.4 Commercial Fisheries and For Hire Recreational Fishing depict relative vessel density between 2015 and 2016.

- Unlikely – species range does not overlap with the Offshore Project Area or the Offshore Project Area lacks suitable habitat;
- Low – species range overlaps with the Offshore Project Area and the Offshore Project Area contains marginally suitable habitat; and
- Moderate – species range overlaps with the Offshore Project Area and the Offshore Project Area contains suitable habitat.

Table 4.6-4 List of Threatened and Endangered Species with Ranges that have Potential to Overlap the Offshore Project Area

Species (Scientific Name)	ESA Status	Likelihood of Occurrence
Atlantic sturgeon (*Acipenser oxyrhynchus*)	Endangered	Moderate
Giant manta ray (*Manta birostris*)	Threatened	Low
Shortnose sturgeon (*Acipenser brevirostrum*)	Endangered	Unlikely

Atlantic Sturgeon

The Atlantic sturgeon was listed as a Federally endangered species in 2012. There are five distinct population segments (DPS) for the Atlantic sturgeon including: the Carolina DPS, Chesapeake Bay DPS, New York Bight DPS, South Atlantic DPS, and the Gulf of Maine DPS. These DPSs are listed as endangered, except for the Gulf of Maine DPS which is listed as threatened. Primary threats to Atlantic sturgeon include degraded water quality, habitat impacts from dredging, bycatch in commercial fisheries, and vessel strikes (Federal Register 2012).

Atlantic sturgeon is an anadromous species that spends much of its life in estuarine and marine waters and migrates to freshwater to spawn. They can be found along rivers and nearshore habitats from Canada to Florida (Federal Register 2012, BOEM 2012). The distribution of Atlantic sturgeon changes seasonally within the Mid-Atlantic Bight. During fall and spring, aggregations of Atlantic sturgeon can be found near the mouths of large bays, in water depths less than 20 meters (Dunton et al. 2010). During the winter, these aggregations disperse. Many surveys have linked Atlantic sturgeon distribution to water depth, temperature, and salinity. In addition, Stein, Freidland, and Sutherland (2004a) found that Atlantic sturgeon distribution is strongly associated with prey availability rather than substrate type (e.g., sandy versus rocky bottom). Specifically, along the coast of New Jersey, Atlantic sturgeon feed on a variety of prey such as polychaetes, isopods, shrimp, and mollusks (Johnson et al. 1997).

Spawning timing differs geographically for Atlantic sturgeon. Spawning takes place in the spring or early summer in the northern rivers between Canada and the Delaware River. South of the Delaware River, spawning occurs in late summer and fall (NOAA 2020c). Eggs will strongly adhere to rocks, weeds, and other submerged objects (Gilbert 1989). Once the eggs hatch into larvae, they live along the bottom of the riverbed and drift downstream until they reach brackish water where they can reside as juveniles for 1 to 5 years before moving into nearshore coastal waters (NOAA 2020c).

Stein, Friedland, and Sutherland (2004b) analyzed Atlantic sturgeon bycatch rates in fisheries along the northeastern coastline of the U.S. to predict species distribution and habitat preference. The greatest bycatch rates were found between depths of 33 to 164 ft (10 to 50 m), along gravel or sandy sediment. Similar depths and sediment are found within the Offshore Project Area.

There is no Federally regulated Critical Habitat for Atlantic sturgeon that overlaps with the Offshore Project Area (NOAA 2020b) and the Offshore Project Area is not located within any Atlantic sturgeon spawning areas. The two closest spawning rivers are the Hudson and Delaware Rivers, located 40 mi (64 km) to the north and 53 mi (85 km) to the south of the Offshore Project Area, respectively. However, it is possible that Atlantic sturgeon could migrate through the Offshore Project Area on their way to or from these spawning sites. The Offshore Project Area could also provide foraging habitat given prey availability such as crustaceans, mollusks, and sand lance (NOAA 2020c; Stein et al. 2004a). Spawning adults can be found in the marine environment during the fall and winter, while non-spawning adults may remain in the marine environment during the fall, winter and summer (Stein et al. 2004a).

Giant Manta Ray

The giant manta ray was listed as a Federally threatened species in 2018 (Federal Register 2018). Giant manta rays are a slow growing, migratory species. Movement of giant manta rays is dependent on zooplankton movement, current circulation, tidal patterns, seasonal upwelling, seawater temperature, and mating behavior. Giant manta rays can be found in offshore, oceanic, and nearshore habitats along the Western Atlantic coast and Pacific Islands in small, highly fragmented populations (NOAA 2020c).

Threats to giant manta rays include overutilization by foreign commercial and artisanal fisheries and insufficient enforcement or lack of adequate regulatory mechanisms among foreign nations to protect manta rays from heavy fishing pressure and related mortality in waters outside of U.S. jurisdiction (Federal Register 2018). Giant manta rays are often targeted or caught as bycatch in global fisheries operating within their habitat range. In addition to fishing impacts, recent research suggests that vessel strikes may be another threat facing manta ray species (McGregor et al. 2019). Given their low reproductive output (i.e., one pup every 2 to 3 years), giant manta ray populations are vulnerable to depletion (NOAA 2020c).

Within the last century, giant manta rays have been observed as far north as New Jersey, so occurrence in the Offshore Project Area is possible. In the past, giant manta rays had been rarely sighted further north, such as near Block Island off the Rhode Island coast (Gudger, 1922). However, New Jersey currently represents the northern boundary of manta ray distribution and given their migratory nature, manta rays are likely to occur only on a transitory basis within the Offshore Project Area (NOAA 2016). A recent study by Farmer et al. (2022) evaluated the distribution of giant manta rays off the Eastern U.S. by integrating decades of survey data and sightings from numerous sources, including surveys ranging as far north as Maine. Over 5,000 reported manta ray sightings were identified in the Eastern U.S. from 1925-2020, with sightings recorded only as far north as New Jersey with the bulk of sightings recorded between 26° and 30° N (off the coast of Florida). A species distribution model was developed using these sightings. Though sightings were only recorded as far north as New Jersey, results of the model indicated that there is a non-zero probability that giant manta ray may occur in waters as far north as Nantucket from June through October. Individuals would be expected to most frequently occur either nearshore or along the continental shelf edge (Farmer et al., 2022).

Shortnose Sturgeon

The shortnose sturgeon was listed as a Federally endangered species in 1967. Shortnose sturgeon are an anadromous species that travel between rivers and coastal waters along the coastline from Canada to Florida (NMFS 1998). The shortnose sturgeon can be found in 41 bays and rivers along the east coast and have been documented to spawn in approximately 19 rivers (NOAA 2020c). Primary threats to the shortnose sturgeon include habitat degradation, water pollution, dredging, water withdrawal, fisheries bycatch, and habitat impediments restricting access to spawning habitat (e.g., dams) (NMFS 1998; BOEM 2012; NOAA 2020c). A recovery plan was created in 1998 which focuses on maintenance of essential habitat, and the minimization and monitoring of mortality (NMFS 1998).

There are no known shortnose sturgeon populations in rivers between the Hudson and Delaware Rivers (NMFS 1998) and therefore no populations in New Jersey coastal rivers. The closest population to the Offshore Project Area is the Delaware River population, within the Mid-Atlantic metapopulation (NOAA 2020c; NMFS 1998). Shortnose sturgeon migratory activities occur in the spring and winter, coinciding with spawning events. Spawning takes place during the spring or late summer (NMFS 1998; BOEM 2012; NOAA 2020c). Once laid, the eggs adhere to rocks, weeds, or other submerged objects (Gilbert 1989). After spawning, adults typically move quickly downstream to the lower reaches of rivers or estuaries.

The Offshore Project Area is not located within any shortnose sturgeon spawning areas. The closest shortnose sturgeon spawning river is the Delaware River, located 53 mi (85 km) to the south of the Offshore Project Area. In addition, there is no Federally regulated Critical Habitat for shortnose sturgeon that overlaps with the Offshore Project Area (NOAA 2020b). Shortnose sturgeon could migrate through the Offshore Project Area on their way to or from spawning sites. However, shortnose sturgeon are expected to occur rarely in the Offshore Project Area since they are more closely restricted to freshwater than the Atlantic sturgeon (Gilbert 1989). The Shortnose Sturgeon Status Review Team (2010) also described shortnose sturgeon as spending less time in open ocean habitats and spawning farther upriver than Atlantic sturgeon. Therefore, the presence of shortnose sturgeon in the Offshore Project Area is unlikely due to its lack of river or estuarine features (Geo-Marine 2010).

4.6.1.6 Essential Fish Habitat

EFH is an important part of the Magnuson–Stevens Fishery Conservation and Management Act (MSFCMA) regulations and is defined as: "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (16 U.S.C. § 1802(10)). NOAA further clarifies the terms in this definition as follows (50 CFR 600.10):

- Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate.
- Substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities.
- Necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem.
- Spawning, breeding, feeding, or growth to maturity covers a species' full life cycle.

A Preliminary EFH Assessment (see Appendix II-J1), which followed the approach suggested by NOAA Fisheries in a virtual meeting held on May 20, 2020 (NOAA Fisheries, 2020 personal communication), was prepared at the request of BOEM to provide information needed to begin their consultation with NOAA Fisheries regarding EFH and EFH species. Throughout 2019 and 2020, Atlantic Shores conducted high resolution geophysical (HRG) and geotechnical surveys in the Offshore Project Area, including benthic grab samples, seafloor plan and profile imagery, and ecological classification of benthic habitats to support the assessment of EFH in the Offshore Project Area. Existing available data and information from these surveys are included in the Preliminary and Revised EFH Assessments (see Appendix II-J1 and J2). Additional video surveys were conducted through 2021, resulting in high-resolution mapping of benthic habitat. The results of these surveys are provided in Appendices II-A1 and II-G1 through II-G4. Additional discussion of benthic habitat and EFH is provided in the Revised EFH Assessment (Appendix II-J2).

EFH data and text descriptions were downloaded from the NOAA Fisheries Essential Fish Habitat Data Inventory for the Essential Fish Habitat Mapper, an online mapping application (NOAA 2021c). The data were then queried using GIS software to obtain results for EFH designations in the WTA for Projects 1 and 2, Atlantic ECC, and Monmouth ECC. Within these areas that encompass the Offshore Project Area, a total of 36 fish and five invertebrate species have designated EFH for various life stages. Table 4.6-5 summarizes the life stages of each species that has designated EFH within the WTA for Projects 1 and 2, Atlantic ECC, and Monmouth ECC. If a life stage for a particular species is checked as potentially present in one of the offshore project areas, then some or all of that area overlaps with designated EFH for that life stage and species. Detailed EFH definitions and life history descriptions for designated species and life stages and an assessment of potential Project effects to EFH and EFH species are included in the Revised EFH Assessment (see Appendix II-J2).

NOAA Fisheries also defines habitat areas of particular concern (HAPC) as a subset of EFH for areas that exhibit one or more of the following traits: rare, stressed by development, provides important ecological functions for Federally managed species, or is especially vulnerable to anthropogenic degradation. There is one HAPC located within the Offshore Project Area, HAPC for sandbar shark (*Carcharhinus plumbeus)*. Sandbar shark HAPC constitutes important nursery and pupping grounds which have been identified in shallow areas and at the mouth of Great Bay, New Jersey; in lower and middle Delaware Bay, Delaware; lower Chesapeake Bay, Maryland; and offshore of the Outer Banks of North Carolina in water temperatures ranging from 59 to 86 °F (15 to 30 °C); salinities at least from 15 to 35 parts per thousand (ppt); water depth ranging from 2.6 to 75 ft (0.8 to 23 m); and in sand and mud habitats (NOAA, 2017).

Part of the HAPC for sandbar shark at the mouth of Great Bay, New Jersey overlaps with the inshore portion of the Atlantic ECC (see Figure 4.6-3). Pregnant sandbar shark females have the potential to occur in the area between late spring and early summer, when they reportedly give birth and depart shortly after (Merson and Pratt 2007). Sandbar shark neonates and juveniles occupy the nursery grounds to feed in early summer until they migrate to warmer waters in the fall (Rechisky and Wetherbee, 2003; Springer, 1960). The majority of neonate and juvenile sandbar sharks within the Great Bay HAPC have been documented in mid-summer in shallow, near shore-areas including inside Great Bay and in the vicinity of Little Egg Inlet, and not within the Atlantic ECC area (Rechisky and Wetherbee, 2003; Merson and Pratt, 2007). Further details on sandbar shark HAPC are provided in the Revised EFH Assessment (see Appendix II-J2).

Table 4.6-5 EFH Designations for Species in the Offshore Project Area

Species and Life Stages[1]	Eggs				Larvae/Neonate				Juvenile				Adult			
	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC
New England Finfish Species																
Atlantic Cod (*Gadus morhua*)	x		x	x	x	x		x					x			x
Atlantic Herring (*Clupea harengus*)									x	x	x	x	x	x	x	x
Clearnose Skate (*Raja eglanteria*)									x	x	x	x	x	x	x	x
Haddock (*Melanogrammus aeglefinus*)									x	x		x				
Little Skate (*Leucoraja erinacea*)									x	x	x	x	x	x	x	x
Monkfish (*Lophius americanus*)	x	x	x	x	x	x	x	x					x	x		x
Ocean Pout (*Macrozoarces americanus*)	x	x	x	x									x	x	x	x
Pollock (*Pollachius virens*)								x								

Table 4.6-5 EFH Designations for Species in the Offshore Project Area (continued)

Species and Life Stages[1]	Eggs				Larvae/Neonate				Juvenile				Adult			
	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC
New England Finfish Species																
Red Hake (*Urophycis chuss*)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
New England Finfish Species																
Red Hake (*Urophycis chuss*)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Silver Hake (*Merluccius bilinearis*)	x	x	x	x	x	x	x	x					x	x		x
White Hake (*Urophycis tenuis*)													x	x		x
Windowpane Flounder (*Scophthalmus aquosus*)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Winter Flounder (*Pseudopleuronectes americanus*)	x		x	x	x	x		x	x	x		x	x	x		x

Table 4.6-5 EFH Designations for Species in the Offshore Project Area (continued)

Species and Life Stages[1]	Eggs				Larvae/Neonate				Juvenile				Adult			
	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC
New England Finfish Species																
Winter Skate (Leucoraja ocellate)									x	x	x	x	x	x	x	x
Witch Flounder (*Glyptocephalus cynoglossus*)	x	x	x	x	x	x		x					x	x	x	x
Yellowtail Flounder (*Limanda ferruginea*)	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Mid-Atlantic Finfish Species																
Atlantic Butterfish (*Peprilus triacanthus*)	x			x	x	x	x	x	x	x	x	x	x	x	x	x
Atlantic Mackerel (*Scomber scombrus*)	x	x		x	x	x		x	x	x		x	x	x	x	x
Black Sea Bass (*Centropristis striata*)					x	x		x	x	x	x	x	x	x	x	x

Table 4.6-5 EFH Designations for Species in the Offshore Project Area (continued)

Species and Life Stages[1]	Eggs				Larvae/Neonate				Juvenile				Adult			
	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC
Bluefish (*Pomatomus saltatrix*)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Mid-Atlantic Finfish Species																
Scup (*Stenotomus chrysops*)									x	x	x	x	x	x	x	x
Spiny Dogfish[3] (*Squalus acanthias*)													x	x	x	x
Summer Flounder (Paralichthys dentatus)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
New England Invertebrate Species																
Atlantic Sea Scallop (*Placopecten magellanicus*)	x	x		x	x	x		x	x	x		x	x	x		x
Mid-Atlantic Invertebrate Species																

Table 4.6-5 EFH Designations for Species in the Offshore Project Area (continued)

Species and Life Stages[1]	Eggs				Larvae/Neonate				Juvenile				Adult			
	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC
Atlantic Surfclam (*Spisula solidissima*)									x	x	x	x	x	x	x	x
Mid-Atlantic Invertebrate Species																
Longfin Inshore Squid (*Doryteuthis pealeii*)	x		x	x					x	x	x	x	x	x	x	x
Northern Shortfin Squid (*Illex illecebrosus*)									x	x		x				
Ocean Quahog (*Arctica islandica*)									x				x	x		x
Highly Migratory Species																
Tunas																
Albacore Tuna (*Thunnus alalunga*)												x				
Bluefin Tuna (*Thunnus thynnus*)									x	x	x	x				x

Table 4.6-5 EFH Designations for Species in the Offshore Project Area (continued)

Species and Life Stages[1]	Eggs				Larvae/Neonate				Juvenile				Adult			
	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC
Skipjack Tuna (*Katsuwonus pelamis*)									x	x	x	x	x	x	x	x
Highly Migratory Species																
Yellowfin Tuna (*Thunnus albacares*)									x	x	x	x				
Sharks																
Blue Shark (*Prionace glauca*)									x	x		x	x	x		x
Common Thresher Shark (*Alopias vulpinus*)					x	x	x	x	x	x	x	x	x	x	x	x
Dusky Shark (*Carcharhinus obscurus*)					x	x	x	x	x	x	x	x	x	x	x	x
Sand Tiger Shark (*Carcharias taurus*)					x	x	x	x	x	x	x	x				

Table 4.6-5 EFH Designations for Species in the Offshore Project Area (continued)

Species and Life Stages[1]	Eggs				Larvae/Neonate				Juvenile				Adult			
	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC
Sandbar Shark (*Carcharhinus plumbeus*)					x	x	x	x	x	x	x	x	x	x	x	x
Highly Migratory Species																
Shortfin Mako Shark (*Isurus oxyrinchus*)																
Smoothhound Shark Complex (*Atlantic Stock*) (*Mustelus canis*)					x	x	x	x	x	x	x	x	x	x	x	x
Tiger Shark (*Galeocerdo cuvieri*)									x	x	x	x	x	x	x	x
White Shark (*Carcharodon carcharias*)					x	x	x	x				x				x
South Atlantic Finfish Species[4]																

Table 4.6-5 EFH Designations for Species in the Offshore Project Area (continued)

Species and Life Stages[1]	Eggs				Larvae/Neonate				Juvenile				Adult			
	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC	Project 1 WTA[2]	Project 2 WTA[2]	A. ECC	M. ECC
King Mackerel (*Scomberomorus cavalla*)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
South Atlantic Finfish Species[4]																
Spanish Mackerel (*Scomberomorus maculatus*)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

[1] A.ECC- Atlantic ECC; M.ECC- Monmouth ECC

[2] The WTA is comprised of Project 1, Project 2, and the Overlap Area. For the purposes of this table, sampling stations located in the Overlap Area were incorporated into the analysis of both Project 1 and Project 2 WTAs.

[3] Spiny dogfish EFH can be further broken down by sub-male and sub-female life stages. These life stages refer to smaller adults that are not full grown. These stages have a different spatial distribution than full-grown adults. Spiny dogfish sub-female EFH can be found in the WTA, Atlantic and Monmouth ECC. Spiny dogfish sub-male EFH is only located in the Monmouth ECC.

[4] Based on consultations with NOAA, EFH for king and Spanish mackerel occurs in the Mid-Atlantic Bight, and therefore was added to the analysis; however, based on a review of available data, EFH for these species does not exist in the Offshore Project Area.

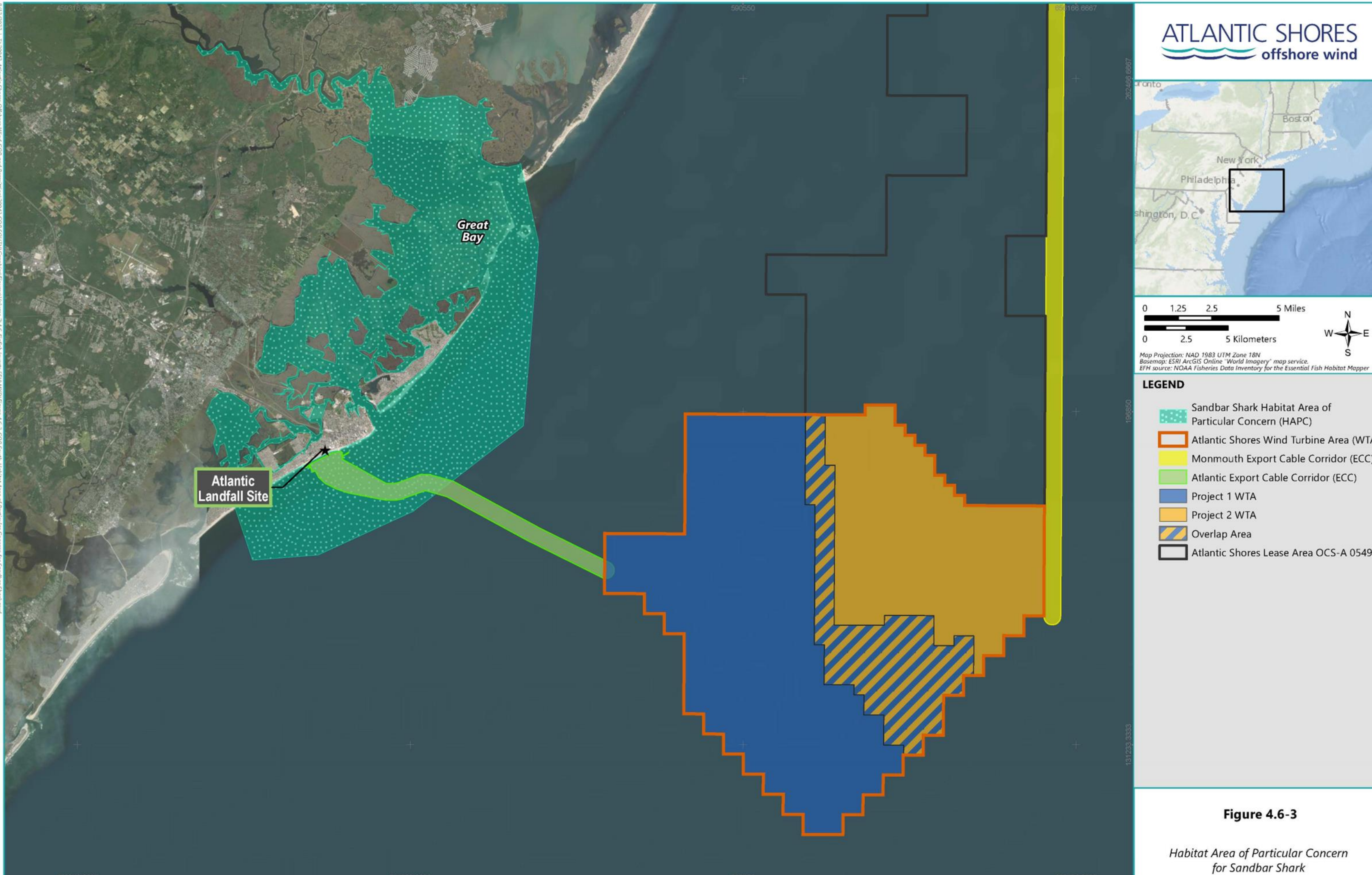


Figure 4.6-3

Habitat Area of Particular Concern for Sandbar Shark

4.6.2 Potential Impacts and Proposed Environmental Protection Measures

The potential IPFs which may affect finfish and pelagic invertebrate resources, and their respective EFH, during Project construction, operations and maintenance (O&M), or decommissioning are presented in Table 4.6-6.

Table 4.6-6 Impact Producing Factors for Finfish and Pelagic Invertebrates

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Installation and maintenance of new structures and cables	●	●	●
Anchoring and jack-up vessels	●	●	●
Noise	●	●	●
Electromagnetic fields		●	
Light	●	●	●
Presence of structures and cables		●	●
Monitoring Surveys	●	●	●
Vessel Movement	●	●	●

The maximum Project Design Envelope (PDE) analyzed for impacts to finfish and pelagic invertebrate resources and EFH is the maximum offshore build-out of the Projects (as defined in Section 4.11 of Volume I), assuming the use of all piled foundations for the assessment of underwater noise. Potential impacts from offshore spills, discharges, and accidental releases are considered to have a low likelihood of occurrence and are discussed in Section 9.2.3. Section 3.2 Water Quality provides further detail on measures to minimize the potential for drilling fluid release and frac-outs during horizontal directional drilling (HDD) installation at the landfall sites, including the development of an HDD Contingency Plan.

Due to the important conservation status of the threatened and endangered species that have the potential to occur in the Offshore Project Area, a brief discussion of potential effects to these species is provided. As described in Section 4.6.1.5, based on their range and habitat preference, it is unlikely for the endangered shortnose sturgeon to occur in the Offshore Project Area and the threatened giant manta ray is at the northern boundary of its range in New Jersey and may only occur on a transitory basis. Therefore, potential impacts from Project activities to protected finfish species were only considered for Atlantic sturgeon.

Potential Project-related impacts to the Atlantic sturgeon would not be materially different from those described for other fish species in the following sections. As described in Section 4.6.1.5, no spawning areas or Federally regulated Critical Habitat for Atlantic sturgeon overlap with the

Offshore Project Area (NOAA 2020b). Therefore, no eggs or larvae of Atlantic sturgeon are expected to be present in the Offshore Project Area. Seasonal migratory patterns allow the potential for juvenile and/or adult Atlantic sturgeon to be present in the Offshore Project Area. However, they are not expected to be a regular visitor or occupant in large numbers. Where relevant, IPFs evaluated in the following sections identify how Project activities may affect Atlantic sturgeon.

4.6.2.1 Installation and Maintenance of New Structures and Cables

The installation and maintenance of new foundation structures and offshore cables includes installation of associated scour and cable protection. These activities may affect finfish and pelagic invertebrate resources and EFH through direct seafloor disturbance and temporary increases in suspended sediment and deposition; however, as evident from environmental assessments and surveys performed in the Offshore Project Area, this area is dynamic in nature and experiences regular disturbance from natural (e.g., waves, storms, mobile sediment) and anthropogenic (e.g., fishing and vessel activity) sources. In addition, the area of disturbance will be small relative to the total area of surrounding habitat.

This section focuses on the temporary direct and indirect disturbances that will primarily occur during the construction phase. Section 4.6.2.6 addresses permanent seafloor disturbance from the footprints of foundations, scour protection, and offshore cable protection that will result in habitat conversion of primarily sandy substrate to hard substrate. The O&M phase is expected to have significantly lower seafloor disturbance than Project construction. During O&M, Project components will be carefully monitored as described in Volume I, Section 5.0. If portions of buried offshore cables require maintenance, the sediment cover may need to be removed temporarily for inspection and possible replacement of a portion of the cable. These activities would temporarily disturb the seafloor but would be short-term and extremely localized. The decommissioning phase is expected to have similar, but less seafloor disturbance than Project construction.

Temporary Habitat Loss and Disturbance from Direct Seafloor Disturbance

Benthic habitat will be temporarily disturbed during construction. However, as evidenced by site-specific HRG and benthic survey images conducted for the Projects, this area is dynamic in nature and exhibits wide-spread bottom disturbance from existing marine uses and mobile sediment. The species and habitat in the Offshore Project Area, including EFH, are adapted to disturbance and are expected to recover in the short-term. In addition, the area of disturbance is small relative to the total area of available surrounding habitat (Table 4.6-7).

Seafloor-disturbing activities during construction of the wind turbine generator (WTG) and offshore substation (OSS) foundations include jack-up vessel positioning and anchoring (impacts described in Section 4.6.2.2), seabed preparation, foundation placement, and scour protection installation. Seabed preparation may be required for gravity-based foundations or in areas with large sand bedforms. Seafloor-disturbing activities during installation of the offshore cables include anchoring, pre-installation activities (e.g., sand bedform removal, boulder relocation, and a pre-lay grapnel run), offshore cable installation, cable protection installation, where needed, and excavation of the HDD pit. Detailed methodologies for conducting these activities are described in Section 4.0 of Volume I.

The maximum area of seabed disturbance associated with these activities in the Offshore Project Area is summarized in Table 4.6-7. Based on the range of activities in the Project lifecycle associated with the maximum case PDE, the total area of temporary seafloor disturbance (not including the area of the seafloor that will be permanently occupied by structures or cables [see Section 4.6.2.6]) in the WTA is 4.41 square miles (mi^2) (11.42 square kilometers [km^2]), which represents approximately 2.8% of the 160 mi^2 (413 km^2) WTA area. Within the Project 1 WTA, the total temporary seafloor disturbance is 2.32 mi^2 (5.99 km^2). Within the Project 2 WTA, the total temporary seafloor disturbance is 2.17 mi^2 (5.63 km^2). The total temporary seafloor disturbance in the Atlantic ECC is 0.83 mi^2 (2.14 km^2) and the total temporary seafloor disturbance in the Monmouth ECC is 2.26 mi^2 (5.86 km^2), for a total temporary disturbance of 3.09 mi^2 (8 km^2) for both ECCs combined (Table 4.6-7). This estimated area of disturbance represents approximately 6.3% of the entire ECC area which is small relative to the total area of available surrounding habitat in the WTA and ECCs. Temporary direct seabed disturbance from the Projects will be limited to these areas.

Table 4.6-7 Maximum Total Seabed Disturbance

Offshore Project Area Component	Maximum Area of Seafloor Disturbance		
	Permanent Disturbance	Additional Temporary Disturbance	Total
Maximum Total Seabed Disturbance in the WTA[1,2]	1.01 mi^2 (2.60 km^2)	4.41 mi^2 (11.42 km^2)	5.42 mi^2 (14.02km^2)
Maximum Total Seabed Disturbance in Project 1 WTA[1]	0.57 mi^2 (1.50 km^2)	2.32 mi^2 (5.99 km^2)	2.88 mi^2 (7.48 km^2)
Maximum Total Seabed Disturbance in Project 2 WTA[1]	0.49 mi^2 (1.25 km^2)	2.17 mi^2 (5.63 km^2)	2.66 mi^2 (6.87 km^2)
Maximum Total Seabed Disturbance in the ECCs	0.38 mi^2 (0.98 km^2)	3.09 mi^2 (8.00 km^2)	3.47 mi^2 (8.99 km^2)
Atlantic ECC	0.06 mi^2 (0.16 km^2)	0.83 mi^2 (2.14 km^2)	0.89 mi^2 (2.30 km^2)
Monmouth ECC	0.32 mi^2 (0.83 km^2)	2.26 mi^2 (5.86 km^2)	2.58 mi^2 (6.69 km^2)

[1] Seabed disturbance values within the WTA are reflective of a monopile-only scenario for WTG foundations due to monopiles resulting in the largest area of disturbance to the seabed. If piled jackets are used for WTG foundations in Project 2, the area of disturbance to the seafloor will be less. See Section 4.11 of Volume I for additional information about impacts from piled jackets.

[2] Given that the Overlap Area could be incorporated into Project 1 or Project 2, disturbance associated with the Overlap Area is included in both the Project 1 WTA and Project 2 WTA disturbance calculations.

Given the dynamic nature of sediment processes and existing disturbances in the Offshore Project Area, Project seabed disturbing activities are expected to create only temporary and localized alterations to the seafloor habitat. The benthic community associated with the fine, medium, and gravelly sand that dominates the Offshore Project Area is expected to rapidly recover following construction (Brooks et al., 2004; Guarinello et al., 2017; Guida et al. 2017). A review of studies of the recovery and recolonization along the U.S. East Coast by Brooks et al. (2004) reported that recovery of benthic assemblages to background levels following dredging disturbance can range from 3 months to 2.5 years with recovery time dependent on site-specific taxa, type of sediment disturbance, and environmental conditions. BOEM (2021) reported that benthic assemblages subjected to physical disturbance in soft sediment communities typically recover in 6 to 18 months through dispersal from adjacent areas, assuming the affected area is not disturbed during the recolonization period. Therefore, Project-related seabed disturbance is unlikely to result in long-term adverse effects to benthic habitat or displacement of finfish or invertebrate species because these habitats have persisted through natural and anthropogenic disturbances (e.g., vessel traffic and fishing activities) and the finfish, invertebrate, and EFH species in these dynamic areas are adapted to survive periodic disturbances (Guida et al. 2017) similar to those associated with Project activities. For these reasons, Project-related impacts from the installation and maintenance of structures and cables to the benthic community, which supports benthic and demersally-oriented finfish species and their EFH, are expected to be temporary and localized.

For those locations in the Offshore Project Area identified by site-specific surveys as complex habitat, the installation and maintenance of new structures, cables, and associated vessel anchoring and jacking activities could result in longer-term effects to finfish habitat, including EFH, because complex habitats are reported to have longer recovery times than areas with soft sediment (HDR 2020). Mapped complex habitat in the Offshore Project Area is reported in Appendix II-A1 and II-J2. All Project activities will occur in previously surveyed areas and Atlantic Shores has selected installation tools and methods that minimize disturbance to bottom habitats, including complex habitats, to the maximum extent practicable. In addition, the Offshore Project Area does not contain any salt marshes, mud flats, coral reefs, or significant areas of submerged aquatic vegetation such as eel grass, which are considered sensitive habitats for finfish, invertebrates and EFH species.

Another sensitive habitat in the Offshore Project Area is the sandbar shark HAPC, part of which overlaps with the nearshore portion of the Atlantic ECC (see Figure 4.6-3). The portion of the HAPC closest to the Atlantic Landfall Site will be avoided by using HDD techniques. The remaining approximately 4.7 mi (7.67 km) of the Atlantic ECC that traverses the HAPC will be temporarily disturbed during ECC cable installation. Specifically, offshore cable installation is anticipated to create a trench with a maximum width of up to approximately 3.3 ft (1 m) with the installation tool's skids or tracks creating an additional 13 ft (4 m) of surficial seabed disturbance. This results in approximately 0.01 mi^2 of direct seabed disturbance to sandbar shark HAPC, which is a small area in relation to the surrounding available undisturbed HAPC for sandbar shark. In addition, nearshore cable installation activities will be conducted outside of the anticipated peak period of sandbar shark nursery and pupping activity between June 1 and September 1. Other environmental protection measures employed to minimize impacts to finfish, pelagic invertebrates, and EFH (e.g., cable burial, use of anchor midline buoys and anchor plan) will also contribute to minimizing impacts to sandbar shark HAPC. Atlantic Shores will coordinate with BOEM, NOAA Fisheries, and NJDEP during the EFH Consultation process to further establish mutually agreeable mitigation measures for sandbar shark HAPC, as necessary.

Most species in the Offshore Project Area, including those with designated EFH, have pelagic early life histories (eggs and larvae) and are not dependent on benthic habitat. Therefore, modification and/or disturbance of the seafloor, including temporary sediment suspension and deposition will not impact these species or life stages. There may be some temporary impacts on the use of specific areas by these species during construction resulting from increased sediment suspension in the lower water column; however, as stated in the following section, any sediment plume generated during Project construction is expected to be small, localized, and temporary. In addition, given their mobile nature, pelagic juvenile and adult life stages should largely avoid these areas during the period of disturbance. During this time, these species will be able to forage in nearby areas and are expected to return soon after sediment disturbing activities are complete.

Sessile benthic species (e.g., Atlantic surfclam and ocean quahog) or species with early life stages that are dependent on benthic habitat (e.g., ocean pout (*Macrozoarces americanus*) eggs, winter flounder eggs and larvae, Atlantic sea scallop eggs and larvae, and longfin inshore squid eggs) will be more susceptible to injury or mortality from seabed disturbing Project activities. Mortality of these species will most likely be limited to the direct footprint of the disturbance. These species will also be more susceptible to temporary increases in sediment suspension and deposition; however, as stated in the following section, any sediment plume generated during Project construction is expected to be small, localized, and temporary. Any injury of mortality to these species and life stages is not expected to result in population level effects given the surrounding available habitat that will not be disturbed. The extent of impacts on the early life stages of these species will also be dependent on the time of year that Project activities occur, as early life stages will only be present for short periods during specific times of year depending on the species. Therefore, the potential exposure of the most vulnerable early life stages to seabed disturbance will be limited to only their seasonal presence in the Offshore Project Area.

Mobile juvenile and adult life stages of benthic and demersal finfish species are less likely to experience injury or mortality during seafloor disturbing activities because they are expected to temporarily leave the immediate area during these activities. By moving away from Project-related activities, mobile finfish would be able to avoid direct mortality and injury; however, they may be temporarily displaced from a portion of available habitat in the Offshore Project Area. During this time, these species will be able to forage in nearby areas and are expected to return soon after sediment disturbing activities are complete. The extent of impacts to individual older life stages of species is also affected by the time of year that Project activities occur. Many species within the Offshore Project Area migrate seasonally, such as black sea bass, scup, monkfish (*Lophius americanus*), and spiny dogfish and use benthic habitat for only a portion of their life stage.

Therefore, the potential exposure of these species to seabed disturbance will be limited to their seasonal presence in the Offshore Project Area.

Based on documented cases of habitat recolonization and recovery, after significant disturbances involving benthic communities like those found in the Offshore Project Area, and the assumption that the surrounding available habitat will not be disturbed, seafloor-disturbing Project activities are not expected to result in long-term population-level effects to the resident benthic organisms and communities that support finfish, pelagic invertebrates, and their EFH. Although localized mortality of some benthic invertebrates is anticipated in the Offshore Project Area, impacts are not expected to be significant at the population level and would not measurably alter the environmental baseline, as similarly concluded in BOEM (2021).

Environmental protection measures such as using HDD techniques to avoid seabed disturbance impacts at the landfall sites, burying offshore cables to a target depth of 5 to 6.6 ft (1.5 to 2 m), using installation tools that minimize seabed disturbance to the maximum extent practicable, and using anchor midline buoys and an anchoring plan, where feasible, will support the avoidance and/or minimization of impacts to finfish, pelagic invertebrates, and their EFH.

Suspended Sediment and Deposition

Various sediment-disturbing Project activities conducted during construction, O&M, and decommissioning have the potential to suspend sediments into the water column resulting in the transport and deposition of these sediments on the seafloor. As described in Section 2.1 Geology, sediments disturbed during Project activities are not expected to contain hazardous contaminants. Therefore, during all phases of the Projects, finfish and pelagic invertebrates will primarily be affected by the short-term, localized, and temporary physical suspension of sediments and resulting deposition.

The primary construction activities that will result in elevated suspended sediment concentrations and deposition include seabed preparation, sand bedform removal, offshore cable installation, and excavation at the offshore HDD pit. In order to determine the extent of suspended sediment and deposition produced by construction activities, a Sediment Transport Modeling study was conducted (see Appendix II-J3). This study examined the extent and duration of elevated total suspended solids (TSS) concentrations and sediment deposition as a result of offshore cable installation and HDD activities at the Monmouth and Atlantic Landfall Sites. Additional modeling of sandwave clearance[30] was performed to bound the potential effects of seabed preparation, prior to cable installation (Attachment A of Appendix II-J3).

[30] Dredged material from sandwave removal will be discharged low in the water column within surveyed areas that contain sand bedforms, used for ballast in GBS foundations if those foundations are selected for the Projects, or transported a short distance to an agreed-upon disposal site outside the Lease Area.

Suspended Sediment Concentration Predictions

Model simulation results of above-ambient TSS concentrations stemming from cable installation for the inter-array cable, Monmouth ECC, and Atlantic ECC remained relatively close to the route centerline, were constrained to the bottom of the water column, and were short-lived. Table 4.6-8 summarizes the extent and duration of suspended sediment concentrations resulting from cable installation, HDD activities, and sandwave clearance. Simulations of several possible inter-array cable or offshore export cable installation methods using either jet trenching installation parameters (for inter-array cable and export cable installation) or mechanical trenching installation parameters (for inter-array cable installation only) predicted above-ambient TSS of ≥10 milligrams per liter (mg/L)[31] stayed relatively close to the route centerline. This is due to sediments being introduced to the water column closer to the seabed. TSS concentrations of ≥10 mg/L traveled a maximum distance of approximately 1.8 mi (2.9 km), 1.6 mi (2.6 km), and 1.1 mi (1.7 km) for inter-array, Monmouth ECC, and Atlantic ECC cable installation, respectively (see Table 4.6-8). For the landfall approach scenarios, use of an excavator was assumed and sediment was introduced at the surface. This resulted in a maximum distance for the predicted above-ambient TSS concentrations ≥10 mg/L of approximately 2.1 mi (3.3 km) and 1.2 mi (1.9 km) for the Monmouth and Atlantic HDD pits, respectively (see Table 4.6-8).

For the inter-array cable and Atlantic ECC model scenarios, above-ambient TSS concentrations substantially dissipated within 2 to 4 hours and fully dissipated in 6 or less hours. For the Monmouth ECC model scenarios, above-ambient TSS concentrations substantially dissipated within 2 to 6 hours but required up to 13 hours to fully dissipate, likely due to the relatively longer route (i.e., larger volume of suspended sediment), route orientation in relation to currents, and more frequent occurrence of fine sediment. For the landfall approach scenarios, the tails of the plumes, with concentrations of ≥10 mg/L, were transported away from the source and were short-lived, while concentrations around the HDD pits dissipated within 12 hours for the Monmouth HDD pit and 11 hours for the Atlantic HDD pit. The larger areas of TSS concentrations above thresholds and the longer time for the plume to diminish to ambient conditions for the Monmouth HDD pit may be attributed to sediments being released in deeper water, the higher fraction of fine sediments taking longer to settle, and slightly stronger currents transporting the sediments parallel with the shore.

Predicted above-ambient TSS concentrations stemming from sandwave clearance activities also remained relatively close to the route centerline and were short-lived. The maximum distance for predicted above-ambient TSS concentrations of ≥10 mg/L was approximately 2.0 mi (3.2 km) (see Table 4.6-8). Above-ambient TSS concentrations were predicted to substantially dissipate within 4 to 6 hours and to fully dissipate in less than 12 hours for most areas.

[31] In the Mid-Atlantic Bight, 10 mg/L is considered within the range of ambient TSS concentration conditions (Balthis et al. 2009).

Table 4.6-8 Suspended Sediment Modeling Results from Cable Installation and HDD Activities

Scenario	Maximum Duration of TSS >10 mg/L (hrs)	Maximum Extent of TSS ≥10 mg/L (km)	Maximum Duration of TSS >100 mg/L (hrs)	Maximum Extent of TSS ≥100 mg/L (km)
Offshore Cable Installation				
Inter-array Cable - Jet Trencher	5.7	2.6	2.5	1.5
Inter-array Cable - Mechanical Trencher	6.3	2.9	2.7	0.9
Monmouth Export Cable - Jet Trencher	12.8	2.6	6.0	1.5
Atlantic Export Cable - Jet Trencher	5.5	1.7	0.8	<0.1
HDD Activities at Landfall Site				
Monmouth Landfall Representative HDD Pit Excavator	12.3	3.3	11	0.4
Atlantic Landfall Representative HDD Pit Excavator	10.7	1.9	10.3	0.1
Sandwave clearance				
Representative Sandwave Clearance, Monmouth ECC	12.5	3.2	7.0	2.1

These model predictions agree with modeling results conducted for similar projects in similar sediment conditions (BOEM 2021; Elliot et al. 2017; West Point Partners, LLC 2013; ASA 2008). Actual suspended sediment concentrations and sediment transport during installation may be even lower given that environmental monitoring surveys conducted during installation of the Block Island Wind Farm submarine cable found that suspended sediment levels measured during jet plow installation were up to 100 times lower than those predicted by the modeling (Elliot et al. 2017).

Elevated suspended sediment concentrations have the potential to influence feeding and foraging behavior, respiratory functionality, and survival of finfish species; however, impacts vary by species and life stage (Wilber and Clark 2001). Historically, studies on the impacts of suspended sediments on marine organisms have heavily focused on sediment concentrations. More recent studies have shown that exposure duration is also an important influencing factor (Wilber and Clark 2001). Wilber and Clark (2001) compiled numerous studies which examined the impacts of suspended sediment concentration and exposure duration. A majority of the studies observed lethal impacts at high sediment concentrations and long exposure durations. One study conducted by Auld and Schubel (1978) showed a 13% mortality rate in American shad larvae when exposed to suspended sediment concentrations of 100 mg/L for a duration of 4 days (Wilber and Clark 2001). Another study conducted by Sherk et al. (1974) showed a 10% mortality in Atlantic silverside juveniles and adults when exposed to sediment concentrations of 580 mg/L for 1 day (Wilber and Clark 2001).

Results from the Sediment Transport Modeling report showed that suspended sediment concentrations greater than 100 mg/L are only anticipated to last up to 11 hours for HDD activities, 6 hours for cable installation, and 7 hours for sandwave clearance (Table 4.6-8), all of which are significantly less than the multiple-day studies compiled by Wilber and Clark (2001). Additionally, concentrations greater than 100 mg/L are expected to be localized, extending up to a maximum distance of 0.9 mi (1.5 km), 0.2 mi (0.4 km), and 1.3 mi (2.1 km) from cable centerlines, HDD activities, and sandwave clearing, respectively. Therefore, while effects could occur to less mobile individuals and early life stages in the immediate vicinity of the cable and HDD activities, these effects are expected to be short-term and not result in high levels of mortality.

Sediment Deposition Predictions

Installation and maintenance of structures and cables will also result in the transport of sediment that will subsequently deposit over time as sediment particles settle through the water column to the seabed. Sediment deposition levels were modeled, as part of the Sediment Transport Modeling study, for the offshore installation of inter-array cables, the Monmouth ECC, Atlantic ECC, as well as HDD activities at the Monmouth and Atlantic Landfall Sites and sandwave clearance in a representative area of the Monmouth ECC.

Table 4.6-9 summarizes the areal extent and maximum distance of sediment deposition due to cable installation, sandwave clearance, and HDD activities when the depositional thickness is ≥0.04 in (1 mm). A threshold of 0.04 in (1 mm) was used in this analysis as it is cited in literature as the level at which burial and mortality occurs in demersal eggs (Berry et al. 2011).

Deposition ≥0.04 inches (in) (1 mm) was limited to 360 ft (110 m) from the inter-array cable centerline for jet trenching installation parameters and to 164 ft (50 m) for mechanical trenching installation parameters (see Table 4.6-9). Variations in plume extent and duration for inter-array cable installation can be attributed to differences in cross-sectional area and advance rates, which impacted the timing of the currents. Deposition ≥0.04 in (1 mm) was limited to 656 ft (200 m) from the Monmouth ECC centerline and to 164 ft (50 m) of the Atlantic ECC centerline. The maximum deposition associated with inter-array cable, Atlantic ECC, and Monmouth ECC model scenarios was less than 0.2 in (5 mm), between 0.2 and 0.4 in (5-10 mm), and between 0.4 and 0.8 in (10-20 mm), respectively.

Deposition ≥0.04 in (≥1 mm) resulting from sandwave clearance was limited to 2,805 ft (855 m) from the route centerline and covered a maximum area of 2.01 mi^2 (5.20 km^2). The maximum deposition predicted for sandwave clearance was ≥3.9 inches (100 mm) and predicted to extend a maximum distance of 66 ft (20 m) from the route centerline.

For the Monmouth and Atlantic HDD pit excavations, deposition ≥0.04 in (1 mm) was predicted to extend a maximum distance of 1,571.5 ft (479 m) and 656 ft (200 m), respectively. The Atlantic landfall approach scenario was predicted to have higher areas of deposition for the 0.4 in (10 mm) and 0.8 in (20 mm) thresholds due to a higher fraction of coarse sediment. In combination with the sediment type and the relatively more shore-perpendicular nature of the currents at the Atlantic HDD pit, more sediment remained close to the pit and settled to the bottom rather than lingering in the water column or being transported as a suspended sediment plume.

Table 4.6-9 Deposition Modeling Results from Cable Installation and HDD Activities

Scenario	Area of Deposition ≥0.04 in (1 mm)[1] (km^2)	Maximum Extent of Deposition ≥0.04 in (1 mm)[1] (m)
Offshore Cable Installation		
Inter-array Cable - Jet Trencher	0.6	110
Inter-array Cable - Mechanical Trencher	0.4	50
Monmouth Export Cable - Jet Trencher	8.32	200
Atlantic Export Cable - Jet Trencher	1.39	50
HDD Activities at Landfall Site		
Monmouth Landfall - Representative HDD Pit Excavator	0.09	479
Atlantic Landfall - Representative HDD Pit Excavator	0.04	200
Sandwave clearance		
Representative Sandwave Clearance, Monmouth ECC	5.20	855

[1] A depositional threshold of 0.04 in (1 mm) was used in the Sediment Transport Modeling report as it is the burial and mortality threshold for demersal eggs (Berry et al. 2011).

Sediment deposition has the potential to bury demersal eggs and larvae of finfish or squid that are within the zone of deposition. According to Berry et al. (2011), deposition ≥0.04 in (1 mm) can result in delayed hatching or mortality of demersal eggs (e.g., Atlantic herring, winter flounder, longfin inshore squid). Results from the Sediment Transport Modeling report show that deposition greater than 0.04 in (1 mm) will occupy a maximum area of 3.21 mi^2 (8.32 km^2), 0.03 mi^2 (0.09 km^2), and 3.2 mi^2 (5.20 km^2) for cable installation, HDD activities, and sandwave clearing, respectively.

Based on the modeling results, the area of deposition ≥0.04 in (1 mm) will be minimal compared to the surrounding available habitat.

With respect to sedimentation and deposition, it is important to note that finfish and pelagic invertebrates that occupy the Mid-Atlantic Bight are generally adapted to periodic seafloor disturbance and deposition events. Therefore, sediment disturbing Project activities are not expected to result in population-level effects to finfish or squid, including EFH-designated species. Although sessile egg and larvae stages could experience localized increases in physical abrasion, burial, or limited mortality, mobile, older life stages, including those of the Atlantic sturgeon, are expected to temporarily vacate the area during these activities and return shortly after sediment conditions return to ambient conditions, a phenomenon that has commonly been observed following dredging activities and other physical disturbance of seafloor conditions (Brooks et al. 2004; BOEM 2021; Guida et al. 2017).

The degree of suspended sediment and deposition will be significantly lower during O&M activities than during Project construction. Some sediment suspension and deposition may occur from maintenance of structures and cables if repairs are required, but impacts are expected to be short term and temporary, due to the predominantly sandy seafloor and shallow sediments in the Offshore Project Area. Decommissioning of structures and cables is expected to have similar limited impacts as those described for construction. During all Project phases, dynamically positioned vessels and jet plow embedment will be used to the maximum extent practicable to reduce sediment disturbance during cable laying processes.

Impingement or Entrainment of Fish Larvae

Project operations requiring the use of water, such as standard vessel operations, jet plow, or jet trenching activities, will likely result in the impingement and/or entrainment of pelagic planktonic species. Entrainment of planktonic species typically results in high levels of mortality due to temperature changes and injury as organisms travel through piping systems (USDOE 2009). With respect to jet plowing activities, injury to entrained organisms can occur when water is injected into sediments at high pressure, resulting in mortality. However, such occurrence will be limited to periods of vessel operation and jet plowing.

Assuming an installation rate between 492 and 984 ft (150 m and 300 m) per hour for export, inter-array, and interlink cable installation using jet plowing, and a water withdrawal rate between 14,125 and 49,441 feet^3 (ft^3) (400 meters^3 [m^3] and 1,400 m^3) per hour for jet plow activities, water withdrawal volumes are expected to range from approximately 1,100 to 2,100 million gallons (4,400 to 7,700 million liters) from jet plowing activities for both projects (831 to 1,500 million gallons [3,100 to 5,500 million liters] per project). Additional water withdrawal may be required for sandwave clearance using a hydraulic dredge. Though the exact locations of sandwave clearance will be determined closer to construction, a conservative estimate of 30% of the export and interlink cable lengths and 15% of the inter-array cable length was used to calculate total water withdrawal. Assuming an installation rate between 344 and 1,476 ft (105 and 450 m) per hour for export, inter-array, and interlink cable and a water withdrawal rate between 353,146 and

1,059,440 ft^3 (10,000 m^3 and 30,000 m^3) per hour, water withdrawal volumes are expected to range from approximately 7,610 to 10,200 million gallons (29,000 to 38,300 million liters) from hydraulic dredging activities for both projects (6,050 to 8,050 million gallons [22,900 to 30,400 million liters] per project).

Mortality of ichthyoplankton is considered likely due to water withdrawal activities; however, many species that inhabit the Offshore Project Area produce millions of eggs each year (e.g., Atlantic herring, Atlantic cod, haddock, winter flounder) which allows the species to persist in the presence of natural and anthropogenic-related effects (NOAA 2020c, Adams 1980). Additionally, cable installation activities requiring water withdrawal will be limited in time and space. As a result, water withdrawal activities are not expected to cause population-level impacts to icthyoplankton.

4.6.2.2 Anchoring and Jack-Up Vessels

Temporary anchoring and use of jack-up vessels within the Offshore Project Area may occur during construction and decommissioning and to a lesser extent during O&M with variations in duration and extent according to the specific work activity. All vessel anchoring and jacking-up associated with Project activities will occur within surveyed areas of the WTA or ECCs. These activities may affect finfish and pelagic invertebrate resources and EFH through direct seafloor disturbance and temporary increases in suspended sediment and deposition and effects are expected to be similar to those described in Section 4.6.2.1.

Positioning of anchors and jack-up vessels is expected to result in temporary impacts in the immediate area where anchors, chains, or jack-up legs meet the seafloor. Potential effects to finfish, invertebrates and EFH during anchoring and jack-up vessel positioning include temporary surficial disturbances of the seafloor and increases in suspended sediments and deposition, which could cause mortality to early life stages of benthic and demersal species or cause temporary habitat disruption in limited areas. The severity of impacts for each event would depend on the specific location, habitat type, and season, with greater effects expected when seafloor-disturbing activities interact with sensitive habitats, early life stages (eggs and larvae), and sessile or slow-moving species. The Offshore Project Area does not contain any eelgrass (see Section 4.2 Coastal and Terrestrial Habitat and Fauna) or critical habitat for Atlantic sturgeon (see Section 4.6.1.5). Benthic and demersal early life stages of finfish, squid, or EFH species (e.g., ocean pout eggs, winter flounder eggs and larvae, Atlantic sea scallop eggs and larvae, and longfin inshore squid eggs) in the direct path of anchor or jack-up vessel disturbance may be subject to injury or mortality; however, this is not expected to result in population-level effects given the surrounding available habitat that will remain undisturbed (Table 4.6-7).

Juvenile and adult life stages of benthic and demersal species, including those of the Atlantic sturgeon, are less likely to experience these impacts as they are mobile and more likely to leave the area during anchoring activities. By moving away from Project-related activities, mobile finfish would be able to avoid direct mortality and injury; however, they may be temporarily displaced from a portion of available habitat in the Offshore Project Area. While temporarily displaced, these species likely will be able to forage in nearby areas and are expected to return after anchoring activities are complete.

The maximum seabed disturbance in the WTA and ECCs resulting from jack-up or anchored vessel use is included in the temporary seafloor disturbance calculations presented in Table 4.6-7. Disturbance caused by anchoring and jack-up vessels will occur in small areas relative to the total available surrounding habitat in the WTA and ECCs. Impacts would be temporary and localized, and any isolated mortality of early life stages or sessile organisms are not expected to have population-level effects. As described in more detail in Section 4.6.2.1, benthic macroinvertebrates (prey for many finfish and EFH species) are expected to recolonize the area after the physical disturbance ceases, allowing these temporarily disturbed areas to continue to serve as habitat. HDR (2019) as cited in BOEM (2021) reported that post-construction monitoring at the Block Island Wind Farm showed seabed scars from anchoring disturbance recovered to baseline conditions within 18 months to 2 years.

As previously stated, Atlantic Shores is committed to minimizing the impacts to complex habitat to the maximum extent practicable by using tools and installation methods that minimize the potential disturbance. Atlantic Shores also proposes to use midline buoys on anchored construction vessels to minimize seabed disturbance and will develop an anchoring plan for areas where anchoring is required to avoid impacts to sensitive habitats to the maximum extent practicable, including hard bottom and structurally complex habitats, as identified in site-specific HRG and benthic surveys.

Vessels are not expected to anchor or use jack-up positioning during O&M activities unless the WTGs, OSSs, or offshore cables require major maintenance (e.g., component replacement or cable repair). Impacts associated with potential vessel positioning with anchors or jack-up legs during O&M and decommissioning are expected to be similar, but less than those described for the construction phase.

4.6.2.3 Noise

This section addresses underwater sound that may be generated during activities conducted in the Offshore Project Area, including impulsive pile driving and other noise sources (e.g., HRG surveys, vessels, cable installation, vibratory pile driving during cofferdam installation, operational WTGs, operational offshore cables, and decommissioning) and assesses the potential effects noise generated from these activities may have on finfish and pelagic invertebrates, including EFH-designated species. Noise, defined as unwanted sound, is detected by fish and invertebrates as particle motion, with some fish additionally sensing pressure. Noise generated during Project construction, O&M, and decommissioning has the potential to result in physiological stress and behavioral changes, as well as limited mortality or injury in finfish and pelagic invertebrates when the noise is present. As described in the following sections, effects to finfish and pelagic invertebrates from underwater noise will be limited to radial distances from the source where sound levels are above regulatory thresholds. Pile driving noise during construction (if a piled foundation type is chosen) would be mitigated through the use of noise abatement systems such as bubble curtains and hydro-dampeners and noise mitigating measures such as soft starts and ramp up procedures.

Fish and invertebrates are sensitive to particle motion and some fish are additionally sensitive to pressure. Particle motion is described by displacement, velocity, and acceleration. Because the ears of fish function as inertial accelerometers, all fish are sensitive to particle motion. In contrast, sensitivity to sound pressure in fish is functionally correlated to the presence or absence of gas-filled chambers, such as the swim bladder. Sensing pressure extends hearing to higher frequencies (Ladich and Popper 2004, Braun and Grande 2008). The presence of a swim bladder, or other gas-filled cavity, makes fish more susceptible to injury from anthropogenic sound as these loud, often impulsive, noises can cause swim bladders to vibrate with enough force to cause damage to tissues and organs around the bladder (Halvorsen et al. 2011, Casper et al. 2012). Invertebrates and crustaceans lack swim bladders and are therefore less sensitive to sound.

The most sensitive fish species are those with swim bladders connected or close to the inner ear. These species can acquire both recoverable and mortal injuries at lower sound levels than other species (Thomsen et al. 2006, Popper et al. 2014). EFH-designated species and other NOAA Trust Resource species[32] that may be present in the WTA and are considered high-sensitivity fish species (Popper et al. 2014) due to swim bladder involvement in hearing, include Atlantic cod, Atlantic herring, silver hake, white hake (*Urophycis tenuis)*, alewife (*Alosa pseudoharengus)*, blueback herring (*Alosa aestivalis)*, American eel (*Anguilla rostrata)*, American shad (*Alosa sapidissima*), Atlantic menhaden (*Brevoortia tyrannus)*, and weakfish.

Some fish found in the WTA have swim bladders not involved in hearing (e.g., Atlantic sturgeon, Atlantic butterfish, Atlantic mackerel [*Scomber scombrus]*, black sea bass, bluefish [*Pomatomus saltatrix]*, haddock, monkfish, ocean pout, red hake, scup, bluefin tuna [*Thunnus thynnus]*, yellowfin tuna [*Thunnus albacares]*, striped bass [*Morone saxatilis]*, tautog). Their detection of sound is mediated primarily through particle motion, and these species have relatively low susceptibility to anthropogenic sound-induced effects (Popper et al. 2014). The least sound-sensitive fish species are those that have no swim bladder, including elasmobranchs (i.e., sharks and rays) and flatfish such as summer flounder.

Impact (impulsive) pile driving may occur if piled foundation types (monopile and jackets) are chosen as the foundation type for the Projects. Impulsive sounds are discontinuous, high intensity sounds that are extremely short in duration (with a rapid onset and decay) but may be repetitive. There are also other noise sources associated with offshore Project construction, O&M, and decommissioning that are primarily non-impulsive in nature. Non-impulsive sounds are continuous sounds that remain constant and relatively stable over time (e.g., vessel sounds, WTG operational noise, vibratory pile driving noise).

[32] NOAA GARFO provided a list of Other NOAA Trust Resources to be evaluated in the EFH Assessment in a virtual meeting held on May 20, 2020.

To assess the potential effects from impact pile driving to finfish, if piled foundations are used, Atlantic Shores conducted quantitative acoustic modeling and compared the results against impulsive acoustic thresholds. For other sound sources from the Projects, Atlantic Shores provides a qualitative assessment of potential impacts to finfish and invertebrates in relation to the relevant acoustic thresholds. These other sound sources were not quantitatively modeled because the potential acoustic impact of these sound sources is expected to be much less than impulsive pile driving.

Injury and behavioral response exposure criteria for impulsive and non-impulsive sounds are based on relevant regulatory-defined thresholds and best available science for fish (NOAA 2005, Andersson et al. 2007, Wysocki et al. 2007, FHWG 2008, Mueller-Blenkle et al. 2010, Purser and Radford 2011) and are described in detail in Appendix II-L. Table 4.6-10 provides regulatory approved acoustic thresholds to evaluate the potential for finfish to experience injury and behavioral response from impulsive sounds. Because few data are available regarding particle motion sensitivity in fish (Popper and Fay 2011, Popper et al. 2014), the thresholds for acoustic sensitivity are based on sound pressure only (FHWG 2008, Stadler and Woodbury 2009). The thresholds that are currently used by NOAA Fisheries Greater Atlantic Regional Fisheries Office (GARFO) and BOEM to assess potential impacts to fish exposed to pile driving sounds are based on criteria adopted from the Fisheries Hydroacoustic Working Group (FHWG 2008, Stadler and Woodbury 2009). Table 4.6-10 also presents threshold levels suggested by Popper et al. (2014) for injury and TTS for impulsive sounds, which are based on the presence, and role, of a swim bladder.

Table 4.6-10 Interim Fish Injury and Behavioral Acoustic Thresholds Currently Used by NOAA Fisheries GARFO and BOEM for Impulsive Pile Driving

<table>
<tr><th rowspan="2">Fish Group</th><th colspan="2">Injury Thresholds</th><th>TTS</th><th>Behavior Threshold</th></tr>
<tr><th>L_{pk}</th><th>L_e</th><th>L_e</th><th>L_p</th></tr>
<tr><td>Fish without a swim bladder (particle motion detection)[1]</td><td>213</td><td>216</td><td rowspan="3">186</td><td>—</td></tr>
<tr><td>Fish with swim bladder not involved in hearing (particle motion detection)[1]</td><td rowspan="2">207</td><td rowspan="2">203</td><td>—</td></tr>
<tr><td>Fish with swim bladder involved in hearing (primarily pressure detection)[1]</td><td>—</td></tr>
<tr><td>Fish weighing ≥2 grams[2,3]</td><td rowspan="2">206</td><td>187</td><td>—</td><td rowspan="2">150[4]</td></tr>
<tr><td>Fish weighing <2 grams[2,3]</td><td>183</td><td>—</td></tr>
</table>

Notes:
All thresholds are unweighted.; L_{PK} – peak sound pressure (decibel [dB] re 1 micropascal [μPa]).; L_E – sound exposure level (dB re 1 μPa^2·s).; L_p – root mean square sound pressure (dB re 1 μPa).; TTS – temporary, recoverable hearing effects.
1 Popper et al. (2014).
2 NMFS recommended criteria adopted from the Fisheries Hydroacoustic Working Group (FHWG 2008).
3 Stadler and Woodbury (2009)

4 Andersson et al. (2007), Mueller-Blenkle et al. (2010), Purser and Radford (2011), Wysocki et al. (2007).

Impulsive underwater noise generated from Project activities has the potential to cause mortality or injury (e.g., ruptured gas bladders, damage to auditory processes) mainly to the finfish identified above that have swim bladders connected or close to the inner ear (Casper et al. 2012; Popper and Hastings 2009; Riefolo et al. 2016). Exposure to intense anthropogenic sound levels can also cause an increase in the hearing thresholds of fishes, resulting in less sensitive (i.e., poorer) hearing abilities. This change in hearing threshold may be temporary (i.e., temporary threshold shift [TTS]) or permanent (i.e., permanent threshold [PTS]). In addition, underwater noise may elicit a behavioral response in finfish and pelagic invertebrates, such as avoidance, changes in feeding, breeding, schooling, migration behavior, or masking of environmental auditory cues (Buerkle 1973; Mitson and Knudsen 2003; Olsen et al. 1983; Ona et al. 2007; Sarà et al. 2007; Schwarz and Greer 1984; Soria et al. 1996; Vabø et al. 2002). Behavioral responses in fish differ depending on species and life stage, with younger, less mobile age classes being the most vulnerable (Gedamke et al. 2016; Popper and Hastings 2009).

The effects of impulsive sound on fish eggs and larvae have been studied in the context of offshore pile driving. Bolle et al. (2012) investigated the risk of mortality in common sole larvae by exposing them to impulsive stimuli in an acoustically well-controlled study. Even at the highest exposure level tested, at a sound exposure level (SEL) of 206 dB re 1 $\mu Pa^2 \cdot s$ (corresponding to 100 strikes at a distance of 100 m) no statistically significant differences in mortality were found between exposure and control groups. Popper et al. (2014) published exposure guidelines for fish eggs and larvae, which are based on pile driving data. The guidelines proposed a precautionary threshold for mortality of fish eggs and larvae of greater than 207 dB re 1 µPa PK, which they note is likely conservative. As no thresholds exist for pelagic invertebrates, fish eggs and larvae thresholds are used as a proxy for these species.

There are very few studies on the effect of non-impulsive sound sources on fish and no data exist for eggs and larvae (Popper et al. 2014). Acoustic thresholds for fish used to qualitatively evaluate impacts from non-impulsive sounds are provided in Table 4.6-11. As with impulsive sounds, the eggs and larvae thresholds are considered proxy for marine invertebrates.

Table 4.6-11 Interim Fish Injury and Behavioral Acoustic Thresholds Currently Recommended by Bureau of Ocean Energy Management (BOEM) for Non-Impulsive Sources

<table>
<tr><th rowspan="2">Fish Group</th><th rowspan="2">Mortality and Potential Mortal Injury</th><th colspan="3">Impairment</th><th rowspan="2">Behavior</th></tr>
<tr><th>Recoverable injury</th><th>TTS</th><th>Masking</th></tr>
<tr><td>Fish without a swim bladder (particle motion detection)[1]</td><td rowspan="4">(N) Low
(I) Low
(F) Low</td><td rowspan="2">(N) Low
(I) Low
(F) Low</td><td rowspan="2">(N) Moderate
(I) Low
(F) Low</td><td rowspan="2">(N) High
(I) High
(F) Moderate</td><td rowspan="2">(N) Moderate
(I) Moderate
(F) Low</td></tr>
<tr><td>Fish with swim bladder not involved in hearing (particle motion detection)[1]</td></tr>
<tr><td>Fish with swim bladder involved in hearing (primarily sound pressure detection)[1]</td><td>170 (SPL_{48hr})</td><td>158 (SPL_{12hr})</td><td>(N) High
(I) High
(F) High</td><td>(N) High
(I) Moderate
(F) Low</td></tr>
<tr><td>Eggs and larvae[1]</td><td>(N) Low
(I) Low
(F) Low</td><td>(N) Low
(I) Low
(F) Low</td><td>(N) High
(I) Moderate
(F) Low</td><td>(N) Moderate
(I) Moderate
(F) Low</td></tr>
<tr><td>Fish weighing ≥2 grams[2,3]</td><td rowspan="2">—</td><td rowspan="2">—</td><td rowspan="2">—</td><td rowspan="2">—</td><td rowspan="2">150[4]</td></tr>
<tr><td>Fish weighing<2 grams[2,3]</td></tr>
</table>

Notes:
All thresholds are unweighted.
Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N – tens of meters), intermediate (I – hundreds of meters), and far (F – kilometers).
SPL – sound pressure level
1 Popper et al. (2014).
2 NMFS recommended criteria adopted from the Fisheries Hydroacoustic Working Group (FHWG 2008).
3 Stadler and Woodbury (2009)
4 Andersson et al. (2007), Mueller-Blenkle et al. (2010), Purser and Radford (2011), Wysocki et al. (2007)

4.6.2.3.1 Impact Pile Driving Noise

Atlantic Shores conducted site-specific acoustic propagation modeling assuming the maximum PDE to assess the potential risks to marine mammals from pile driving noise. This analysis can also be used to evaluate potential risks to finfish from pile driving noise during construction (see Appendix II-L). The model evaluated distances to NMFS thresholds based on a range of operational conditions (e.g., foundation type, hammer type, pile-driving schedule) as well as levels of potential noise attenuation (ranging from 0 to 15 dB) that could potentially be achieved through the application of industry standard noise abatement systems (NAS). For the exposure assessment conducted, the 10 dB attenuation level was conservatively chosen as the minimum sound reduction achievable with the application of a single NAS. The acoustic modeling maximum radial distances to regulatory thresholds results are provided in summary below (Table 4.6-12) and in detail in Appendix II-L.

Table 4.6-12 Maximum Radial Distance (km) to Thresholds for Fish Due to Impact Pile Driving of One 15 m Monopile with a 4,400 Kilojoule (kJ) Hammer with Varying Levels of Attenuation

Fish Group	Metric	Threshold	Distance From Pile To Threshold (km)			
Attenuation Level			0 dB	6 dB	10 dB	15 dB
Fish without a swim bladder (particle motion detection)[1]	Injury (L_{PK})	213	0.21	0.08	0.05	0.02
	Injury (L_E)	216	1.45	0.64	0.34	0.15
	TTS (L_E)	186	9.85	7.56	6.27	4.86
Fish with swim bladder not involved in hearing (particle motion detection) [1]	Injury (L_{PK})	207	0.41	0.21	0.10	0.06
	Injury (L_E)	203	4.34	2.89	1.97	1.13
	TTS (L_E)	186	9.85	7.56	6.27	4.86
Fish with swim bladder involved in hearing (primarily sound pressure detection) [1]	Injury (L_{PK})	207	0.41	0.21	0.10	0.06
	Injury (L_E)	203	4.34	2.89	1.97	1.13
	TTS (L_E)	186	9.85	7.56	6.27	4.86
Fish weighing ≥2 grams[2,3,4]	Injury (L_{PK})	206	0.43	0.26	0.11	0.07
	Injury (L_E)	187	9.46	7.22	5.99	4.60
	Behaviour (L_P)	150	11.16	8.72	7.23	5.68
Fish weighing <2 grams[2,3,4]	Injury (L_{PK})	206	0.43	0.26	0.11	0.07
	Injury (L_E)	183	11.05	8.67	7.22	5.70
	Behaviour (L_P)	150	11.16	8.72	7.23	5.68

Notes:
All thresholds are unweighted.
L_{PK} – peak sound pressure (dB re 1 µPa).
L_E – sound exposure level (dB re 1 µPa²·s).
L_p – root mean square sound pressure (dB re 1 µPa).
TTS – temporary, recoverable hearing effects.
1 Popper et al. (2014).
2 NMFS recommended criteria adopted from the Fisheries Hydroacoustic Working Group (FHWG 2008).
3 Stadler and Woodbury (2009)
4 Andersson et al. (2007), Mueller-Blenkle et al. (2010), Purser and Radford (2011), Wysocki et al. (2007)

Based on the regulatory-defined thresholds for fish and the corresponding exposure ranges, and the intermittent nature of the sound source, effects on finfish and pelagic invertebrates from pile driving noise are expected to be localized and short-term. Therefore, the risk of noise-related impacts from pile driving is expected to be low. In addition, the most sensitive species will likely only be present in the WTA between fall and winter. By spring, all high-sensitive species discussed above, except for Atlantic cod, are expected to migrate inshore or southward, to spawn (NOAA 2020c; ASMFC 2020; Geo-Marine 2010).

Atlantic Shores is implementing measures to avoid Project-related impacts to finfish and invertebrates. In addition to continuing existing marine programs to study important habitats, key noise mitigation and monitoring strategies that will be implemented throughout all phases of the Projects include equipment operating procedures to protect or prevent finfish and invertebrate species from harmful underwater sound levels generated by pile driving. For example, noise abatement systems that reduce the likelihood for exposure to threshold sound levels arising from pile driving for marine mammals will also benefit other marine fauna, including finfish. Soft starts will be implemented for activities such as impact pile driving. Standard soft-start procedures are a "ramp-up" procedure whereby the sound source level is increased gradually before full use of power. In combination, these impact mitigation strategies are expected to minimize impacts to fish and invertebrates.

4.6.2.3.2 Other Noise Sources

There are several other potential anthropogenic sound sources associated with offshore Project construction, O&M, and decommissioning. These sources were not quantitatively modeled because the potential acoustic impact of these noise sources is expected to be much less than impulsive pile driving. A qualitative assessment of possible effects to finfish and pelagic invertebrates from other noise sources generated by Project activities, including HRG surveys, vessels, cable installation, vibratory pile driving during cofferdam installation (if needed), operational WTGs, operational offshore cables, and decommissioning is summarized in this section.

As detailed in Sections 4.5.3 and 4.5.9 of Volume I, HRG surveys may be conducted to support pre-construction site clearance activities as well as post construction facilities surveys. The HRG survey equipment used for this type of survey work would be the same or similar to the equipment deployed during Atlantic Shores' 2019-2021 site characterization surveys including multibeam echosounders, side scan sonars, sub-bottom profilers, and high-resolution seismic equipment. Of this equipment, sub-bottom profilers and high-resolution seismic equipment emit acoustic signals vertically downwards into the water column, some of which will penetrate the seabed. Studies of stronger HRG survey equipment (not being deployed by Atlantic Shores, e.g., seismic airguns), have shown mortality is very unlikely; however, behavioral responses have been observed in fish exposed to airgun sound levels exceeding 147–151 sound pressure level (SPL) (Fewtrell and McCauley 2012) and some HRG active acoustic sound sources can produce these sound levels within tens to a few hundred meters of the source (Halvorsen and Heaney 2018). Based on the variable responses observed in studies used to establish threshold levels of sound for impulsive sources (see Table 4.6-10), finfish would be expected to either vacate the survey area, experience short-term TTS and/or masking of biologically relevant sounds, show no visible effects, or be completely unaffected. Given the results of these studies, the mobile and intermittent nature of HRG surveys, the short-term and infrequent nature of surveying small areas of the seafloor relative to the overall area, and the likelihood that finfish will move away from the sound source, noise from HRG surveys is not expected to pose a risk to finfish or pelagic invertebrates.

Vessel noise includes non-impulsive sounds that arise from vessel engines, propellers, and thrusters. Sound levels emitted from vessels depend on the vessel's operational state (e.g., idling, in transit) and are strongly weather dependent. Zykov et al. (2013) and McPherson et al. (2019) report a maximum broadband source level of 192 dB re 1 µPa for numerous vessels with varying propulsion power. The characteristics of these noises are described in more detail in Appendix II-L. Noise from Project vessels is likely to be similar in frequency characteristics and sound levels to existing commercial vessel traffic in the region. Given the rapid attenuation of underwater vibrations with increasing distance from a sound source (Morley et al. 2014), it is unlikely that these stimuli will cause more than short-term behavioral effects (e.g., flight or retraction) or physiological (e.g., stress) responses. Overall, impacts to finfish and pelagic invertebrates from vessel noise are expected to be short-term and localized and are not anticipated to pose a risk to these resources.

Noise impacts from cable installation activities (e.g., from sand bedform removal [if needed], jet trenching, plowing/jet plowing, mechanical trenching) are expected to be similar to those described for vessel noise. A detailed modeling and measurement study conducted for construction activities associated with cable installations concluded that underwater sound generated by cable laying vessels was similar to that of other vessels already operating in the area and no significant acoustic impacts were identified (JASCO 2006). Therefore noise associated with cable laying activities is not expected to pose a risk to finfish or pelagic invertebrates.

As part of the export cable landing, temporary cofferdams may be constructed at two locations using non-impulsive vibratory pile driving to install and remove steel sheet piles. A total of 8 cofferdams, four at each of the landfall sites, may be constructed and dismantled using vibratory driving of steel sheet piles. Compared to noise generated from impulsive pile driving, non-impulsive vibratory pile installation typically produces lower amplitude sounds in the marine environment (Rausche and Beim 2012). Received peak sound pressure levels (PK) and sound exposure levels (SEL) near impact pile driving can exceed 200 dB, while studies of vibratory pile driving measured source levels ranging from 177 to 195 dB PK and 174.8 to 190.6 dB SEL (Hart Crowser and Illingworth and Rodkin 2009; Houghton et al. 2010). Suction bucket installation, which is also a non-impulsive pile installation method that may be used for OSS foundations, is also expected to result in lower peak pressure levels than impact pile driving. Exposure to vibratory hammer and suction bucket installation noise is unlikely to induce injury in EFH-designated fish or pelagic invertebrates because of its lower peak pressure levels and its relatively short duration.

During Project operation, WTGs will generate non-impulsive sound in the nacelle that will be transmitted down the WTG tower to the foundation and then radiated into the water. Underwater sound levels generated by an operational WTG are related to the WTG's power and wind speed, with increased wind speeds creating increased underwater sound (Wahlberg and Westerberg 2005). Under normal conditions, the sound level that results from WTG operation is of low intensity (Madsen et al. 2006), with energy concentrated at low frequencies (below a few kilohertz) (Tougaard et al. 2008). At high wind speeds, Wahlberg and Westerberg (2005) estimated permanent avoidance by fish would only occur within a range of 13 ft (4 m) to 820 ft (250 m) of a turbine. These findings were dependent on the number and size of windmills, wind speed, background noise level, hearing abilities of the fish, bathymetry, and seabed characteristics (Wahlberg and Westerberg 2005).

Pangerc et al. (2016) recorded SPL measurements at approximately 164 ft (50 m) from two individual 3.6 megawatt (MW) monopile wind turbines over a 21-day operating period. The sound pressure level increased with wind speed up to an average value of 128 dB re 1 µPa at a wind speed of about 10 meters per second (m/s), and then showed a general decrease. Additional studies conducted during operation of the Block Island Wind Farm measured sound levels below 120 dB SPL at wind speeds less than 13 m/s (HDR 2019). These sound levels are expected to be similar to those reported for cable laying/trenching and are well below existing non-impulsive acoustic thresholds for injury or behavioral response in fish (Table 4.6-12). Overall, current literature indicates sound generated from the operation of wind farms is of minor significance for fish (Wahlberg and Westerberg 2005, Stenberg et al. 2015). Therefore, the effects of WTG noise on finfish, while long-term, are not expected to be substantial and will not cause population-level effects.

High-voltage alternating current (HVAC) offshore cables are expected to produce non-impulsive low-frequency tonal vibration sound in the water. High voltage direct current (HVDC) cables do not produce a similar tonal sound because the current is not alternating. Low level tonal sound from an existing 138 kV transmission line buried up to 4 ft (1 m) was measured in Trincomali Channel, offshore Vancouver Island, British Columbia during a quiet period of recording. The SPL at approximately 328 ft (100 m) from the cable was below 80 dB. Assuming cylindrical spreading of sound, the source level of the submarine cable was approximately 100 dB SPL (JASCO 2006). Anticipated SPL arising from the vibration of AC cables during operation are significantly lower than SPL that may occur during cable installation (Meißner et al. 2006) and may be undetectable in the ambient soundscape of the WTA. Based on these studies, no effects to finfish or pelagic invertebrates are expected from low-frequency tonal vibration sound emitted during cable operation.

Sounds associated with decommissioning are reasonably assumed to be similar to, or less than, those produced during either the construction or O&M phases of the Projects. The methods used to decommission and remove the Projects' foundations will depend on the type of foundation (see Section 6.2.3 of Volume I); therefore, the level and duration of sounds emitted during decommissioning will depend on the type (e.g., gravity versus piled foundation), size, and location of the foundation. Piled foundations, if used, will be cut below the mudline, likely using underwater acetylene cutting torches, mechanical cutting, and/or a high-pressure water jet. Mechanical cutting tools and high-pressure water jetting will generate non-impulsive broadband sound (Topham and McMillan 2017). Regardless of the foundation type used, removal and transport of Project components (e.g., foundations, WTGs, OSSs, etc.), will require the use of vessels, which will also generate non-impulsive sound. Potential impacts to finfish and pelagic invertebrates, including EFH species, from sound generated during decommissioning activities are expected to be similar or less than those produced during the construction or O&M phases of the Projects.

The risk of noise-related impacts from other sound sources to finfish, pelagic invertebrates, and EFH species due to noise exposure and associated behavioral responses are expected to be very low. The mitigation measures that will be implemented for both marine mammals and sea turtles (see Sections 4.7 Marine Mammals and 4.8 Sea Turtles), including noise abatement systems and soft starts, are expected to minimize any sound-related impacts during all phases of the Projects.

4.6.2.4 Electromagnetic Fields

This section addresses electromagnetic fields (EMF) generated during operation of the Projects and the localized effects on finfish and pelagic invertebrate resources. EMFs are invisible areas of electric and magnetic energy that occur both naturally and anthropogenically in the marine environment. Atlantic Shores conducted an EMF study to predict EMF levels from operation of the Projects' submarine electrical system which includes a combination of HVDC and HVAC cables and OSSs (see Appendix II-I). The modeling results show that EMF levels are predicted to decrease exponentially with increasing distance from the cables and are therefore expected to cause minimal risk to finfish or pelagic invertebrates.

Within the Offshore Project Area, the only groups of finfish anticipated to be electrosensitive are elasmobranchs (i.e., sharks, skates, rays, and ratfishes), lampreys, and sturgeon. Studies have shown that these groups detect changes in electric fields using ampullary receptors for the purposes of prey and predator detection and navigation (CSA Ocean Sciences Inc. and Exponent 2019; Normandeau et al. 2011). However, due to cable configuration and shielding, electric fields will not be released into the marine environment from Project cable operation, and therefore were not modeled in Appendix II-I and are not further discussed in this section.

Magnetic fields will however be generated by the offshore cable system, which includes HVAC and HVDC export cables, HVAC inter-link cables, and HVAC inter-array cables. Multiple theories have been proposed for finfish detection of magnetic fields. The most supported theory proposes the use of a magnetite-based system which involves the presence of magnetic crystals (magnetite) that can detect differences in magnetic fields (CSA Ocean Sciences, Inc. and Exponent 2019; Normandeau et al. 2011). Researchers believe magnetosensitive species use magnetic fields for migration, navigation, and to locate food, habitat, and spawning grounds (CSA Ocean Sciences, Inc. and Exponent 2019). Magnetosensitivity has been observed in elasmobranchs and select bonyfish, including species of commercial and recreational importance that could be present in the Offshore Project Area. Such species include, but are not limited to American eel, blacktip shark (*Carcharhinus limbatus*), blue shark (*Prionace glauca*), clearnose skate, common thresher shark, cownose ray, little skate, porbeagle shark (*Lamna nasus*), shortfin mako (*Isurus oxyrinchus*), smooth dogfish, spiny dogfish, and tiger shark (*Galeocerdo cuvier*) (CSA Ocean Science Inc. and Exponent 2019). Other finfish and pelagic invertebrate species of commercial or recreational value in the Offshore Project Area (e.g., flounder species, longfin squid, spot (*Leiostomus xanthurus)*, scup, bluefish, hake species, black sea bass) likely lack the physiological components necessary to detect electric and magnetic fields and therefore are not expected to be adversely affected by EMF outputs from Project HVAC and HVDC export cables, HVAC inter-link cables, and HVAC inter-array cables.

Well-established magnetic field thresholds are lacking for finfish; however, research suggests that fish may be more likely to detect magnetic fields from DC sources than AC sources (Normandeau et al. 2011). Magnetic fields generated from HVAC and HVDC export cables, HVAC inter-link cables, and HVAC inter-array cables used for the Projects will be minimized by cable burial (between approximately 5 to 6.6 ft [1.5 to 2 m]) and armoring (see Section 4.5.1 of Volume I), which will minimize potential impacts to demersal and pelagic species. Table 4.6-13 summarizes the modeled peak magnetic field production anticipated for Project HVAC and HVDC export cables and HVAC inter-array cables under maximum power generation scenarios for cable crossing and normal conditions. Model results also showed that magnetic fields produced by HVAC and HVDC export cables and HVAC inter-array cables decrease exponentially with increasing horizontal and vertical distance (see Appendix II-I).

Table 4.6-13 Peak Magnetic Fields Modeled under Maximum Power Generation for the Atlantic Shores Export and Inter-Array Cables

Cable Type	Peak Magnetic Field (mG) for Maximum Modeled Case
HVAC[1]	
Export Cable	107.82
Export Cable (at cable crossing)	244.42
Inter-array Cable	60.07
HVDC	
Export Cable	152.68
Export Cable (at cable crossing)	349.22

[1] HVAC inter-link cables are part of the larger OSS electrical system, and were not analyzed as isolated, individual cables. However, due to the configuration of the inter-link cables, they are expected to operate in a similar fashion as either HVAC export cables or the inter-array cables.

Biologically significant impacts to finfish, pelagic invertebrates, and EFH species have not been documented for EMF generated from AC cables (BOEM 2020). Multiple studies provide evidence that fish are unlikely to detect high frequency fields (e.g., 60 hertz [Hz]) produced by AC cables (CSA Ocean Sciences Inc. and Exponent 2019; Normandeau et al. 2011). Laboratory studies examining frequency impacts from an AC source on skates found decreasing sensitivity as frequencies incrementally increased above 1 Hz (CSA Ocean Sciences Inc. and Exponent 2019). Researchers also believe that marine species with magnetite-based systems may not be able to detect magnetic fields below 50 milligauss (mG) from a high frequency (e.g., 50 or 60 Hz) AC source (Normandeau et al. 2011). Modeling of the Atlantic Shores' HVAC export and inter-array cables, which will operate at 60 Hz, predict magnetic fields ranging from 60.07 to 244.42 mG at the cable centerline. However, the field is predicted to drop to approximately 50 mG between 5.4 and 8.4 ft (1.6 to 2.6 m) in horizontal distance from the HVAC export cables and between 1.7 and 2.8 ft (0.52 to 0.85 m) in horizontal distance from the inter-array cables. Additionally, magnetic field strength will drop to approximately 50 mG between 3.0 and 5.0 ft (0.91 and 1.5 m) in vertical distance from HVAC export cables and 0.61 ft (0.19 m) in vertical distance from inter-array cables. Since the HVAC export and inter-array cables will operate at 60 Hz, and the magnetic fields are predicted to drop to approximately 50 mG at a maximum horizontal distance of 8.4 ft (2.6 m) and a maximum vertical distance of 5.0 ft (1.5 m), it can reasonably be assumed that magnetic fields produced by Project HVAC offshore cables will result in minimal impacts to fish and pelagic invertebrate species in the Offshore Project Area.

It is likely that fish and pelagic invertebrates potentially present in the immediate vicinity of the HVAC and inter-array cables, where modeled magnetic levels are larger than 50 mG, may not experience effects. Studies on bamboo sharks, a small shark in the same family as dogfish (Scyliorhinidae), observed no impacts to behavior when exposed to magnetic field strengths of 14,300 mG from a 50 Hz AC source (CSA Ocean Sciences Inc. and Exponent 2019). Additional studies conducted on Atlantic salmon and American eel in the presence of a 950 mG magnetic field from a 50 Hz AC power source showed no impact on swimming behavior (CSA Ocean Sciences Inc. and Exponent 2019). Results of these studies provide evidence that magnetosensitive species may not be able to detect magnetic fields above 50 mG emitted from a high frequency AC source. Since magnetosensitive species have shown minimal effects in the presence of high magnetic field strengths emitted from high frequency AC sources, it can reasonably be assumed that other species in the Offshore Project Area which lack the physiological components to detect magnetic fields would not experience adverse impacts from magnetic fields produced by AC cable operation.

As previously stated, studies have shown finfish to be more sensitive to magnetic fields produced by DC cables than AC cables (Normandeau et al. 2011). Though thresholds have not been established for marine species in the presence of magnetic fields from a DC source, studies have aimed to determine potential impacts from such sources. Hutchison et al. (2018) examined behavioral impacts in little skates when exposed to a magnetic field of 655 mG from a DC cable. Results of this field study showed changes in behavior such as altered travel pattens and increased travel speed; however, the cable did not represent a barrier for crossing. Additional field studies observed migrating European eels (*Anguilla anguilla*) across a DC cable. While slower swimming speeds were observed when crossing the DC cable, the cable did not create a barrier to crossing or present any permanent obstacles to migrating adult eels or elvers (Normandeau et al. 2011). Woodruff et al. (2013) studied responses in the non-mangetosensitive Atlantic halibut (*Hippoglossus hippoglossus*) to graduated magnetic field strengths from a DC source ranging from

2,700 to 12,300 mG and found no significant changes in behavior. Given that the magnetic fields used in these studies far exceed the modeled magnetic fields from HVDC export cables for the Projects (see Table 4.6-13) and the results of those studies did not result in substantial effects to the subject species, impacts from the Projects' HVDC export cables are not expected to adversely affect fish behavior in the Offshore Project Area.

Demersal and benthic-oriented species that live on or close to the bottom have the greatest likelihood of encountering EMF from the Projects. Pelagic species that swim higher in the water column have a lower likelihood of encountering Project-generated EMF given the modeling results which showed an exponential decrease in magnetic fields with increasing vertical distance from the export or inter-array cable. CSA Ocean Sciences, Inc. and Exponent (2019) concluded that finfish species that are exposed to EMF from buried power cables may experience a behavioral effect during the time of exposure; however, most exposures would be short in duration (minutes, not hours) and the area affected would be small compared to surrounding available habitat for fish. Therefore, although magnetic fields would be present as long as the Projects are in operation, impacts from EMFs generated by Project offshore cables on finfish, pelagic invertebrates, and EFH species would be highly localized and would likely be biologically insignificant, a conclusion also reached by BOEM (2020).

4.6.2.5 Light

Artificial light can attract or deter certain finfish and invertebrates with reactions being highly species dependent. The amount of artificial Project lighting that would penetrate the sea surface is expected to be minimal and not likely to cause adverse effects to finfish or invertebrates, including EFH-designated species.

During construction, O&M, and decommissioning, vessels working or transiting during periods of darkness and fog will utilize navigational and deck lighting. During O&M, regardless of the foundation type selected, all WTG and OSS foundations will contain marine navigational lighting and marking in accordance with USCG and BOEM guidance. In addition to any required marine navigational lighting, some outdoor lighting on the OSS structures will be necessary for maintenance at night, which would be illuminated only when the OSS is manned.

Artificial light has the potential to cause behavioral reactions in finfish or pelagic invertebrates such as attraction or avoidance in a highly localized area. Artificial light could also disrupt diel vertical migration patterns in some fish and potentially increase the risk of predation or disrupt predator/prey interactions (Orr 2013; BOEM 2020). Artificial light generated from Project vessels used during construction, O&M, and decommissioning would be more intense from downward directed deck lighting compared to navigational lights. However, potential impacts from vessel lights will be transient and will only occur in a limited and localized area relative to surrounding unlit areas. Therefore, no substantial impacts to finfish or pelagic invertebrates are expected from vessel and deck lighting. The navigation lighting on the WTG and OSS structures during O&M is also not expected to substantially impact finfish or pelagic invertebrates since it is not downward-focused and the amount of light penetrating the sea surface is expected to be minimal (BOEM 2020).

4.6.2.6 Presence of Structures and Cables

The seafloor of the Offshore Project Area is predominately comprised of flat, sandy habitat with ripples, sandwaves, and textured seafloor inhabited by both demersal and pelagic species. Introduction of new foundations, scour protection, offshore cables, and offshore cable protection introduces habitat complexity and diversity in a largely homogenous environment. Within the Offshore Project Area, the presence of foundations, cable protection, and scour protection may result in habitat conversion/creation, increased food availability, localized hydrodynamic alterations, and species attraction. This section addresses the potential effects that the presence of structures and cables in the Offshore Project Area may have on finfish and pelagic invertebrate resources and EFH.

The presence of foundations and scour protection will result in localized habitat conversion of any sandy, soft bottom habitat to a coarser, complex habitat. The maximum total area of permanent seafloor disturbance in the WTA, using the foundation type with the maximum footprint, is 1.01 mi^2 (2.60 km^2) (Table 4.6-7), which represents approximately 0.6% of the 160 mi^2 (413 km^2) WTA area. The maximum total area of permanent seafloor disturbance in the Project 1 and Project 2 WTA is 0.57 mi^2 (1.5 km^2) and 0.49 mi^2 (1.25 km^2), respectively. The maximum total permanent seafloor disturbance in the Atlantic and Monmouth ECCs from the placement of cable protection is 0.06 mi^2 (0.16 km^2) and 0.32 mi^2 (0.83 km^2), respectively (Table 4.6-7). The combined permanent seafloor disturbance for the Atlantic and Monmouth ECCs represents 0.8% of the total ECC area. This permanent habitat conversion of predominantly sandy benthic habitat to hard structure habitat will be localized and restricted to the foundation, cable protection, and scour protection footprints (ICF, 2020).

Even though the presence of foundations, cable and scour protection will eliminate a small percentage of flat sandy habitat in the Offshore Project Area, the Projects are expected to produce ecological benefits by creating new, diverse habitat for structure-oriented species (e.g., black sea bass, tautog, cunner). In two different wind farms, the Block Island Wind Farm off the coast of Rhode Island and the Horns Rev Wind Farm in the North Sea, abundance within soft-bottom communities largely remained the same between pre- and post-construction (ICF 2020). At the Block Island Wind Farm, abundance of small invertebrates (e.g., nematodes and polychaetes) in existing soft-bottom benthic communities increased after construction around some WTGs. The increase in smaller invertebrate species can lead to finfish attraction due to prey availability (ICF 2020).

Foundations can create a “reef effect”, providing ecological benefits and habitat diversity in the Mid-Atlantic Bight. Introduction of hard structures such as WTG, OSS, and meteorological (met) tower foundations and scour protection provide shelter and feeding opportunities as well as spawning and nursery grounds in an area that is largely comprised of flat, sandy habitat (ICF 2020). Leonhard et al. (2011) studied fish assemblages 1 year before and 8 years after the construction of the Horns Rev Wind Farm in the North Sea and observed an increase in species diversity close to WTGs, specifically in reef fishes (Leonhard et al. 2011). This increase in fish diversity may be attributed to the diversification of feeding opportunities by newly established epibenthic invertebrates (Leonhard et al. 2011). A visual transect study of two windfarms in the Baltic Sea observed higher fish abundance in the vicinity of the turbines, and at individual turbines when compared with the surrounding environment, indicating that turbine foundations may function as combined artificial reefs and fish aggregation devices for small demersal and semi-pelagic fish (Wilhelmsson et al. 2006). The same study observed the retreat of some species to the monopile foundation upon the introduction of disturbance, which could indicate that turbines provide a source of refuge (Wilhelmsson et al. 2006).

The presence of foundations and scour protection have the potential to provide supporting habitat for structure-oriented species (e.g., black sea bass, Atlantic cod, and tautog) that seasonally migrate from nearshore to offshore environments, a common phenomenon for species off the coast of New Jersey and within the Offshore Project Area (Steimle and Zetlin 2000; Causon and Gill 2018). Structures may also attract highly migratory species. However, limited evidence of this behavior in operating windfarms has been documented (ICF 2020). Studies have shown aggregations of highly migratory species, around oil platforms and artificial reefs. One study in the North Sea examined the presence of porbeagle sharks at an oil platform and found a minimum of 20 individuals aggregating around the structure at one time (Haugen and Papastamatiou 2019). In the United States, a study off the coast of North Carolina found a high presence of transient predator density (e.g., sand tiger shark and sandbar shark) around artificial reefs compared to natural reefs (Paxton et al. 2020). Similar aggregation of highly migratory species could occur at structures within the Offshore Project Area. Though foundations and cable protection could be utilized by migratory species for food and shelter, migration is largely driven by water temperatures and seasonality rather than the availability of resources (BOEM 2020). Therefore, any use of structures by migratory species is expected to be temporary, and the overall presence of foundations and cable protection is not expected to hinder migration patterns (BOEM 2020).

While the introduction of foundations and scour protection could result in increased fish abundance due to increased habitat diversity and foraging opportunities, there is the possibility that the new habitat could attract non-indigenous fish species (BOEM 2020). However, based on available literature, non-indigenous species observed at operating windfarms were primarily benthic invertebrate species (e.g., European green crab (*Carcinus maenus*), red rust bryozoan (*Watersipora subtorquata*)), not fish species. Therefore, it is unlikely that the presence of foundations and scour protection will result in the facilitation of non-indigenous fish species.

The presence of WTGs and other foundation structures in the WTA may affect currents and water movement within the WTA; however, effects are expected to be highly localized at the foundations. As water moving along a current approaches a turbine or foundation, it changes and accelerates around a structure, creating turbulence (ICF 2020). This phenomenon is known as the wake effect (ICF 2020). The magnitude of wake effect depends on the diameter of foundation structures, volume of impervious surface in the water column and seafloor, and current speed (ICF

2020; English et al. 2017). Wake effect from monopile foundations has been observed approximately 600 ft (200 m) down-current of the structures (English et al. 2017). During peak tidal movements, turbulent wakes have been observed as far as 1,312 ft (400 m) from the monopile (English et al. 2017). These localized wake effects could influence primary productivity and feeding efficiency of predators (ICF 2020, English et al. 2017; Vanhellemont and Ruddick 2014). Changes in turbulence around the foundations could result in increased food availability for plankton-consuming finfish and could result in fish aggregations (e.g., Atlantic silverside and Atlantic menhaden) (Andersson 2011, ICF 2020). Increased turbulence also has the potential to reduce visibility around the turbine which may reduce feeding efficiency of predators, thereby indirectly affecting the risk of predation on prey species (English et al. 2017, Vanhellemont and Ruddick 2014).

Monitoring the physical dynamics in the Mid-Atlantic Bight and Cold Pool are important to understanding how placement of wind turbines may affect ocean mixing and marine resources like fish and pelagic invertebrates. The formation and the nutrient fluxes of the Cold Pool are important to fish and their movement in the Mid-Atlantic Bight. The breakdown of the stratified Cold Pool is known to influence the timing of migration for species such as winter flounder (*Pseudopleuronectes americanus*), summer flounder (*Paralichthys dentatus*), black sea bass (*Centropristis striata*), and Atlantic butterfish (*Peprilus triacanthus*) (Kohut and Brodie 2019). Modeling studies, considering varying sizes of wind projects and technology, have indicated that wind turbines may cause atmospheric disturbances to near-surface winds that influence ocean mixing (Afsharian and Taylor 2019). The extent of changes to ocean mixing at local and regional, or mesoscale, scales is not well known and can vary widely in magnitude as local mixing is dependent on atmospheric forcing, daily heating and cooling, wind, changes in temperature and humidity associated with mesoscale weather, and other processes (Paskyabi et al. 2015). Measuring and predicting any possible effects to ocean mixing is highly dependent on the characteristics of the wind project (e.g., spacing between turbines, size of turbines) and the local and regional atmospheric and oceanographic conditions (Moum and Smyth 2019), including conditions of fish and fisheries in the local and regional areas.

Conditions and observations at local and regional scales are necessary to understand if effects to mixing may occur from the Projects and if so, whether those effects may influence the Cold Pool dynamics. Drawing early conclusions from European or modeling studies have inherent differences, as the Mid-Atlantic Bight has weaker tidal currents and more intense stratification than the North Sea and is different from other western boundary currents or mesoscale circulation features in European waters. It has been suggested that slower ocean velocities in the southern Mid-Atlantic Bight would result in significantly less mixing than has been found in Europe (Carpenter et al., 2016). European studies are more representative of Mid-Atlantic Bight conditions during weaker stratification. Therefore, it is not likely that structure-induced mixing would be sufficient to overcome intense summer stratification to influence the Cold Pool and cause broader ocean mixing (Miles et al., 2020). As a result, substantial impacts to the Cold Pool and ocean mixing from the presence of Project WTGs is not expected. However, considering the seasonal, annual, and longer scale changes in the Cold Pool and Mid-Atlantic Bight, Atlantic Shores is supportive of contributing to regional collaborative science to study and monitor the Cold Pool and its influence on benthic invertebrates, fish, and fisheries.

In 2019, Atlantic Shores, in collaboration with Rutgers University and MARACOOS, deployed a metocean buoy to contribute to the study of the Mid-Atlantic Cold Pool. This buoy contains sensors at the atmospheric-boundary layer and ocean floor that will allow for continuous measurements of the Cold Pool, as well as support regional oceanographic and atmospheric modeling efforts. The data collected by this buoy is publicly accessible and can be accessed through MARACOOS' data portal at https://ioos.noaa.gov/regions/maracoos. Once operational, the Projects will also represent a living laboratory as they provide abundant opportunities for direct ocean and ecological observations, such as the anticipated beneficial effects of introducing structure to a homogenous sandy sea floor.

As stated, the presence of foundations and cable and scour protection could create a range of effects to finfish, invertebrates, and EFH species during the O&M phase of the Projects. Foundations and cable and scour protection are expected to produce ecologically beneficial effects that could outweigh the risk of introducing hard structure to a small area of the vast flat, sandy habitat found in the Mid-Atlantic Bight. Once the Projects are decommissioned, the local environmental and ecological features of the area are expected to revert to pre-construction conditions. Potential impacts from decommissioning include the loss of Project-related hard structures, which are expected to be colonized at the time of decommissioning. Reef or structure-oriented finfish will be displaced during decommissioning as the foundations and scour protection are removed.

4.6.2.7 Monitoring Surveys

Atlantic Shores will implement its Fisheries Monitoring Plan (Appendix II-K) and Benthic Monitoring Plan (Appendix II-H) to monitor baseline environmental conditions relevant to fisheries and benthic resources and how these conditions may change throughout Project construction and operation. Proposed fisheries surveys include a demersal otter trawl survey, fish trap survey, and hydraulic clam dredge survey. Proposed benthic surveys include the use of benthic grab samplers, multibeam echosounders, and underwater video.

The use of survey equipment such as the demersal otter trawl, hydraulic clam dredge, fish trap, and grab sampler may result in impacts to finfish and invertebrate species as this equipment causes seabed disturbance. The benthic grab sampler is expected to cause only localized impacts at the sample locations within the WTA and ECC. Similarly, the trap survey equipment is expected to cause localized impacts at the sampling sites within the WTA. The fisheries surveys using towed gear (demersal otter trawl and hydraulic clam dredge) would disturb benthic habitat and fauna in the areas of the survey strata. As discussed in Section 4.5, while sessile species and life stages in the surveyed areas may be subject to injury or mortality, the benthic community is expected to recover and benthic infauna and epifauna are expected to recolonize the area after physical disturbance from anthropogenic activities cease in a given location (Brooks et al. 2006; Guarinello et al. 2017; Guida et al. 2017). Soft bottom habitat and communities may recover more quickly from disturbances than hard-substrate/complex habitat. Additionally, the area of disturbance from monitoring surveys is small relative to the total area of available surrounding habitat.

4.6.2.8 Vessel Movement

Vessel movement to and from ports during the construction, operations and maintenance, and decommissioning phases of the Project have the potential to impact threatened and endangered species that may occur in the Offshore Project Area; specifically, the Atlantic sturgeon and giant manta ray. During construction and operation, Project vessels may use the Portsmouth Marine Terminal in Norfolk, Virginia, near the James River where migrating adult Atlantic sturgeon are known to occur (Balazik et al. 2020). Project vessels will also be transiting through the Delaware River, where both Atlantic and shortnose sturgeon can occur. Giant manta ray may also occur around the Offshore Project Area on a transitory basis and may be vulnerable to vessel strikes. The increase in Project-related vessel traffic in these areas may lead to a minor increase in the risk of vessel strikes on these species.

Vessel movement during all phases of the Project may also impact threatened and endangered species outside of the Offshore Project Area. Ports under consideration for use by the Project include three in New Jersey, one in Viriginia, and one in Texas, in addition to existing ports for O&M and other support minor services. Threatened and endangered species that may be encountered during vessel traffic transiting from ports include endangered smalltooth sawfish, threatened gulf sturgeon, threatened Nassau grouper, and threatened scalloped hammerhead shark. However, interactions between transiting vessels and these species are expected to be minimal and brief in duration, given that vessels will be moving from one point to another and not performing any Project-related construction in waters outside the Offshore Project Area. Additionally, given that these ports are utilized by many large vessels, Project-related vessels are not expected to significantly increase the potential for interactions with listed species beyond existing traffic conditions.

4.6.2.9 Summary of Proposed Environmental Protection Measures

The majority of potential effects to finfish, invertebrates and EFH are expected to be temporary and localized as described in the previous sections. Many of the permanent effects from the presence of structures, including cable and scour protection, are expected to be ecologically beneficial. Atlantic Shores has extensively studied the benthic habitat in the Offshore Project Area and has already taken precautionary steps and commitments to avoid, mitigate, and monitor Project effects on finfish, invertebrates and EFH during construction, O&M, and decommissioning. Additional avoidance and mitigation measures and tools will be evaluated further as the Projects progress through development and permitting and in cooperation and coordination with Federal and State jurisdictional agencies and other stakeholders. The following provides a summary of proposed environmental protection measures that Atlantic Shores will implement to reduce impacts to finfish, invertebrates, and EFH within the Offshore Project Area.

- Comprehensive benthic habitat surveys (seafloor sampling, imaging, and mapping) have been conducted in consultation with BOEM and NOAA to support the identification of sensitive and complex habitats and the development of strategies for minimizing impacts to identified areas to the maximum extent practicable.
- HDD will be used to avoid seabed disturbance impacts to benthic habitat at the landfall sites. All HDD activities will be managed by an HDD Contingency Plan for the Inadvertent Releases of Drilling Fluid to ensure the protection of marine and inland surface waters from an accidental release of drilling fluid. All drilling fluids will be collected and recycled upon HDD completion.
- Inter-array, inter-link, and export cables will be buried to a target depth of 5 to 6.6 ft (1.5 to 2 m) which will allow the benthic community to recover and recolonize, avoid direct interaction with finfish and benthic invertebrates, and minimize impacts from EMF.
- Dynamically positioned vessels and jet plow embedment will be used to the maximum extent practicable to reduce sediment disturbance during cable laying processes.
- Vessels will operate in compliance with regulatory requirements related to the prevention and control of discharges and accidental spills.
- Accidental spill or release of oils or other hazardous materials will be managed through the OSRP (see Appendix I-D).
- Anchor midline buoys will be used on anchored construction vessels, where feasible, to minimize seabed disturbance.
- An anchoring plan will be employed for areas where anchoring is required to avoid impacts to sensitive habitats to the maximum extent practicable, including hard bottom and structurally complex habitats, identified through the interpretation of site-specific HRG and benthic assessments.
- Soft starts and gradual "ramp-up" procedures (i.e., gradually increase sound output levels) will be employed for activities such as pile driving to allow mobile individuals to vacate the area during noise-generating activities.
- During impact pile-driving, a noise abatement system consisting of one or more available technologies (e.g., bubble curtains evacuated sleeve systems, encapsulated bubble systems, Helmholtz resonators) will be implemented to decrease the propagation of potentially harmful noise.
- Nearshore cable installation activities will be conducted outside of the anticipated peak period of sandbar shark nursery and pupping activity between June 1st and September 1st.
- A fisheries monitoring plan will be implemented to monitor baseline environmental conditions relevant to fisheries and how these conditions may change throughout Project construction and operation. Proposed fisheries surveys detailed in the Fisheries Monitoring Plan (see Appendix II-K) include a demersal fish trawl survey, fish pot survey, and clam dredge survey.

- Atlantic Shores will implement the following measures in accordance with the Offshore Renewable Energy Credit (OREC) allowance that the New Jersey Board of Public Utilities (NJBPU) awarded to Atlantic Shores on June 30, 2021:
  - Maintain and update the Environmental Protection Plan (EPP) and Fisheries Protection Plan (FPP) at key Project milestones, including commencement of construction, completion of construction, and every 2 years thereafter, through decommissioning, or at other times as requested by NJDEP to ensure that impacts are being actively monitored and mitigated.
  - Update the EPP and FPP to ensure New Jersey's natural resources, including finfish and shellfish, sea turtles, marine mammals, avian species, bats and benthic populations are protected throughout the life of the Project from pre-construction through decommissioning and to ensure that any impacts are being actively monitored and mitigated as required by law.
  - Provide funding to the State of New Jersey for research initiatives and the regional monitoring of wildlife and fisheries related to the introduction of offshore wind projects. The funding will be administered by the New Jersey Department of Environmental Protection (NJDEP) and NJBPU, with stakeholder input to aid in the identification and prioritization of regional research and monitoring needs.
  - Report annually in writing to BPU and NJDEP beginning June 30, 2022, on actions taken to ensure environmental protection, fisheries protection, mitigation of environmental and/or fishing impacts. This report will specifically address how Atlantic Shores is enacting its plans for environmental and fisheries protection and mitigation of impacts as articulated in its Application to BPU. An appendix to the report will indicate the data collected in the reporting period, and will include an accessibly-written, narrative description(s) of the dataset(s), the associated findings made based upon these data, and reference(s) to the data portal(s) where these data can be publicly accessed. This appendix will be made public..
  - Report annually in writing to BPU and NJDEP beginning June 30, 2022, on the policies and programs that may be adopted by BPU or NJDEP to help reduce future environmental or fisheries impacts or enhance the protection of natural resources. This report will detail any proposed future mitigation or protection measures that could be adopted, providing a description, proposed timeline, and expected outcomes of the recommended action.

Make public through appropriate data portals, all data collected in the development of the Project from pre-construction activities through decommissioning activities. All collected information and scientific data not deemed confidential by statute or regulation will be made publicly available. Specifically, data with particular emphasis on natural resources including, but not limited to, finfish and shellfish, sea turtles, marine mammals, avian species, bat and benthic populations, as well as data regarding vessel strikes, avoidance, observations on habitat, and routine data collection on ocean conditions will be shared in a manner that is in keeping with best practices for the reporting of these types of data. Atlantic Shores will report annually to BPU and NJDEP beginning June 30, 2022, describing the type of data shared, and where the data is shared. Should a common database for New Jersey-related, scientific data generated in association with offshore wind development be created, Atlantic Shores will archive all data collected with the development of the Project in that data repositor.

4.7 Marine Mammals

This section describes marine mammals that may be present in the Offshore Project Area, associated impact producing factors (IPFs), and anticipated measures to avoid, minimize, or mitigate potential impacts to marine mammals during construction, operations and maintenance (O&M), and decommissioning (See Appendix II-L3). Marine mammals are charismatic and important species to any marine ecosystem, occupying many ecological roles in the world's oceans, including predators, prey, and nutrient vectors (e.g., whale falls; Roman et al. 2014). Whales also enhance primary productivity in their feeding areas by concentrating nitrogen at the surface (Roman and McCarthy 2010), and have even been identified as important for both the storage and transfer of carbon (Pershing et al. 2010). All marine mammals are protected under the Marine Mammal Protection Act (MMPA), and some species (e.g., North Atlantic right whale [NARW]) are protected under the Endangered Species Act (ESA). Given these statutory protections, marine mammals are a biological resource that must be considered in environmental and acoustic impact assessments for offshore wind development.

Atlantic Shores is conducting an assessment that considers how the Projects' activities may affect marine mammals in the Offshore Project Area based on marine mammal distributions in the larger context of the Mid-Atlantic Bight. The wide distribution of marine mammals is influenced by oceanographic features in the Mid-Atlantic Bight, while small-scale distributions are influenced by factors such as the animal's physiology, behavior, and ecology (Waring et al. 2009). Because of these different distribution drivers, Atlantic Shores' marine mammal assessment builds upon and fills data gaps from previously completed Federally and State funded research efforts. Relevant studies, both completed and ongoing, have provided data to inform which species occupy these habitats by conducting state-of-the-art underwater acoustic modeling; animal movement and exposure modeling; and aerial digital surveys to document wildlife usage of the Offshore Project Area.

4.7.1 Affected Environment

The marine mammal species that occur in the Offshore Project Area during construction, O&M, or decommissioning may experience certain effects of Project activities. Descriptions of the marine mammal species, their distribution and abundance, and estimated densities in the vicinity of the Offshore Project Area are based on reviews of existing technical reports, academic publications, and public reports (e.g., press releases), where relevant, to describe recent events not yet published. Examples of primary data sources referenced in this assessment include the following:

- Marine Mammal Stock Assessment Reports and Potential Biological Removal (PBR) Levels (Hayes et al. 2017, 2018a, 2019, 2020, 2021)
- Ocean Wind Power Ecological Baseline Studies conducted for the New Jersey Department of Environmental Protection (NJDEP) Office of Science by the Geo-Marine, Inc. (Geo-Marine 2010)

- NOAA Northeast Fisheries Science Center's (NEFSC's) Atlantic Marine Assessment Program for Protected Species (AMAPPS)
    - Phase I surveys conducted from 2010 to 2014 (NEFSC and SEFSC 2011a, 2011b, 2012, 2014a, 2014b)
    - Phase II surveys from 2015 to 2019 (NEFSC and SEFSC 2015, 2016, 2018, 2019),
- Duke University Habitat-based Cetacean Density Models (Roberts et al. 2015, 2016a, 2016b, 2017, 2018, 2020) that combine data from 15 aerial and shipboard surveys covering 556,127 mile (mi) (895,000 kilometers [km]) of track line in the Western Atlantic over 22 years from 1992 to 2014.

In addition to these sources of information, Atlantic Shores is conducted aerial digital surveys of the Offshore Project Area. The results of these surveys and a detailed technical report are provided in Appendix II-L2 - Marine Mammal and Sea Turtle Presence in Atlantic Shores Lease Area OCS-A 0499. Atlantic Shores has also completed an underwater acoustic and animal exposure modeling analysis for impact pile-driving sound based on the maximum Project Design Envelope (PDE). The results of this analysis and its potential effects on marine mammals are discussed in Section 4.7.2.2. The complete, Underwater Acoustic and Animal Exposure Modeling Technical Report (Modeling Report) as provided within the original COP submittal, is provided as Appendix II-L1 to this COP.

4.7.1.1 Marine Mammal Species

There are 37 marine mammal species, comprising 38 stocks, that are known to be present either seasonally or year-round in the Northwest Atlantic Outer Continental Shelf (OCS; Table 4.7-1). Marine mammals present in this region are represented by the Cetacea order, which includes seven mysticetes (baleen whales) and 26 odontocetes (toothed whales, dolphins, and porpoise), and the Pinnipedia order, which includes four species of phocids (earless seals). Baleen whales (other than Bryde's whale) migrate seasonally between cold high-latitude feeding grounds in summer and warm low-latitude breeding/nursery grounds in winter, rarely spending extended time in a single area. Odontocetes, or toothed whales, occupy coastal, shelf, and slope/deep water habitats inclusive, and further offshore, of the Mid-Atlantic Bight. Most toothed whale species do not undergo long-range seasonal migrations, instead moving between southern and northern waters of the western North Atlantic or between shelf waters and deeper waters beyond the shelf break within a relatively regionalized area (Hayes et al. 2020). Phocid species of the western North Atlantic primarily occupy coastal and shelf habitats in the cooler waters north of Cape Cod, Massachusetts to eastern Canada and Maine throughout the year (Hayes et al. 2020). One species of sirenian, the Florida manatee (*Trichechus manatus latirostris*), is an occasional, and therefore rare, visitor to the region during summer (USFWS 2019). The manatee is listed as threatened under the ESA and is protected under the MMPA. It is the only marine mammal in the western North Atlantic under the regulatory jurisdiction of the U.S. Fish and Wildlife Service (USFWS).

Table 4.7-1 provides a list of the 37 marine mammal species present in the OCS and their relative occurrence in the Project Area. Species categories for relative occurrence include:

- Common – Occurring consistently in moderate to large numbers.
- Regular – Occurring in low to moderate numbers on a regular basis or seasonally.
- Uncommon – Occurring in low numbers or on an irregular basis.
- Rare – There are limited species records for some years; range includes the Mid-Atlantic Bight but due to habitat preferences and distribution information, species are not expected to occur in the Mid-Atlantic Bight.

The protection status, stock identification, occurrence, and abundance estimate of the species listed in Table 4.7-1 and categorized as common, regular, and uncommon, are discussed in more detail. Uncommon species for the Offshore Project Area include sperm whales, Risso's dolphins, pilot whales, and Atlantic white-sided dolphins. There were no sperm whales, Risso's dolphins, pilot whales or Atlantic white-sided dolphin sightings during the New Jersey Ecological Baseline Studies conducted by Geo-Marine (2010); however, these species are discussed in this section because they are expected to be seasonal visitors off of New Jersey based on historic occurrence data (Roberts et al. 2018). Species listed as rare are not considered further in this assessment.

Table 4.7-1 Marine Mammal Species in the Mid- and North Atlantic Outer Continental Shelf

Species	Scientific Name	Stock	Abundance[1]	Status Under MMPA	Status Under ESA	Relative Occurrence in Project Region	Typical Habitat[6]		
							Coastal	Shelf	Slope/ Deep
Baleen Whales (*Mysticeti*)									
Fin Whale	*Balaenoptera physalus*	W. North Atlantic	6,802	Strategic	Endangered	Common	X	X	X
Humpback Whale	*Megaptera novaeangliae*	Gulf of Maine	1,396	Non-strategic	Not listed	Common	X	X	X
Minke Whale	*Balaenoptera acutorostrata*	Canadian East Coast	21,968	Non-strategic	Not listed	Common	X	X	X
North Atlantic Right Whale	*Eubalaena glacialis*	W. North Atlantic	368[2]	Strategic	Endangered	Common	X	X	X
Sei Whale	*Balaenoptera borealis*	Nova Scotia	6,292	Strategic	Endangered	Common		X	X
Blue Whale	*Balaenoptera musculus*	W. North Atlantic	402[3]	Strategic	Endangered	Rare		X	X

Table 4.7-1 Marine Mammal Species in the Mid- and North Atlantic Outer Continental Shelf (Continued)

Species	Scientific Name	Stock	Best Population Estimate[1]	Status Under MMPA	Status Under ESA	Relative Occurrence in Project Region	Typical Habitat[6]		
							Coastal	Shelf	Slope/ Deep
Toothed Whales (*Odontoceti*)									
Atlantic White-Sided Dolphin	*Lagenorhynchus acutus*	W. North Atlantic	93,233	Non-strategic	Not listed	Common		X	X
Common Bottlenose dolphin	*Tursiops truncatus*	W. North Atlantic, offshore	62,851	Non-strategic	Not listed	Common		X	X
		W. North Atlantic, Northern Migratory Coastal	6,639	Non-strategic	Not listed	Common	X		
Harbor Porpoise	*Phocoena phocoena*	Gulf of Maine/Bay of Fundy	95,543	Non-strategic	Not listed	Common	X	X	
Long-Finned Pilot Whale	*Globicephala melas*	W. North Atlantic	39,215	Non-strategic	Not listed	Uncommon		X	X
Risso's Dolphin	*Grampus griseus*	W. North Atlantic	35,215	Non-strategic	Not listed	Uncommon			X
Short Beaked Common Dolphin	*Delphinus delphis*	W. North Atlantic	172,974	Non-strategic	Not listed	Common		X	X

Table 4.7-1 Marine Mammal Species in the Mid- and North Atlantic Outer Continental Shelf (Continued)

Species	Scientific Name	Stock	Best Population Estimate[1]	Status Under MMPA	Status Under ESA	Relative Occurrence in Project Region	Typical Habitat[6]		
							Coastal	Shelf	Slope/ Deep
Atlantic Spotted Dolphin	*Stenella frontalis*	W. North Atlantic	39,921	Non-strategic	Not listed	Uncommon			X
Blainville's Beaked Whale	*Mesoplodon densirostris*	W. North Atlantic	10,107[4]	Non-strategic	Not listed	Rare			X
Cuvier's Beaked Whale	*Ziphius cavirostris*	W. North Atlantic	5,744[4]	Non-strategic	Not listed	Rare			X
Dwarf Sperm Whale	*Kogia sima*	W. North Atlantic	7,750[5]	Non-strategic	Not listed	Rare			X
False Killer Whale	*Pseudorca crassidens*	W. North Atlantic	1,791	Strategic	Not listed	Rare			X
Fraser's Dolphin	*Lagenodelphis hosei*	W. North Atlantic	Unknown	Non-strategic	Not listed	Rare			X
Pygmy Killer Whale	*Feresa attenuata*	W. North Atlantic	Unknown	Non-strategic	Not listed	Rare			X
Northern Bottlenose Whale	*Hyperodon ampullatus*	W. North Atlantic	Unknown	Non-strategic	Not listed	Rare			X
Gervais' Beaked Whale	*Mesoplodon europaeus*	W. North Atlantic	10,107[4]	Non-strategic	Not listed	Rare			X

Table 4.7-1 Marine Mammal Species in the Mid- and North Atlantic Outer Continental Shelf (Continued)

Species	Scientific Name	Stock	Best Population Estimate[1]	Status Under MMPA	Status Under ESA	Relative Occurrence in Project Region	Typical Habitat[6]		
							Coastal	Shelf	Slope/ Deep
Killer Whale	*Orcinus orca*	W. North Atlantic	Unknown	Non-strategic	Not listed	Rare		X	
Pan-Tropical Spotted Dolphin	*Stenella attenuata*	W. North Atlantic	6,593	Non-strategic	Not listed	Rare			X
Sperm whale	*Physeter macrocephalus*	North Atlantic	4,349	Strategic	Endangered	Uncommon			X
Pygmy Sperm Whale	*Kogia breviceps*	W. North Atlantic	7,750[5]	Non-strategic	Not listed	Rare			X
Rough-Toothed Dolphin	*Steno bredanesis*	W. North Atlantic	136	Non-strategic	Not listed	Rare		X	
Short-Finned Pilot Whale	*Globicephala macrorhynchus*	W. North Atlantic	28,924	Non-strategic	Not listed	Uncommon		X	X
Sowerby's Beaked Whale	*Mesoplodon bidens*	W. North Atlantic	10,107[4]	Non-strategic	Not listed	Rare			X
Spinner Dolphin	*Stenella longirostris*	W. North Atlantic	4,102	Non-strategic	Not listed	Rare			X
Striped Dolphin	*Stenella coeruleoalba*	W. North Atlantic	67,036	Non-strategic	Not listed	Rare			X
White-Beaked Dolphin	*Lagenorhynchus albirostris*	W. North Atlantic	536,016	Non-strategic	Not listed	Rare			X

Table 4.7-1 Marine Mammal Species in the Mid- and North Atlantic Outer Continental Shelf (Continued)

Species	Scientific Name	Stock	Best Population Estimate[1]	Status Under MMPA	Status Under ESA	Relative Occurrence in Project Region	Typical Habitat[5]		
							Coastal	Shelf	Slope/ Deep
True's Beaked Whale	*Mesoplodon mirus*	W. North Atlantic	10,107[4]	Non-strategic	Not listed	Rare			X
Clymene Dolphin	*Stenella clymene*	W. North Atlantic	4,237	Non-strategic	Not listed	Rare			X
Melon Headed Whale	*Peponocephala electra*	W. North Atlantic	Unknown	Non-strategic	Not listed	Rare			X
Earless Seals (*Phocidae*)									
Gray Seal	*Halichoerus grypus*	W. North Atlantic	27,300	Non-strategic	Not listed	Common	X	X	
Harbor Seal	*Phoca vitulina*	W. North Atlantic	61,336	Non-strategic	Not listed	Regular	X	X	
Hooded Seal	*Cystophora cristata*	W. North Atlantic	Unknown	Non-strategic	Not listed	Rare		X	X
Harp Seal	*Phoca groenlandica*	W. North Atlantic	7.6 M	Non-strategic	Not listed	Rare	X	X	
Sea Cows (Sirenians)									
Florida Manatee	*Trichechus manatus latriostris*	Florida	4,834	Strategic	Threatened				

[1] Best available population estimate is from NOAA Fisheries Stock Assessment Reports (NOAA Fisheries 2021b)..

[2] Best available population estimate is from NOAA Fisheries Stock Assessment Reports (NOAA Fisheries 2021b). NARW consortium has released the 2021 report card results predicting a NARW population of 336 for 2020 (Pettis et al. 2022). However, the consortium "alters" the methods of (Pace et al. 2017) to subtract additional mortality. This method is used in order to estimate all mortality, not just the observed mortality, therefore the 2021 draft SAR (NOAA Fisheries 2021b) will be used to report an unaltered output of the (Pace et al. 2017, 2021) model (DoC and NOAA 2020).

[3] Represents Northern minimum stock population size (Hayes et al. 2021).

[4] This estimate includes Gervais' beaked whales and Blainville's beaked whales for the Gulf of Mexico stocks, and all species of *Mesoplodon* undifferentiated beaked whales in the Atlantic.

[5] This estimate includes both dwarf and pygmy sperm whales.

[6] Coastal habitats are areas within State territorial waters; shelf habitats are those waters on the continental shelf; and slope/deep habitats are waters over the edge of the continental shelf where the sea floor deepens sharply (slope) and then generally flattens at great depths (deep).

4.7.1.2 Baleen Whales

Fin Whales (*Balaenoptera physalus*)

Fin whales are the second largest species of baleen whale that occur in the northern hemisphere, with a maximum length of about 75 feet (ft) (22.8 meters [m]) (NOAA Fisheries 2018b). These whales have a sleek, streamlined body with a V-shaped head that makes them fast swimmers. Fin whales have a distinctive coloration pattern: the dorsal and lateral sides of their bodies are black or dark brownish-gray while the ventral surface is white. The lower jaw is dark on the left side and white on the right side. Fin whales feed on krill (*Euphausiacea*), small schooling fish (e.g., herring [*Clupea harengus*], capelin [*Mallotus villosus*], sand lance [*Ammodytidae* spp.]), and squid (*Teuthida* spp.) by lunging into schools of prey with their mouths open (Kenney and Vigness-Raposa 2010). Fin whales are low-frequency cetaceans producing short duration down sweep calls between 15 and 30 hertz (Hz), typically termed "20-Hz pulses", as well as other signals up to 1 kilohertz (kHz) (Southall et al. 2019). The sound level (SL) of fin whale vocalizations can reach 186 decibels (dB) re 1 μPa, making them one of the most powerful biological sounds in the ocean (Charif et al. 2002).

Distribution

Fin whales found offshore of the U.S. Atlantic, Nova Scotia, and the southeastern coast of Newfoundland are believed to constitute a single stock under the present International Whaling Commission (IWC) management scheme (Donovan 1991), which has been named the Western North Atlantic stock. The current understanding of stock boundaries, however, remains uncertain (Hayes et al. 2019). The range of fin whales in the western North Atlantic extends from the Gulf of Mexico and Caribbean Sea to the southeastern coast of Newfoundland. Fin whales are common in waters of the U.S. Atlantic Exclusive Economic Zone (EEZ), principally from Cape Hatteras northward. There is evidence that fin whales are present year-round throughout much of the U.S. EEZ north of 35° N, but the density of individuals in any one area changes seasonally (NOAA Fisheries 2018b, Hayes et al. 2019) (Figure 4.7-1). Fin whales are the most commonly observed large whales in continental shelf waters from the Mid-Atlantic coast of the U.S. to Nova Scotia (Sergeant 1977, Sutcliffe and Brodie 1977, CeTAP 1982, Hain et al. 1992), and were the most common baleen whale species detected in an ecological baseline survey conducted in coastal New Jersey waters, which surveyed an area that encompassed 97% of the New Jersey Wind Energy Area (Geo-Marine 2010, BOEM 2012). Fin whales are the dominant large cetacean species during all seasons from Cape Hatteras to Nova Scotia, having the largest standing stock, the largest food requirements, and, therefore, the largest influence on ecosystem processes of any baleen whale species (Hain et al. 1992, Kenney et al. 1997).

Fin whales have a high multi-seasonal relative abundance in U.S. Mid-Atlantic waters, and surrounding areas (Figure 4.7-1). During the Geo-Marine (2010) survey, most of the sightings were observed during winter and summer. Within the study area, group size ranged from one to four animals with a mean distance from shore of 20 km and a mean water depth of 21.5 m (Geo-Marine 2010). One calf was observed with an adult fin whale in the area (Geo-Marine 2010). There were mixed aggregations of feeding humpbacks during fin whale sightings, and with the presence of known prey species, it is possible that fin whales use this area to feed (Geo-Marine 2010). Acoustic data also indicate that this species is present in the area in all seasons (CETAP 1982). Fin whales were the most common marine mammal species detected acoustically during the study (Geo-Marine 2010).

While fin whales typically feed in the Gulf of Maine and the waters surrounding New England, their mating and calving (and general wintering) areas are largely unknown (Hain et al. 1992, Hayes et al. 2019). Acoustic detections of fin whale singers augment and confirm these visual sighting conclusions for males. Recordings from the Atlantic Continental Shelf and deep-ocean areas have detected some level of fin whale singing from September through June (Watkins et al. 1987, Clark and Gagnon 2002, Morano et al. 2012, Davis et al. 2020). These acoustic observations from both coastal and deep-ocean regions support the conclusion that male fin whales are broadly distributed throughout the western North Atlantic for most of the year (Hayes et al. 2021). It is likely that fin whales occurring within the U.S. Atlantic EEZ undergo migrations into Canadian waters, open-ocean areas, and perhaps even subtropical or tropical regions; however, the popular notion that entire fin whale populations make distinct annual migrations like some other mysticetes has questionable support (Hayes et al. 2021). Based on an analysis of neonate stranding data, Hain et al. (1992) suggest that calving occurs during October to January in latitudes of the U.S. Mid-Atlantic region.

Low-frequency vocalizing fin whale pulses were detected in the northern and eastern range of the study area where shelf waters are typically deeper (Geo-Marine 2010). Fin whales were acoustically detected on 281 days from March 2008 to October 2009 and documented in every month of acoustic recording indicating a lack of seasonal trends (Geo-Marine 2010). As the detection range for fin whale vocalizations is more than 108 nautical miles (nm) (200 km), detected signals may have originated from areas far outside of the study area; however, the acoustic presence suggest that this species can be found regularly along the New Jersey outer continental shelf (Geo-Marine 2010).

Abundance

The best available abundance estimate for the western North Atlantic fin whale stock in U.S. waters from National Marine Fisheries Service (NMFS) stock assessments is 6,802 individuals (Hayes et al. 2021). Current and maximum net productivity rates and population trends are unknown for this stock due to relatively imprecise abundance estimates and variable survey design (Hayes et al. 2020). From 2015 to 2019, the annual estimated human-caused mortality rate was approximately two whales per year, caused by incidental fishery interactions and vessel collisions; however, this estimate is biased low due to haphazard detections of carcasses (Hayes et al. 2021). Potential biological removal (PBR) for fin whales (11) was calculated based on the most recent stock assessment reports (Hayes et al. 2021).

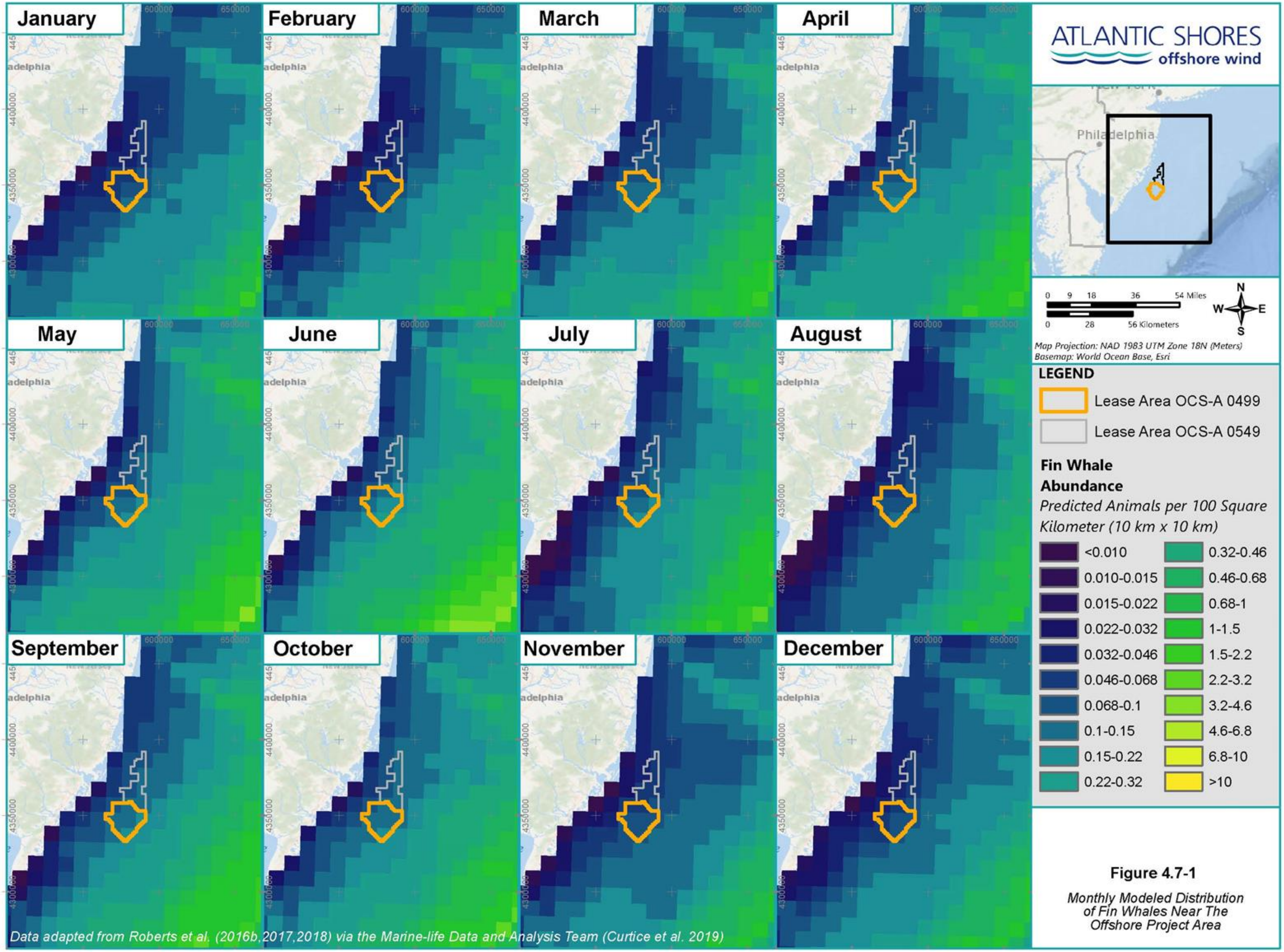


Figure 4.7-1

Monthly Modeled Distribution of Fin Whales Near The Offshore Project Area

Status

The fin whale is Federally listed under the United States Endangered Species Act (ESA) as an endangered marine mammal and are designated as a strategic stock under the Marine Mammal Protection Act (MMPA) due to their endangered status under the ESA, uncertain human-caused mortality, and incomplete survey coverage of the stock's defined range.

Humpback Whales (*Megaptera novaeangliae*)

Humpback whale body coloration is primarily dark gray, but individuals have a variable amount of white on their pectoral fins, belly, and flukes. These distinct coloration patterns are used by scientists to identify individuals. This baleen whale species feeds on small prey often found in large concentrations, including krill and fish such as herring and sand lance (Kenney and Vigness-Raposa 2010). Humpback whales use unique behaviors, including lunge feeding, bubble nets, bubble clouds, and flicking of their flukes and fins, to herd and capture prey (NMFS 1991). Humpback whale females are larger than males and can reach lengths of up to 59 ft (18 m) (NOAA Fisheries 2018d), and reach sexual maturity between the ages four and ten with females producing a single calf every two to three years.

Humpback whales are low-frequency cetaceans but have one of the most varied vocal repertoires of the baleen whales. Male humpbacks will arrange vocalizations into a complex, repetitive sequence to produce a characteristic "song." Songs are variable but typically occupy frequency bands between 300 and 3,000 Hz and last upwards of 10 minutes. Songs are predominately produced while on breeding grounds; however, they have been recorded on feeding grounds throughout the year (Clark and Clapham 2004, Vu et al. 2012). Typical feeding calls are centered at 500 Hz with some other calls and songs reaching 20 kHz. Common humpback calls also contain series of grunts between 25 and 1,900 Hz as well as strong, low-frequency pulses (with sound levels up to 176 dB re 1 μPa) between 25 and 90 Hz (Clark and Clapham 2004, Vu et al. 2012).

Distribution

Humpback whales are a cosmopolitan species and widely distributed in the Western Atlantic. Most humpback whales that inhabit the waters within the U.S. Atlantic EEZ belong to the Gulf of Maine stock, formerly called the Western North Atlantic Stock. Humpback whales in the Gulf of Maine stock typically feed in the waters between the Gulf of Maine and Newfoundland during spring, summer, and fall, but they have been observed feeding in other areas, such as off the coast of New York (Sieswerda et al. 2015). Humpback whales from most feeding areas, including the Gulf of Maine, migrate to the West Indies (including the Antilles, Dominican Republic, Virgin Islands, and Puerto Rico) in winter, where they mate and calve their young (Katona and Beard 1990, Palsbøll et al. 1997). There have been several wintertime humpback sightings in coastal waters of the eastern U.S., including 46 sightings of humpbacks in the New York-New Jersey Harbor Estuary documented between 2011 and 2016 (Brown et al. 2017). However, not all humpback whales from the Gulf of Maine stock migrate to the West Indies every winter because significant numbers of animals are observed in mid- and high-latitude regions at this time (Swingle et al. 1993).

Humpback whales are known to occur regularly throughout the Mid-Atlantic Bight, including New Jersey waters (Figure 4.7-2) (Geo-Marine 2010). The occurrence of this population is strongly seasonal with most observations occurring during the spring and fall, with a peak from April to June (Geo-Marine 2010, Curtice et al. 2019). There have also been documented strandings from the New Jersey coast (Barco et al. 2002). Geo-Marine (2010) observed humpback whales during all seasons including seven observations in the winter. Group size tended to be single animals or pairs with a mean distance from shore of 11.4 mi (18.4 km) and a mean depth of 67 ft (20.5 m) (Geo-Marine 2010). Acoustic data indicate that this species may be present within the surrounding areas year-round, with the highest rates of acoustic detections in adjacent waters in winter and spring (Kraus et al. 2016). Acoustic detections do not differentiate between individuals, so detections on multiple days could be the same or different individuals. Humpback whales have previously been observed feeding off the coast of New Jersey with juveniles exhibiting feeding behavior just south of the study area near the mouth of the Chesapeake Bay (Swingle et al. 2006). There was one instance of observed lunge-feeding on effort within the study area (Geo-Marine 2010). Additionally, a cow-calf pair was seen once north of the study area boundary suggesting that the nearshore waters off of New Jersey may provide important feeding and nursery habitats for humpback whales (Geo-Marine 2010).

Abundance

The Gulf of Maine humpback whale stock consists of approximately 1,396 whales and is characterized by a positive trend in abundance with a maximum annual production rate estimate of 6.5% (Barlow and Clapham 1997, Hayes et al. 2020). The most significant anthropogenic causes of mortality to humpback whales remain incidental fishery entanglements, responsible for roughly eight whale mortalities, and vessel collisions, responsible for four mortalities both on average annually from 2013 to 2017 (Hayes et al. 2020).

Status

The humpback whale was listed under the ESA as endangered throughout its range until 2016 when NOAA Fisheries revised the listing and defined 14 distinct population segments (DPS) based on breeding populations. Under the final determination, the three DPSs that occur in U.S. waters are listed as threatened or endangered (81 FR 62259, September 8, 2016).

The Gulf of Maine stock is not considered depleted because it does not coincide with any ESA-listed DPS. The detected level of U.S. fishery-caused mortality and serious injury, derived from the available records, which is surely biased low, does not exceed the calculated PBR and, therefore, this is not a strategic stock (if the recovery factor is set at 0.5) (Hayes et al. 2019) under the MMPA. Humpback whales in the western North Atlantic have been experiencing an Unusual Mortality Event (UME) since January 2016 that appears to be related to a larger than usual number of vessel collisions (NOAA Fisheries 2018g). In total, 76 mortalities were documented through July 25, 2018, as part of this event (NOAA Fisheries 2018g). A biologically important area (BIA) for humpback whales for feeding from March to December has been designated in the Gulf of Maine, Stellwagen Bank, and the Great South Channel; all of which are north of the WTA (LaBrecque et al. 2015).

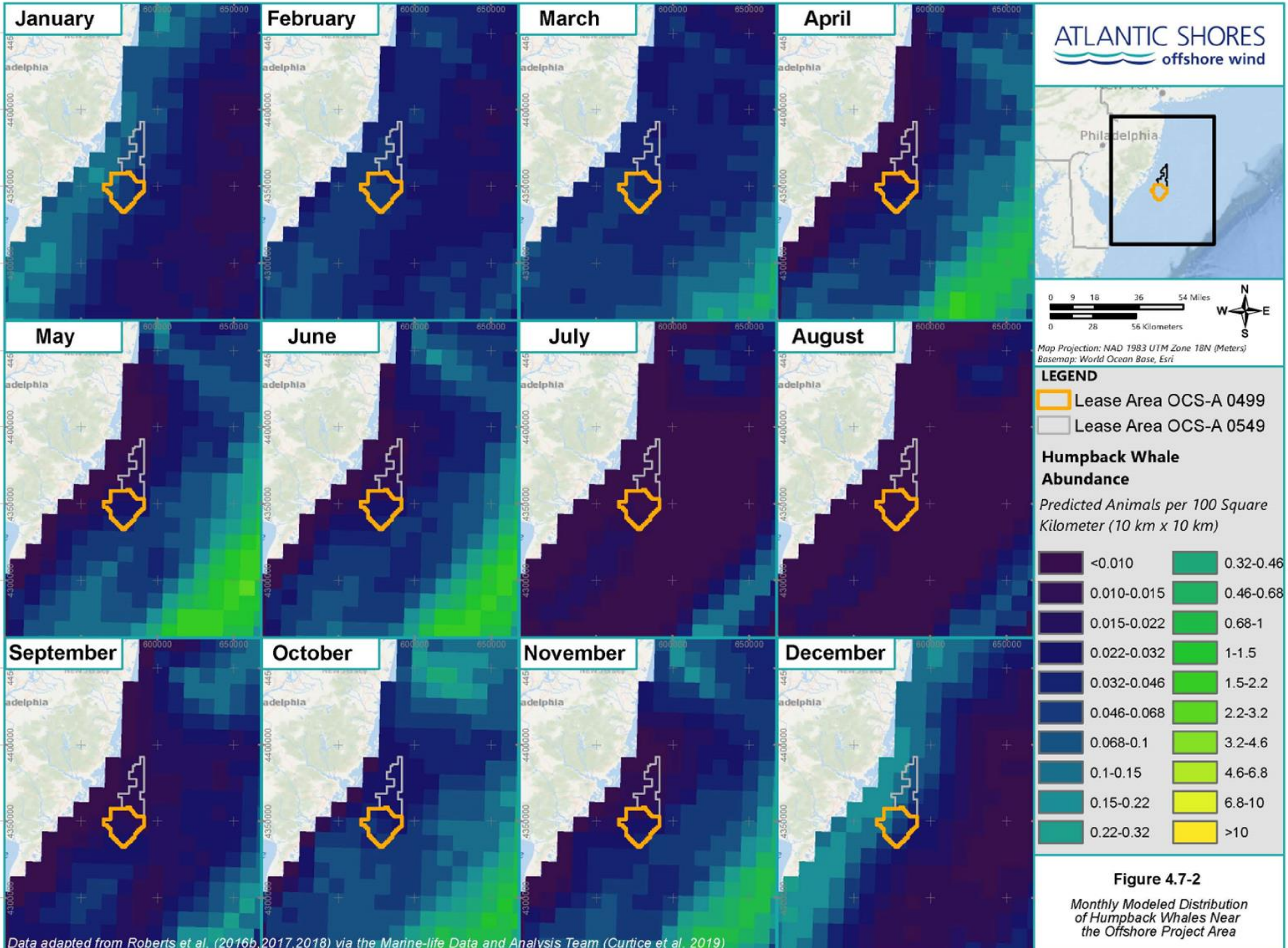


Figure 4.7-2

Monthly Modeled Distribution of Humpback Whales Near the Offshore Project Area

Minke Whales (*Balaenoptera acutorostrata*)

Minke whales are a small baleen whale species reaching 33 ft (10 m) in length (NOAA Fisheries 2018j). This species has a dark gray-to-black back and a white ventral surface (NOAA Fisheries 2018j). Its diet is comprised primarily of crustaceans, schooling fish, and copepods. Minke whales generally travel in small groups (one to three individuals), but larger groups have been observed on feeding grounds (NOAA Fisheries 2018j). Like other baleen whales, minke whales use low-frequency sounds to communicate with one another and to locate prey. They are believed to make mechanical sound calls and a variety of grunts, moans, and belches (Gedamke 2004).

Distribution

This species has a cosmopolitan distribution in temperate, tropical, and high latitude waters (Hayes et al. 2018b). Common and widely distributed within the U.S. Atlantic EEZ, these whales are the third most abundant great whale (any of the larger marine mammals of the order Cetacea) within the U.S. Atlantic EEZ (CeTAP 1982). Until better information is available, minke whales within the U.S. Atlantic EEZ are considered part of the Canadian East Coast stock, which inhabits the area from the western half of the Davis Strait (45°W) to the Gulf of Mexico. It is uncertain if separate sub-stocks exist within the Canadian East Coast stock. Like many of the other pelagic baleen whales, minke whales conduct seasonal migrations between high latitude summer feeding waters and low latitude winter breeding and calving grounds. Acoustic monitoring surveys indicate minke whales leave wintering grounds for their northern migrations from March through April and move south once again in mid-October through November (Risch et al. 2014).

Although primarily documented near the continental shelf offshore of New Jersey (Schwartz 1962, Mead 1975, Potter 1979, Rowlett 1980, Potter 1984, Winn et al. 1985, DoN 2005), minke whales have been sighted nearshore at water depths of 36 ft (11 m) (Geo-Marine 2010). Acoustic recordings of minke whales have been detected north of the WTA within the New York Bight during the fall (August to December) and winter (February to May) (Biedron et al. 2009). A juvenile minke whale was sighted north of the WTA near the New York Harbor in April, 2007 (Hamazaki 2002). The expected occurrence of minke whales near the WTA are likely due to the availability of prey species, such as capelin, herring, mackerel, and sand lance in this region (Kenney et al. 1985, Horwood 1989). Based on habitat information and predictive habitat models, Hamazaki (2002) determined that minke whales are likely to occur in nearshore waters off New Jersey.

Minke whales are most common off New Jersey in coastal waters in the spring and early summer as they move north to feeding ground in New England, and fall as they migrate south (Figure 4.7 3) (Geo-Marine 2010). Geo-Marine (2010) observed four minke whales near the WTA and surrounding waters during winter and spring. This species demonstrated a distinct seasonal habitat usage pattern that was consistent throughout the study. The two winter sightings were recorded in February, northeast of Barnegat Light whereas the two spring sightings were recorded in June, southeast of Sea Isle City. Minke whale sightings off the coast of New Jersey were within water depths of 36 to 79 ft (11 to 24 m) and temperatures ranging from 5.4 to 11.5°C (47°F) (Geo-Marine 2010).

Minke whale recordings have resulted in some of the most variable and unique vocalizations of any marine mammal. Common calls for minke whales found in the North Atlantic include repetitive, low-frequency (100 to 500 Hz) pulse trains that may consist of either grunt-like pulses or thump-like pulses. The thumps are very short duration (50 to 70 milliseconds [ms]) with peak energy between 100 and 200 Hz. The grunts are slightly longer in duration (165 to 320 ms) with most energy between 80 and 140 Hz. In addition, minke whales will repeat a six to 14 minute pattern of 40 to 60 second pulse trains over several hours (Risch et al. 2013). Minke whales produce a unique sound called the "boing", which consists of a short pulse at 1.3 kHz followed by an undulating tonal call around 1.4 kHz. This call was widely recorded but unidentified for many years and had scientists widely speculating as to its source (Rankin and Barlow 2005).

Abundance

The best available abundance estimate for the Canadian East Coast minke whale stock is 21,968 individuals as of 2016 (Hayes et al. 2021). Current population trends and net productivity rates of minke whales in this region are currently unknown. The average annual human-caused mortality is estimated to be 10.55 whales per year caused by entanglement in fishing gear and vessel strike between 2015 and 2019 (Hayes et al. 2021).

Status

Minke whales are not listed as threatened or endangered under the ESA or designated as a strategic stock under the MMPA.

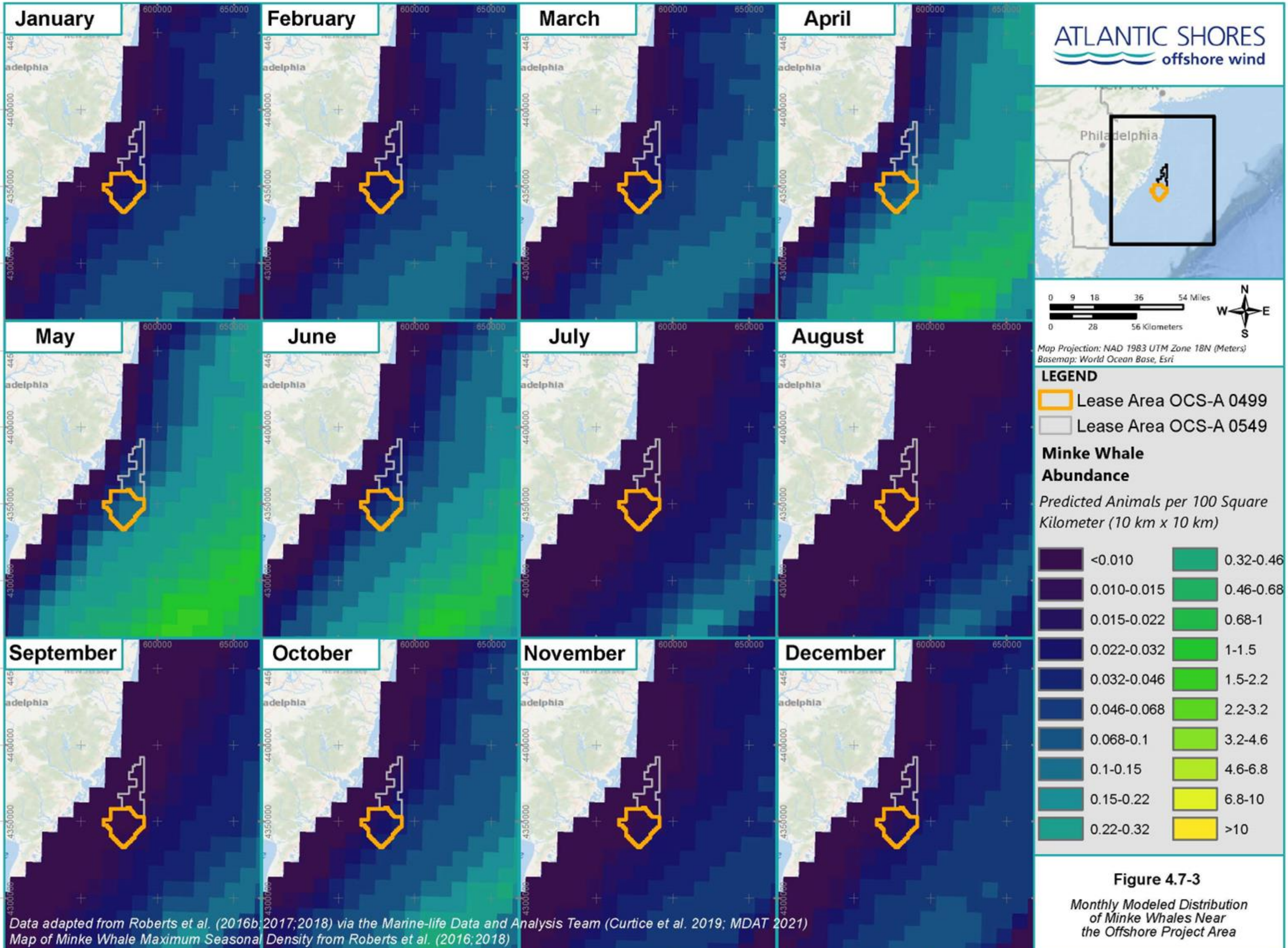


Figure 4.7-3

Monthly Modeled Distribution of Minke Whales Near the Offshore Project Area

North Atlantic Right Whales *(Eubalaena glacialis)*

North Atlantic right whales (NARW) are among the most endangered of all marine mammal species in the Atlantic Ocean. The average adult NARW can grow to approximately 50 ft (15 m) in length, while calves are typically 14 ft (4 m) at birth (NOAA Fisheries 2018m). Members of this species have stocky, black bodies with no dorsal fin, and bumpy, coarse patches of skin on their heads called callosities. NARWs feed mostly on zooplankton and copepods belonging to the *Calanus* and *Pseudocalanus* genera (Hayes et al. 2019). They are slow-moving grazers that feed on dense concentrations of prey at or below the water's surface, as well as at depth (NOAA Fisheries 2018m). Female whales become sexually mature at about age ten and carry a single calf during a year-long gestation period every six to ten years. The life span of NARW is estimated at 70 years, based on the estimated age of found deceased right whales and other closely related species (NOAA Fisheries 2020b).

NARWs are low-frequency cetaceans that vocalize using several distinctive call types, most of which have peak acoustic energy below 500 Hz. Most vocalizations do not go above 4 kHz (Matthews et al. 2014). One typical right whale vocalization is the "up call": a short sweep that rises from roughly 50 to 440 Hz over a period of two seconds. These up calls are characteristic of the NARW and are used by research and monitoring programs to determine species presence. A characteristic "gunshot" call is believed to be produced by male NARWs. These pulses can have sound levels of 174 to 192 dB re 1 μPa with frequency range from 50 to 2,000 Hz (Parks et al. 2005, Parks and Tyack 2005). Other tonal calls range from 20 to 1,000 Hz and have sound levels between 137 and 162 dB re 1 μPa.

Distribution

NARWs in U.S. waters belong to the Western Stock. This stock ranges primarily from calving grounds in coastal waters of the southeastern U.S. to feeding grounds in New England waters and the Canadian Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence (Hayes et al. 2019). Surveys indicate that there are seven areas where NARWs congregate seasonally: the coastal waters of the southeastern U.S., the Great South Channel, Jordan Basin, Georges Basin along the northeastern edge of Georges Bank, Cape Cod and Massachusetts Bays, the Bay of Fundy, and the Roseway Basin on the Scotian Shelf (Hayes et al. 2018b). National Marine Fisheries Service (NMFS) has designated two critical habitat areas for the NARW under the ESA: The Gulf of Maine/Georges Bank region, and the southeast calving grounds from North Carolina to Florida. Two additional critical habitat areas in Canadian waters, Grand Manan Basin and Roseway Basin, were identified in Canada's final recovery strategy for the NARW (Brown et al. 2009). Davis et al. (2017) recently pooled together detections from a large number of passive acoustic devices and documented broad-scale use of much more of the Atlantic Seaboard than previously believed. Further, there has been an apparent shift in habitat use patterns (Davis et al. 2017), which includes an increased use of Cape Cod Bay (Mayo et al. 2018) and decreased use of the Great South Channel. Movements within and between habitats are extensive (Hayes et al. 2019), and there is a high interannual variability in NARW use of some habitats (Pendleton et al. 2009).

The NARW is a migratory species that travels from high-latitude feeding waters to low-latitude calving and breeding grounds, though this species has been observed feeding in winter in the Mid-Atlantic region and has been recorded off the coast of New Jersey in all months of the year (Whitt et al. 2013). NARWs are mainly present in the WTA in winter, with another smaller peak in spring, ranging elsewhere for their main feeding and breeding/calving activities (Geo-Marine 2010). NARW typically occupy coastal and shelf waters within 56 mi (90 km) of the shoreline; however, they have been observed as far as 87 mi (140 km) offshore. These whales undertake a seasonal migration from their northeast feeding grounds (generally spring, summer, and fall habitats) south along the eastern U.S. coast to their calving grounds in the waters of the southeastern U.S. (Kenney and Vigness-Raposa 2010). The WTA is located within the NARW migration BIA (Figure 4.7-4). NARWs are usually observed in groups of less than 12 individuals, and most often as single individuals or pairs. Larger groups may be observed in feeding or breeding areas (Jefferson et al. 2008). Migrating NARWs have been detected acoustically north of the WTA in the New York Bight from February to May and then again in August through December (Biedron et al. 2009).

Historically, there have been several documented sightings of NARW off the coast of New Jersey and surrounding waters (CETAP 1982, Knowlton and Kraus 2001, Biedron et al. 2009). These waters are important migratory routes for NARW as this species travels to their feeding areas near the Gulf of Maine/Georges Bank regions and their breeding/calving grounds off the southeastern U.S. (DoC 2016). Satellite-monitored radio tags on a NARW cow and calf documented the migratory route of this pair from the Bay of Fundy to New Jersey and back during a six-week period (Knowlton et al. 2002). A few NARW sightings were documented east of the south of the WTA near the Delaware Bay in October, December, May, and July (Knowlton et al. 2002). Other visual recordings of NARW were found in New Jersey waters during the spring and fall seasons (CETAP 1982). An entanglement mortality event of a NARW was recorded off the coast of New Jersey in October (Knowlton et al. 2002). It is has been noted, however, that NARW sightings in several traditional feeding habitats has been declining, causing speculation that a shift in NARW habitat usage may be occurring (Pettis et al. 2017).

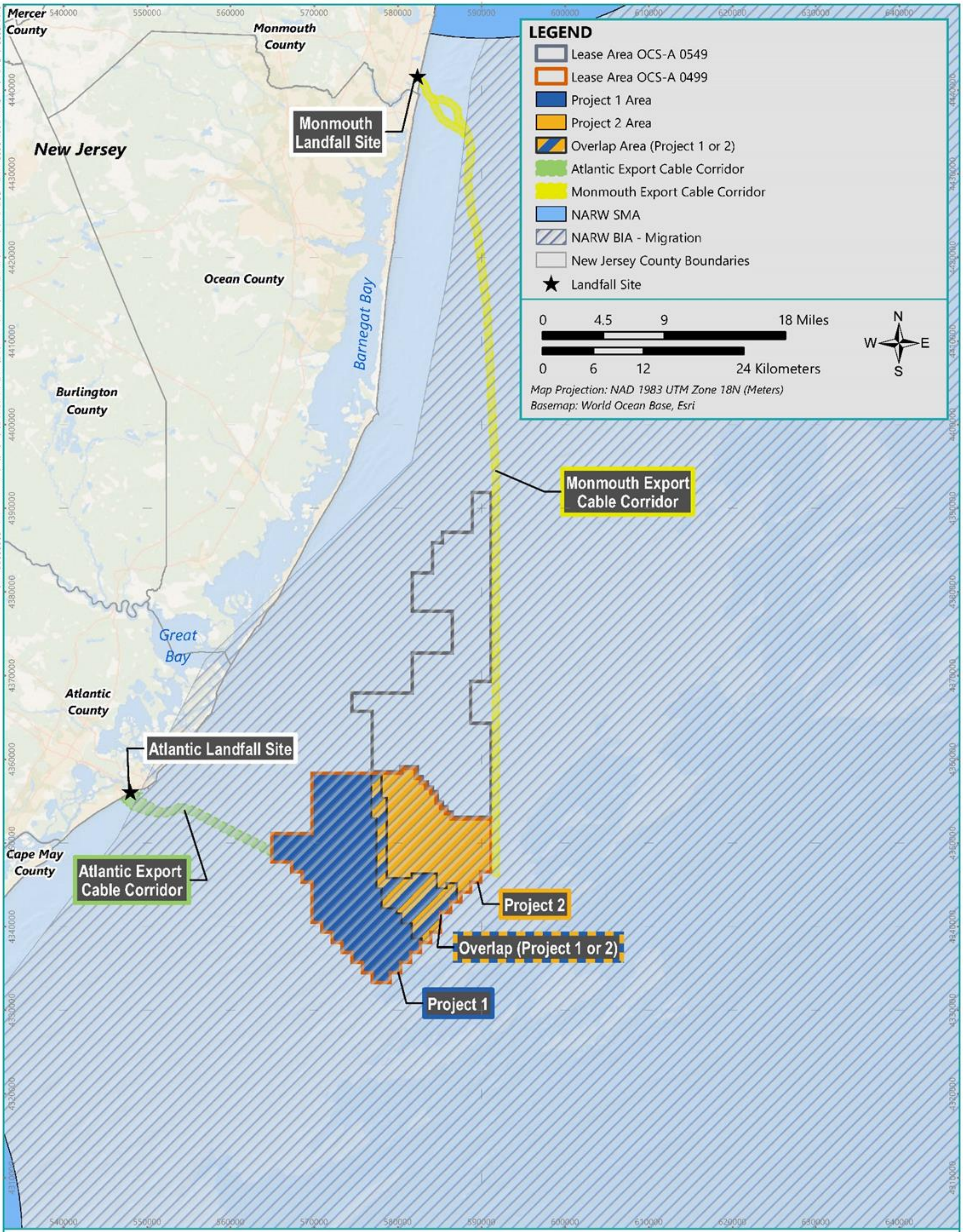
Geo-Marine (2010) observed NARWs offshore of New Jersey during all seasons; except for summer. Three sightings of this species were documented in November, December, and January (Geo-Marine 2010). NARWs exhibit notable seasonal variability, with maximum occurrence in winter (December to February) and minimum occurrence in spring and summer (Figure 4.7-5). These sightings were likely to be migrant movements towards breeding and calving grounds located north and south of the WTA (Winn et al. 1986, Cole et al. 2009). NARWs detected in the Geo-Marine (2010) study area off the coast of New Jersey were seen as single animals or pairs. These sightings occurred within water depths from 56 to 85 ft (17 to 26 m) with distances from shore ranging from 10.7 to 17.2 nm (19.9 to 31.9 km). A January 2009 sighting documented two adult males offshore of Barnegat Light in the northernmost portion of the Geo-Marine (2010) study area. In May 2008, a cow-calf pair were documented in waters (56 ft [17 m] isobath) southeast of Atlantic City (Geo-Marine 2010; M. Zani, New England Aquarium, pers. comm. 6 January 2020).

Abundance

The population of the western Atlantic NARW stock has been in decline since 2011, with a minimum population estimate of 368 as of 30 November 2019 (Hayes et al. 2021). Population growth rates remain low (2.5%), as average calves born per year between 1990 and 2019 was 15 and ranged from one to thirty-nine per year (Hayes et al. 2021). In more recent years, female production has fallen, likely a result of lower female survival rate. The most significant causes of anthropogenic mortality to NARW include incidental fishery entanglement, which takes an estimated six right whales per year, and vessel strikes, which take an estimated two whales per year (Hayes et al. 2021).

Status

The NARW was listed as a Federally endangered species in 1970 and remains critically endangered throughout its range. In addition to its endangered status, the high rate of annual human-related mortality classifies NARW as a strategic stock under the MMPA. An unusual mortality event (UME) was established for NARWs in June 2017. Thirty documented NARW deaths and 8 seriously injured free-swimming whales have been documented as of 2019 (NOAA Fisheries 2020e).



ATLANTIC SHORES offshore wind

Figure 4.7-4

North Atlantic Right Whale (NARW) Biologically Important Area (BIA) Migration (March to April and November to December), and Seasonal Management Areas in the Atlantic Shores Offshore Project Region

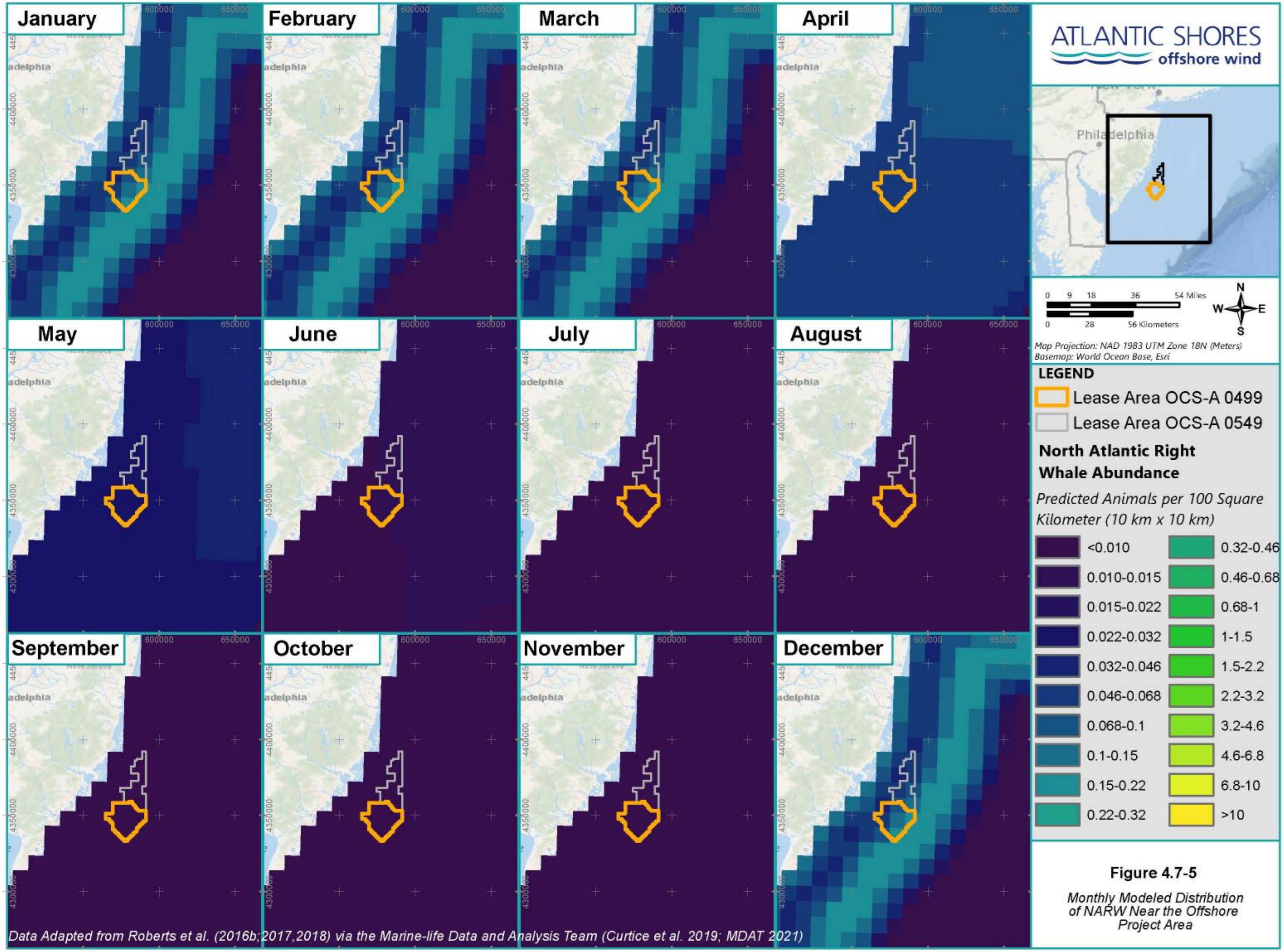


Figure 4.7-5

Monthly Modeled Distribution of NARW Near the Offshore Project Area

Sei Whales (*Balaenoptera borealis*)

Sei whales can reach lengths of about 39 to 59 ft (12 to 18 m) (NOAA Fisheries 2018f). This species has a long, sleek body that is dark bluish-gray to black in color and pale underneath (NOAA Fisheries 2018f). Their diet is comprised primarily of plankton including krill and copepods, schooling fish, and cephalopods. Sei whales generally travel in small groups (two to five individuals), but larger groups are observed on feeding grounds (NOAA Fisheries 2018f).

Sei whales, like all baleen whales, are categorized as low-frequency cetaceans. There are limited confirmed sei whale vocalizations; however, studies indicate that this species produces several, mainly low-frequency (less than 1,000 Hz) vocalizations. Calls attributed to sei whales include pulse trains up to 3 kHz, broadband "growl" and "whoosh" sounds between 100 and 600 Hz, tonal calls and upsweeps between 200 and 600 Hz, and down sweeps between 34 and 100 Hz (McDonald et al. 2005, Rankin and Barlow 2007, Baumgartner et al. 2008).

<u>Distribution</u>

The stock that occurs within the U.S. Atlantic EEZ is the Nova Scotia stock, which ranges along the continental shelf waters of the northeastern U.S. to Newfoundland (Hayes et al. 2017). Sei whales are relatively widespread. Sighting data suggest sei whale distribution is largely centered in the waters of New England and eastern Canada (Roberts et al. 2016a, Hayes et al. 2017). There appears to be a strong seasonal component to sei whale distribution, and they are most abundant in adjacent waters near the continental shelf from winter to spring (Figure 4.7-6) (Roberts et al. 2016a). This general offshore pattern of sei whale distribution is disrupted during episodic incursions into more shallow and inshore waters (Hayes et al. 2017). In years of reduced predation on copepods by other predators, and thus greater abundance of this prey source, sei whales are reported in more inshore locations, such as the Great South Channel (1987 and 1989) and Stellwagen Bank (1986) areas (Payne and Heinemann 1990, Waring et al. 2016). An influx of sei whales into the southern Gulf of Maine occurred in summer 1986 (Schilling et al. 1992). Such episodes, often punctuated by years or even decades of absence from an area, have been reported for sei whales from various places worldwide.

There has been little detection of sei whales within New Jersey and surrounding waters (Kenney et al. 1985, Geo-Marine 2010). According to the NJ ENSP, there have been no sightings of this species documented within State waters. On the shelf offshore of New Jersey, sei whales have been detected in spring. Approximately 200 sei whale vocalizations were detected in mid-September 2006 (Newhall et al. 2009); however, it is unlikely that the sei whale will be present farther nearshore by the WTA.

<u>Abundance</u>

The best available abundance estimate for the Nova Scotia stock of sei whales from NMFS stock assessments is 6,292 individuals (Hayes et al. 2017, 2021). This estimate is considered an underestimate because the full known range of the stock was not surveyed, the estimate did not include availability-bias correction for submerged animals, and there was uncertainty regarding population structure (Hayes et al. 2017).

<u>Status</u>

Sei whales are listed as endangered under the ESA and NJ ENSP and the Nova Scotia stock is considered strategic by NMFS under the MMPA. The minimum population size is 3,098. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor is 0.10 because the sei whale is listed as endangered under the ESA. PBR for the Nova Scotia stock of the sei whale is 6.2. For the period 2015 through 2019, the average annual rate of human-caused mortality and serious injury to sei whales was 0.8 (Hayes et al. 2021). No critical habitat areas are designated for the sei whale under the ESA. A BIA for feeding for sei whales occurs north of WTA in the Gulf of Maine from May through November (LaBrecque et al. 2015).

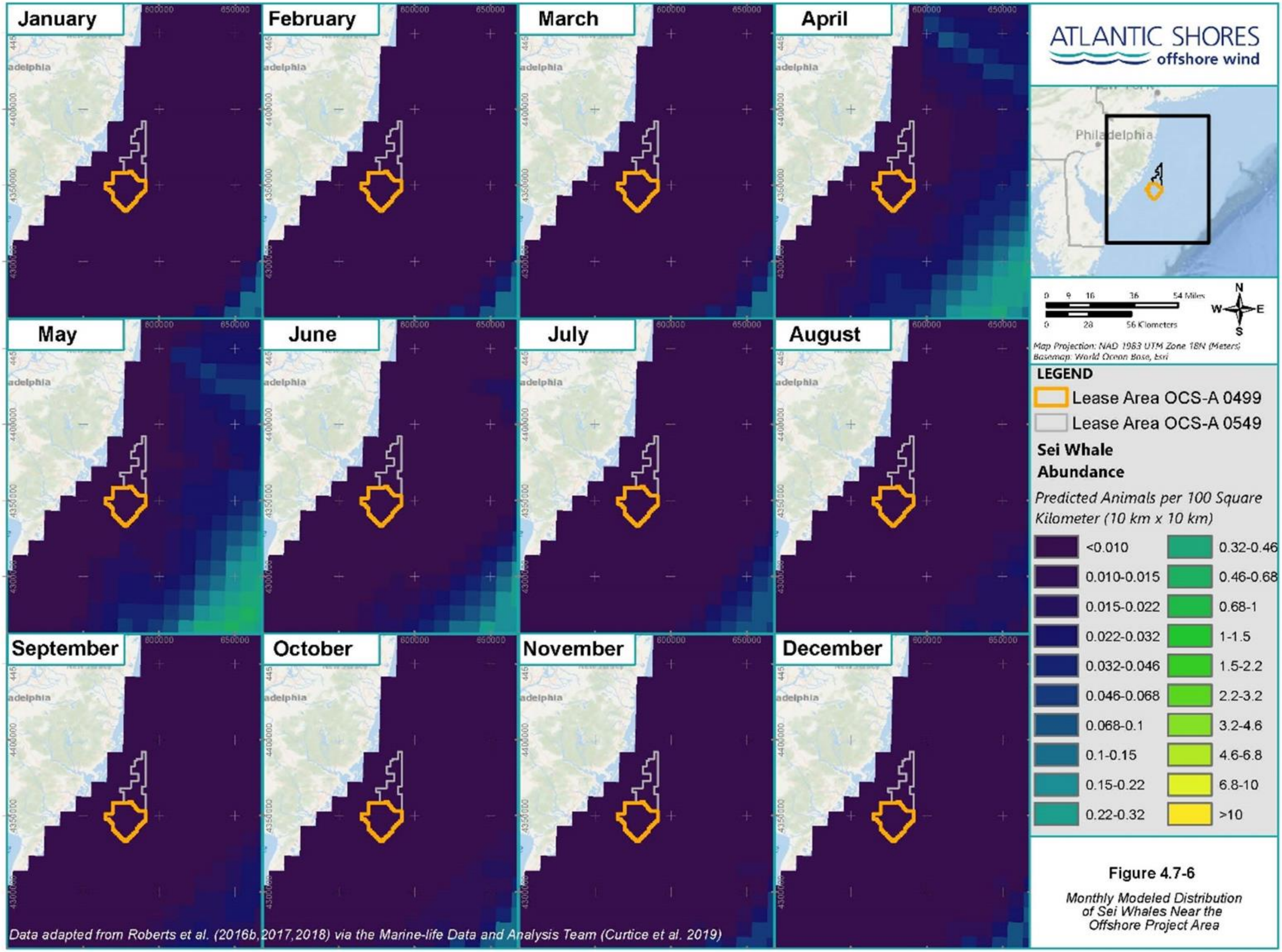


Figure 4.7-6

Monthly Modeled Distribution of Sei Whales Near the Offshore Project Area

4.7.1.3 Toothed Whales

Atlantic White-Sided Dolphins *(Lagenorhynchus acutus)*

Atlantic white-sided dolphins are common in temperate waters of the western North Atlantic. They have a distinctive yellowish-tan patch near their fluke and white patches below the dorsal fin and ventral sides, on both sides of their long, slender bodies. These dolphins grow up to 9 ft (2.7 m) in length and weigh between 400 and 500 pounds as adults. Like other dolphins, Atlantic white-sided dolphins communicate vocally and non-vocally through signals. They produce burst-pulse sounds and echolocation clicks and whistles (Popper 1980).

Distribution

Atlantic white-sided dolphins observed off the U.S. Atlantic coast are part of the Western North Atlantic Stock (Hayes et al. 2019). This stock inhabits waters from central West Greenland to North Carolina (about 35°N), primarily in continental shelf waters to the 328 ft (100 m) depth contour (Doksæter et al. 2008). Sighting data indicate seasonal shifts in distribution (Northridge et al. 1997). From January to May, low numbers of Atlantic white-sided dolphins are found from Georges Bank to Jeffreys Ledge (off New Hampshire). From June through September, large numbers of Atlantic white-sided dolphins are found from Georges Bank to the lower Bay of Fundy. From October to December, they occur at intermediate densities from southern Georges Bank to the southern Gulf of Maine (Payne and Heinemann 1990). No critical habitat areas are designated for the Atlantic white-sided dolphin.

No Atlantic white-sided dolphins were observed in the Geo-Marine (2010) study. This suggests that Atlantic white-sided dolphins occur infrequently in the WTA and surrounding areas. The NJ ENSP noted that there is little information on the sightings of this species and that more information is needed to accurately assess the abundance of Atlantic white-sided dolphins within State waters (see CETAP 1982, Selzer and Payne 1988, Waring et al. 2007, Bowers-Altman and NJ Division of Fish and Wildlife 2009). A shallow water (~188 ft [36 m]) marine mammal survey off of New Jersey found no presence of Atlantic white-sided dolphin across each season (Kenney et al. 1985: p. 91), which further implies that it is unlikely for this species to be present within the WTA. Although regional surveys found very limited presence of this species near the WTA, data adapted from Roberts et al. (2016b; 2017; 2018) via the MDAT (Curtice et al. 2019; MDAT 2021) indicate abundance in this region increases in the spring (Figure 4.7-7).

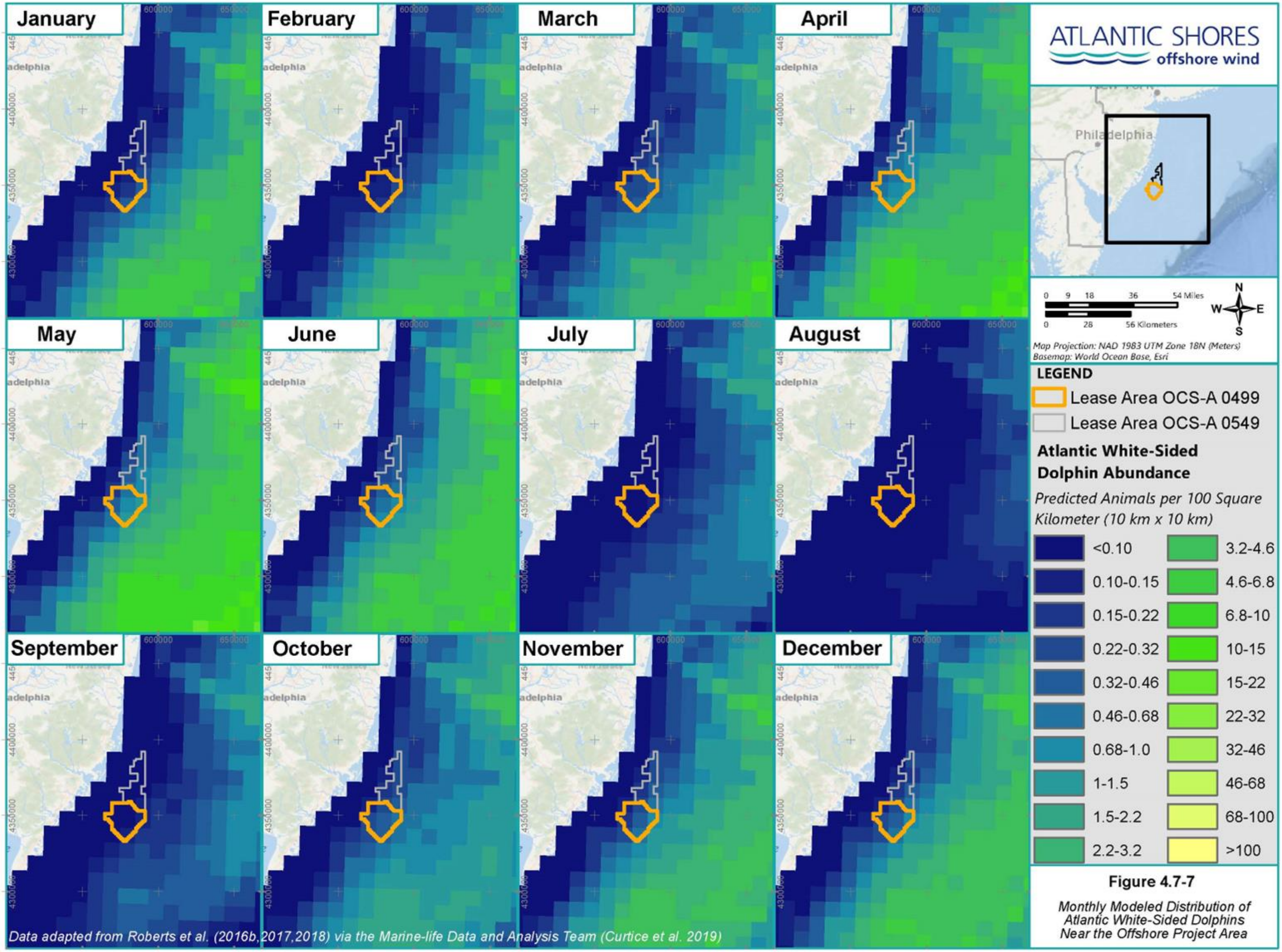


Figure 4.7-7

Monthly Modeled Distribution of Atlantic White-Sided Dolphins Near the Offshore Project Area

Abundance

Roberts et al. (2016a, 2018) habitat-based density models provide an abundance estimate of 37,180 Atlantic white-sided dolphins within the U.S. Atlantic EEZ. There are insufficient data to determine seasonal abundance estimates of Atlantic white-sided dolphins off the U.S. Atlantic coast or their status within the U.S. Atlantic EEZ. The best available abundance estimate for the Western North Atlantic stock of Atlantic white-sided dolphins is 93,233 individuals, which is derived from data collected during a summer survey in 2016 (Hayes et al. 2021).

Status

The Atlantic white-sided dolphin is not listed as threatened or endangered under the ESA or NJ ENSP, and the Western North Atlantic stock of Atlantic white-sided dolphins is not classified as strategic under the MMPA.

Common Bottlenose Dolphins (*Tursiops truncatus*)

Bottlenose dolphins are one of the most well-known and widely distributed species of marine mammals. These dolphins reach 7 to 13 ft (2 to 4 m) in length and are light gray to black in color (NOAA Fisheries 2018a). Bottlenose dolphins are commonly found in groups of two to 15 individuals, though aggregations in the hundreds are occasionally observed (NOAA Fisheries 2018a). They are considered generalist feeders and consume a wide variety of organisms, including fish, squid, shrimp, and other crustaceans (Jefferson et al. 2008). Bottlenose dolphins are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007). Bottlenose dolphin vocalization frequencies range from 3.4 to 130 kHz (DoN 2008).

Distribution

There are multiple genetically distinct bottlenose dolphin stocks present in the Mid-Atlantic including the Western North Atlantic Offshore stock and Northern Migratory Coastal stock (Mead and Potter 1995). The Western North Atlantic Offshore stock inhabits the outer continental slope and shelf edge regions from Georges Bank to the Florida Keys (Hayes et al. 2017). Sightings of this stock of bottlenose dolphin occur from Cape Hatteras to the eastern end of Georges Bank (Kenney 1990). The Northern Migratory Coastal Stock migrates seasonally within coastal waters of the western North Atlantic. The coastal migratory stock typically inhabits nearshore waters with depths less than 80 ft (25 m) north of Cape Hatteras. During warmer months, this stock resides in waters to the 66 ft (~20-m) isobath within New York, Long Island, Virginia, and Assateague (Garrison et al. 2017b). During late summer, fall, and during cooler months (January to February), the Migratory Coastal stock occupies coastal waters from Cape Lookout, North Carolina to North Carolina/Virginia border (Garrison et al. 2017b).

Off the coast of New Jersey, bottlenose dolphins (likely from the Coastal Migratory stock, although there is thought to be some range overlap from the Offshore stock) can occur throughout the year and were the most frequently detected species in an ecological baseline survey conducted in coastal New Jersey waters (Figure 4.7-8)(Geo-Marine 2010, BOEM 2012). Seasonal movements north along the coast occur during the warmer months, are likely directed by the presence of prey (Hayes et al. 2018b). Targeted prey species vary by area, season, and stock; however, sciaenid fishes, such as Atlantic croaker, weakfish, and squid, are common (NOAA Fisheries 2020c). The Northeast Fisheries Science Center (NEFSC) observed bottlenose dolphins during the AMAPPS surveys (NEFSC and SEFSC 2011a, 2011b, 2012, 2014a, 2014b, 2015, 2016, 2018, 2019).

Bottlenose dolphins were the most frequently observed species during the Geo-Marine (2010) study period. A total of 319 bottlenose dolphins with group sizes averaging at 15.3 animals were detected offshore of New Jersey (Geo-Marine 2010). Several other monitoring efforts recorded sightings of this species during geophysical surveys in the potential windfarm sites (including the WTA) southeast of Atlantic City (Geo-Marine 2009a, 2009b). Bottlenose dolphins have been present annually near and offshore of New Jersey; with greater sightings during spring and summer months (Geo-Marine 2010).

Abundance

The best available population estimate for the northern migratory coastal stock is 6,639 bottlenose dolphins, while the offshore stock abundance is estimated at 62,851 individuals (Hayes et al. 2018b, 2020). Current population estimates indicate there is no significant trend in abundance for either stock. Total annual human-caused mortality is unknown for both stocks. Total annual fisheries mortality and serious injury is estimated as 28 individuals for the offshore stock (from 2013 to 2017) and between six and 13 individuals for the coastal stock (between 2011 to 2015; Hayes et al. 2018b, 2020).

Status

The offshore stock of bottlenose dolphin is not listed as threatened or endangered under the ESA or designated as a strategic stock under the MMPA. The northern migratory coastal stock of bottlenose dolphins is designated as a strategic stock under MMPA due to its depleted status and biased low fisheries mortality estimates (Hayes et al. 2018b).

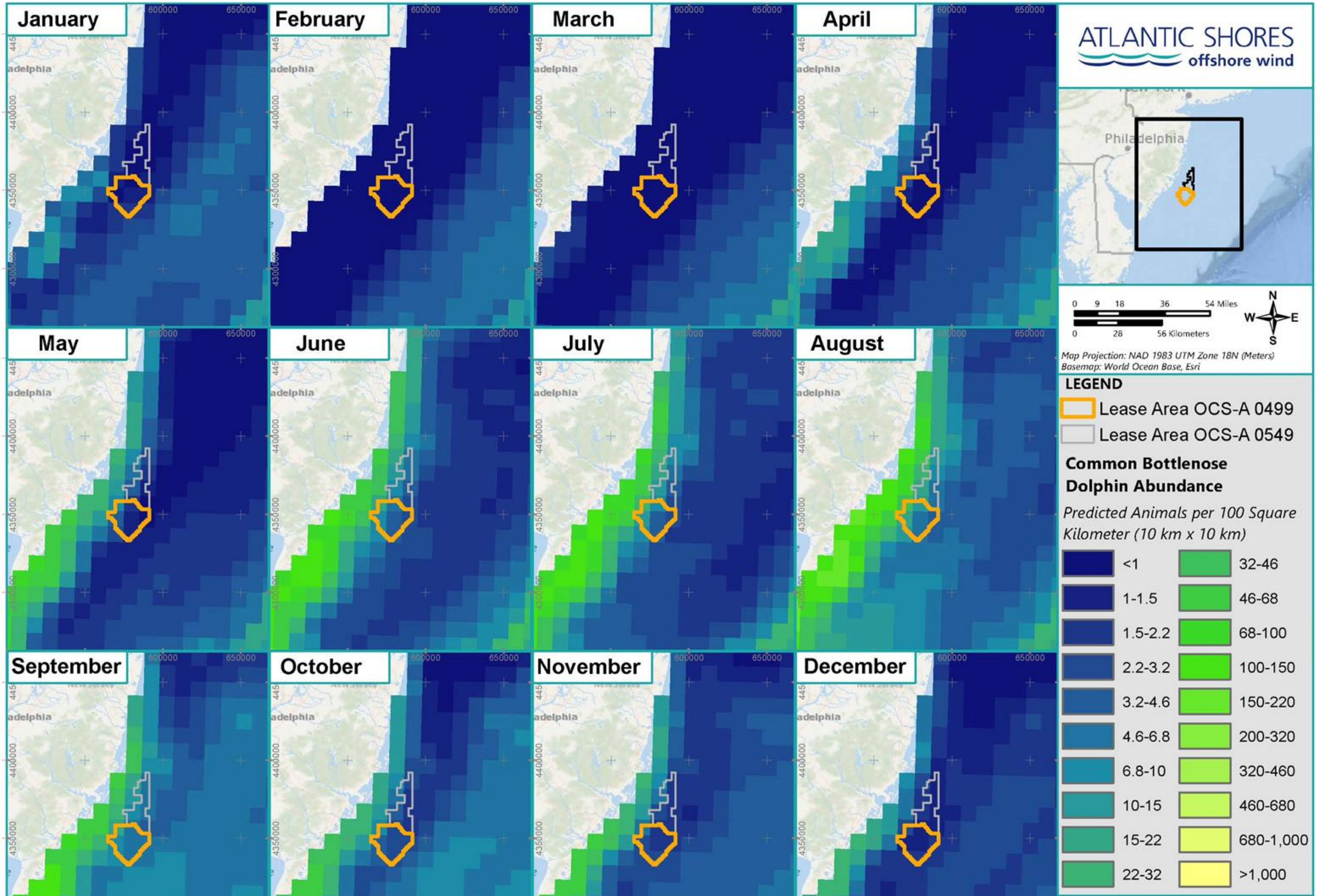


Figure 4.7-8

Monthly Modeled Distribution of Common Bottlenose Dolphins near the Offshore Project Area

Pilot Whales (*Globicephala spp.*)

Two species of pilot whale occur within the western North Atlantic: the long-finned pilot whale (*Globicephala melas*) and the short-finned pilot whale (*Globicephala macrorhynchus)*. These species are difficult to differentiate visually and acoustically due to similarity in appearance at the surface and vocalizations that overlap in frequency range. Consequently, the two species cannot be reliably distinguished (Rone and Pace 2012, Hayes et al. 2019); unless otherwise stated, the descriptions below refer to both species. Pilot whales have bulbous heads, are dark gray, brown, or black in color, and can reach approximately 24 ft (7.3 m) in length (NOAA Fisheries 2018e). These whales form large, relatively stable aggregations that appear to be maternally determined (American Cetacean Society 2018). Pilot whales feed primarily on squid but also eat small to medium-sized fish and octopus when available (NOAA Fisheries 2018e, 2018i). Occurrence of the long-finned pilot whale is considered rare in the WTA, while occurrence of the short-finned pilot whale is considered uncommon.

Pilot whales are acoustic mid-frequency specialists with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007). Pilot whales echolocate and produce tonal calls. The primary tonal calls of the long-finned pilot whale range from 1 to 8 kHz with a mean duration of about one second. The calls can be varied with seven categories identified (level, falling, rising, up-down, down-up, waver, and multi-hump) and are likely associated with specific social activities (Vester et al. 2014).

Distribution

Within the U.S. Atlantic EEZ, both long- and short-finned pilot whales are categorized into Western North Atlantic stocks. In U.S. Atlantic waters, pilot whales are distributed principally along the continental shelf edge off the northeastern U.S. coast in winter and early spring (Figure 4.7-9) (CETAP 1982, Payne and Heinemann 1993, Abend and Smith 1999, Hamazaki 2002). In late spring, pilot whales move onto Georges Bank, into the Gulf of Maine, and into more northern waters, where they remain through late fall (CeTAP 1982, Payne and Heinemann 1993). Short-finned pilot whales are present within warm temperate to tropical waters and long-finned pilot whales occur in temperate and subpolar waters. Long-finned and short-finned pilot whales overlap spatially along the Mid-Atlantic shelf break between New Jersey and the southern flank of Georges Bank (Payne and Heinemann 1993, Hayes et al. 2019). Long-finned pilot whales have occasionally been observed stranded as far south as South Carolina, and short-finned pilot whales have stranded as far north as Massachusetts (Hayes et al. 2017). The latitudinal ranges of the two species therefore remain uncertain. However, south of Cape Hatteras, most pilot whale sightings are expected to be short-finned pilot whales, while north of approximately 42° N, most pilot whale sightings are expected to be long-finned pilot whales (Hayes et al. 2021).

Long-finned and short-finned pilot whales have been known to occur offshore of New Jersey (Abend and Smith 1999, Tyler 2008, Hayes et al. 2017). It is likely that both species overlap along the shelf break between New Jersey and Georges Bank, however, there is limited information on the spatial and temporal distribution of both species near the WTA (Hayes et al. 2017). For instance, pilot whales were not detected during the Geo-Marine (2010) study. The limited information of pilot whale presence within the WTA is likely based on the habitat preference and overall distribution of pilot whales (Hayes et al. 2017). Further, the consensus from the NJ ENSP determined that pilot whales are primarily pelagic and have a rare presence in New Jersey waters (Bowers-Altman and NJ Division of Fish and Wildlife 2009).

Abundance

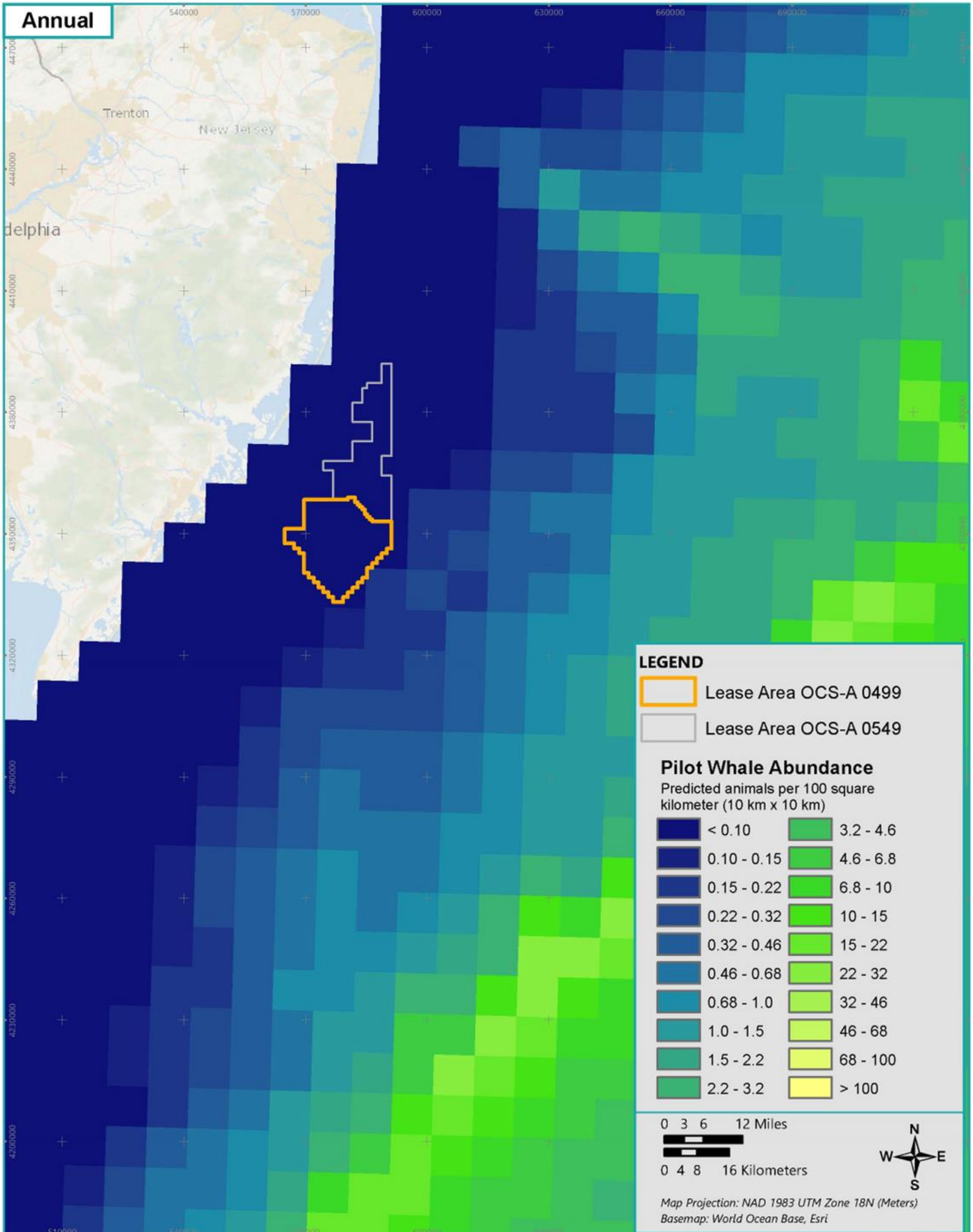
The best available estimate for long-finned pilot whale abundance is 39,215 whales as of surveys conducted through 2016 (Lawson and Gosselin 2018, Hayes et al. 2021). Estimates of population trend or net productivity rates have not been calculated for long-finned pilot whales as abundance estimates remain highly uncertain due to long survey intervals. From 2015 to 2019, total annual observed fishery-related mortality or serious injury was 9 long-finned pilot whales (Hayes et al. 2021). In addition, to direct human-induced mortality, mass strandings of long-finned pilot whales have occurred throughout their range. Between 2015 and 2019, 7 long-finned pilot whales were found stranded between Maine and Florida (Hayes et al. 2021).

Status

Neither the long-finned or short-finned pilot whale species is listed as threatened or endangered under the ESA or the NJ ENSP, and the Western North Atlantic stock is not considered strategic under the MMPA.

Risso's Dolphins *(Grampus griseus)*

Risso's dolphins occur worldwide in both tropical and temperate waters (Jefferson et al. 2008, Jefferson et al. 2014). This species of dolphin attains a body length of approximately 9 to 13 ft (2.6 to 4 m) (NOAA Fisheries 2018k), a narrow tailstock, and a whitish or gray body. Risso's dolphins form groups ranging from 10 to 30 individuals (NOAA Fisheries 2018k). They feed primarily on squid as well as fish, such as anchovies, krill, and other cephalopods (NOAA Fisheries 2018k). Risso's dolphins are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007). Vocalizations range from 400 Hz to 65 kHz (DoN 2008).



ATLANTIC SHORES offshore wind

Figure 4.7-9

Annual Modeled Distribution of Long-finned Pilot Whales near the Offshore Project Area

Distribution

Risso's dolphins within the U.S. Atlantic EEZ are part of the Western North Atlantic stock. The Western North Atlantic stock of Risso's dolphins inhabits waters from Florida to eastern Newfoundland (Leatherwood et al. 1976, Baird and Stacey 1991). During spring, summer, and fall, Risso's dolphins are distributed along the continental shelf edge from Cape Hatteras northward to Georges Bank (CeTAP 1982, Payne et al. 1984). In winter, the distribution extends outward into oceanic waters (Payne et al. 1984) within the Mid-Atlantic Bight, however, very little is known about movement and migration patterns and they are infrequently observed in shelf waters (Figure 4.7-10). The stock may contain multiple demographically independent populations that should themselves be considered stocks because the current stock spans multiple eco-regions (Longhurst 1998, Spalding et al. 2007).

There is limited data regarding Risso's dolphins offshore of New Jersey. Increased strandings of this species were recorded from 2003 to 2004 on New York, New Jersey, and Delaware coasts (DiGiovanni et al. 2005a). Other than strandings, this species has been primarily documented on the shelf break off of New Jersey (DiGiovanni et al. 2005b). There were no Risso's dolphins documented during the Geo-Marine (2010) study. However, one Risso's dolphin observation was recorded during Atlantic Shores 2020 geophysical campaign in Lease Area OCS-A-0499 (Lease Area).

Abundance

The best abundance estimate for Risso's dolphins is 35,215 individuals, calculated from 2016 surveys conducted by Northeast Fisheries Science Center (NEFSC) and Department of Fisheries and Oceans Canada (DFO) (Hayes et al. 2021). Estimates of population trend or net productivity rates have not been calculated for Risso's dolphins. Annual average estimated human-caused mortality or serious injury from 2015 to 2019 was 34 dolphins, most of which was likely due to interactions with fisheries (Hayes et al. 2021).

Status

Risso's dolphins are not listed as threatened or endangered under the ESA or designated as a strategic stock under the MMPA.

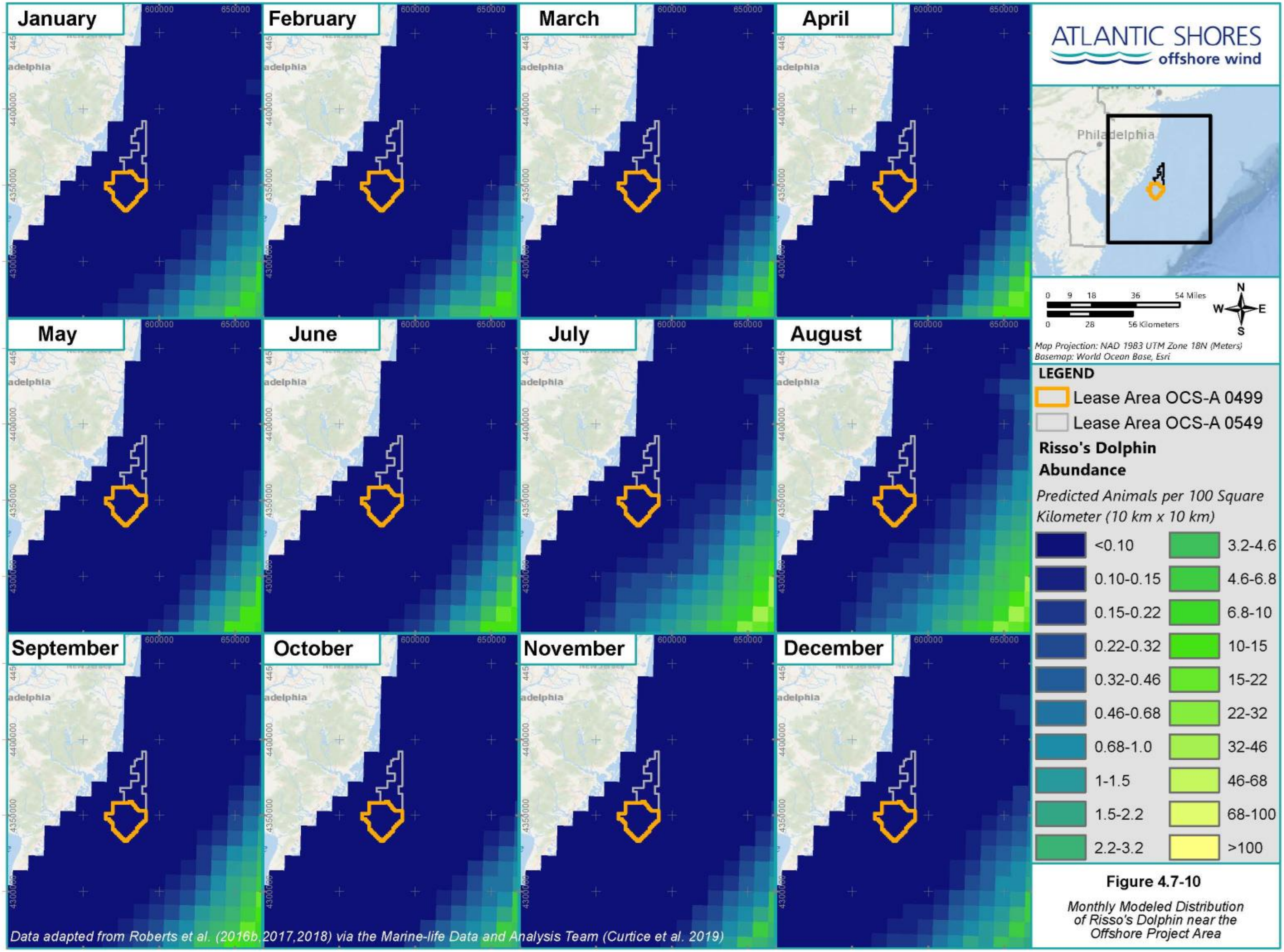


Figure 4.7-10

Monthly Modeled Distribution of Risso's Dolphin near the Offshore Project Area

Short-Beaked Common Dolphins *(Delphinus delphis)*

Short-beaked common dolphins (*Delphinus delphis*) are one of the most widely distributed cetaceans and occur in temperate, tropical, and subtropical regions (Jefferson et al. 2008). Short-beaked common dolphins can reach 9 ft (2.7 m) in length and have a distinct color pattern with a white ventral patch, yellow or tan flank, and dark gray dorsal "cape" (NOAA Fisheries 2018h). This species feeds on schooling fish and squid found near the surface at night (NOAA Fisheries 2018h). Short-beaked common dolphins are in the mid-frequency functional hearing group. Their vocalizations range from 300 Hz to 44 kHz (Southall et al. 2007).

<u>Distribution</u>

Short-beaked common dolphins within the U.S. Atlantic EEZ belong to the Western North Atlantic stock, generally occurring from Cape Hatteras to the Scotian Shelf (Hayes et al. 2018b). Short-beaked common dolphins are a highly seasonal, migratory species. Within the U.S. Atlantic EEZ, this species is distributed along the continental shelf and is associated with Gulf Stream features (CeTAP 1982, Selzer and Payne 1988, Hamazaki 2002, Hayes et al. 2019). Short-beaked common dolphins occur from Cape Hatteras northeast to Georges Bank (35° to 42°N) during mid-January to May and move as far north as the Scotian Shelf from mid-summer to fall (Selzer and Payne 1988). Migration onto the Scotian Shelf and continental shelf off Newfoundland occurs when water temperatures exceed 51.8°Fahrenheit (11°Celsius) (Sergeant et al. 1970, Gowans and Whitehead 1995). Breeding usually takes place between June and September, with females estimated to have a calving interval of two to three years (Hayes et al. 2019).

There have been numerous sightings of short-beaked common dolphins throughout the New Jersey coastline (Ulmer 1981, Hamazaki 2002). Generally, this species has been documented 20 nm (>37 km) near the shelf break within the months of February, May, and July, however, they have been sighted throughout the year (Figure 4.7-11) (Geo-Marine 2010). Short-beaked common dolphins are most common at the surface and are regularly observed in large groups consisting of hundreds of animals (NOAA Fisheries 2020a). Multiple strandings of the short-beaked common dolphins have occurred within the New Jersey coasts across multiple seasons (NOAA/NMFS 2004). Geo-Marine (2010) recorded a total of 32 short-short beaked common dolphin sightings off the coast of New Jersey. The observed species were documented in waters ranging from 33 to 102 ft (10 to 21 m) (Geo-Marine 2010). Approximately 26% of the shipboard sightings were calves during the Geo-Marine (2010) study.

<u>Abundance</u>

The best abundance estimate for the western north Atlantic stock of common dolphins is 172,947 individuals based on 2016 survey results. Average annual estimated human-caused mortality and serious injury between 2015 to 2019 was 390.49 animals (Hayes et al. 2021).

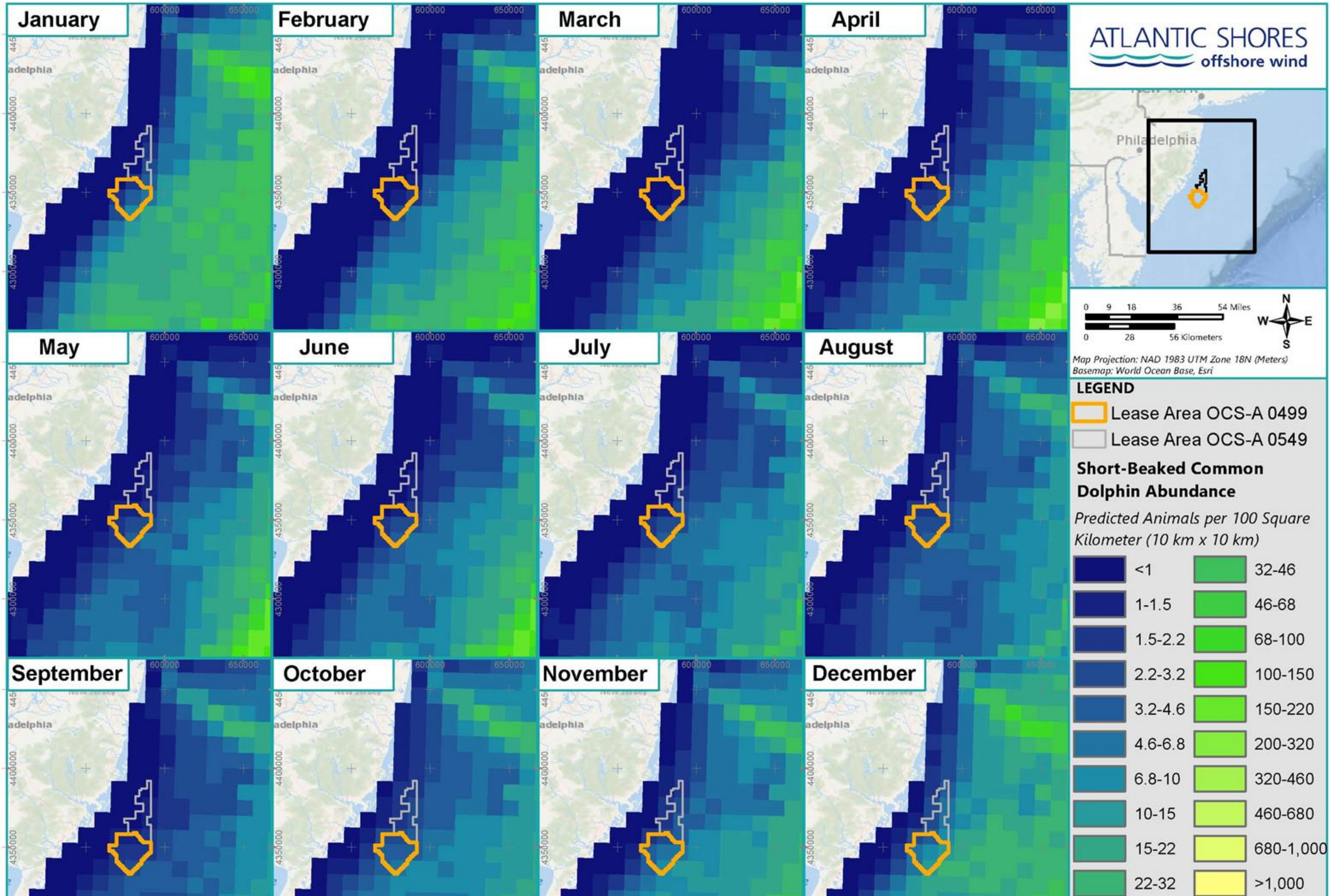


Figure 4.7-11

Monthly Modeled Distribution of Short-beaked Common Dolphin Near the Offshore Project Area

Status

Short-beaked common dolphins are not listed as threatened or endangered under the ESA or designated as a strategic stock under the MMPA.

Sperm Whales (*Physeter macrocephalus*)

Sperm whales are the largest of the toothed whales and characterized by their large, bulbous heads. Adults can achieve 15 tons (females) to 45 tons (males). They mainly reside in deep-water habitats on the OCS, along the shelf edge, and in mid-ocean regions (NOAA Fisheries 2010). However, this species has also been observed in relatively high numbers in shallow continental shelf areas off the coast of southern New England (Scott and Sadove 1997). Sperm whale vocalizations include directional clicks, from less than 100 Hz to 30 kHz with most of the clicks is in the 5 to 25 kHz range. Sperm whales use echolocation and produce repeated patterns of clicks or codas, which are used to attract females, compete for mates, display aggression, and maintain group cohesion (Wahlberg 2002). Foraging sperm whales make regularly spaced clicks interrupted by "creaks" and very rapid clicking for locating and capturing prey (Wahlberg 2002; Richardson et al. 1995).

Distribution

Sperm whale migratory patterns are not well-defined, and no obvious migration patterns have been observed in certain tropical and temperate areas. However, general trends suggest that most populations move poleward during summer (Waring et al. 2015). Within U.S. Atlantic EEZ waters, sperm whales appear to exhibit seasonal movement patterns (CeTAP 1982, Scott and Sadove 1997). During winter, sperm whales are concentrated to the east and north of Cape Hatteras. This distribution shifts northward in spring, when sperm whales are most abundant in the central portion of the Mid-Atlantic Bight to the southern region of Georges Bank. In summer, this distribution continues to move northward, including the area east and north of Georges Bank and the continental shelf to the Mid-Atlantic region. In fall, sperm whales are most abundant on the continental shelf to the south of New England and remain abundant along the continental shelf edge in the Mid-Atlantic Bight (Figure 4.7-12).

There were no sperm whale sightings during the Geo-Marine (2010) study; however, approximately nine individuals were observed offshore of New Jersey near the OCS during shipboard surveys in summer 2011 (Palka 2012). There is substantial information on sperm whale occurrence offshore of New Jersey, but they are exclusively near the OCS (CETAP, 1982 Waring et al. 2007) and are unlikely to be present within the WTA. Due to the rare occurrence of sperm whales within New Jersey waters, the NJ ENSP recommend that the species should be removed from the New Jersey list of species (Bowers-Altman and NJ Division of Fish and Wildlife 2009).

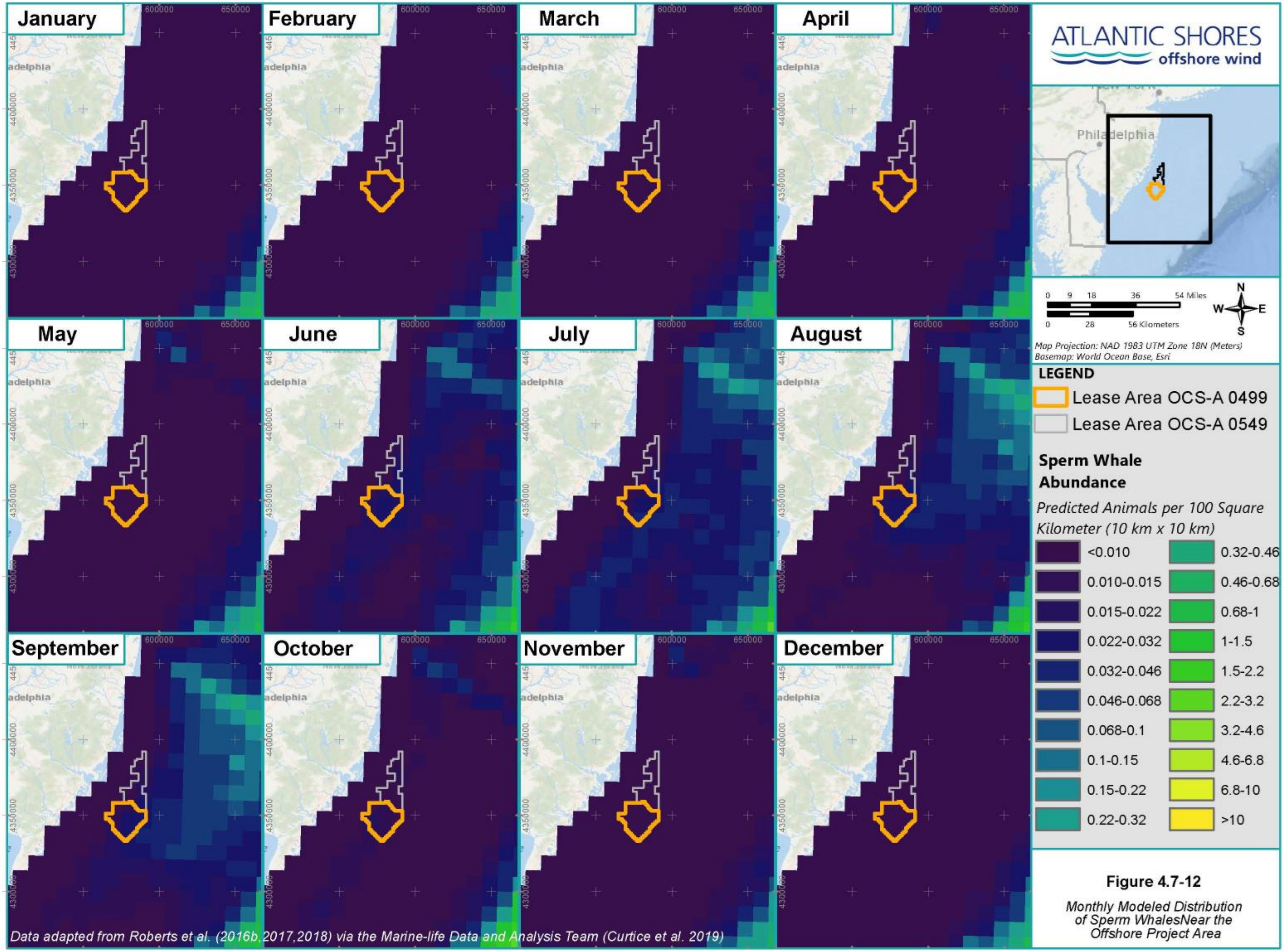


Figure 4.7-12

Monthly Modeled Distribution of Sperm WhalesNear the Offshore Project Area

Abundance

Though there is currently no reliable estimate of total sperm whale abundance in the entire western North Atlantic, the most recent and best available population estimate for the U.S. Atlantic EEZ is 4,439 (Hayes et al. 2020).

Status

Sperm whales are listed as endangered under the ESA and NJDEP, and the North Atlantic stock is considered strategic by NMFS under the MMPA.

Harbor Porpoises (*Phocoena phocoena*)

The harbor porpoise is abundant throughout the coastal waters of the Northern hemisphere and the only porpoise species found in the Atlantic Ocean. This species is the smallest cetacean, with a blunt, short-beaked head, dark gray back, and white underside (NOAA Fisheries 2018c). Harbor porpoises reach a maximum length of 6 ft (1.8 m) and feed on a wide variety of small fish and cephalopods (Reeves and Read 2003, Kenney and Vigness-Raposa 2010). Most harbor porpoise groups are small, usually between five and six individuals, although they aggregate into large groups for feeding or migration (Jefferson et al. 2008). Harbor porpoises are considered high-frequency cetaceans. The dominant component of harbor porpoise echolocation signals are narrowband, high-frequency clicks within 130 to 142 kHz (Villadsgaard et al. 2007).

Distribution

The harbor porpoise occupies both coastal and deep waters from off the coast of North Carolina to Greenland. They are commonly found in bays, estuaries, harbors, and fjords less than 656 ft (200 m) deep (NOAA Fisheries 2018c). Hayes et al. (2019) report that harbor porpoises are generally concentrated along the continental shelf within the northern Gulf of Maine and southern Bay of Fundy region during summer (July to September). During fall (October to December) and spring (April to June), they are more widely dispersed from New Jersey to Maine. In winter (January to March), intermediate densities of harbor porpoises can be found in waters off New Jersey to North Carolina with lower densities found in waters off New York to New Brunswick, Canada (Figure 4.7-13) (Hayes et al. 2019). There are four distinct populations of harbor porpoise in the western Atlantic: Gulf of Maine/Bay of Fundy, Gulf of St. Lawrence, Newfoundland, and Greenland (Hayes et al. 2019). Harbor porpoises observed within the U.S. Atlantic EEZ are considered part of the Gulf of Maine/Bay of Fundy stock.

Harbor porpoises are a frequently sighted cetacean offshore of New Jersey (Geo-Marine 2010). During the Geo-Marine (2010) study, 51 harbor porpoises sightings were documented approximately 0.8 to 19.8 nm (1.5 to 36.6 km) from shore (mean = 10.5 nm/19.5 km). These sightings were primarily during winter months (February to March). It is therefore likely that this marine mammal will be present within the WTA.

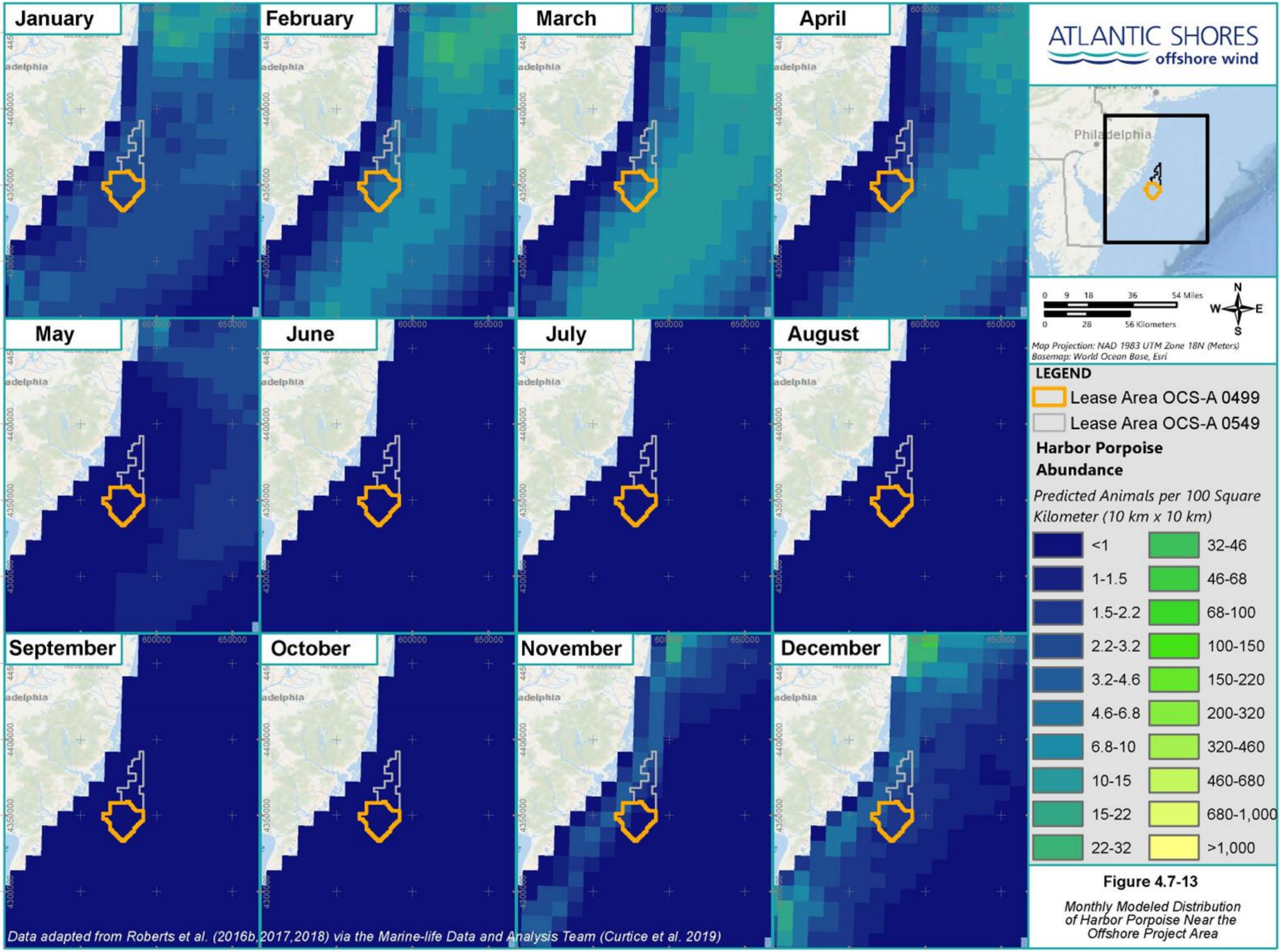


Figure 4.7-13

Monthly Modeled Distribution of Harbor Porpoise Near the Offshore Project Area

Abundance

According to data collected in 2016 by Northeast Fisheries Science Center (NEFSC) and DFO, the best abundance estimate of the Gulf of Maine/Bay of Fundy harbor porpoises is 95,543 individuals (Hayes et al. 2021). The total annual estimated average human-caused mortality and serious injury is 163 harbor porpoises per year based on fisheries observer data (Hayes et al. 2020).

Status

Harbor porpoises are not listed as threatened or endangered under the ESA or designated as a strategic stock under the MMPA.

4.7.1.4 Pinnipeds

Gray Seals (*Halichoerus grypus*)

Gray seals are large, reaching 7 to 10 ft (2 to 3 m) in length, and have a silver-gray coat with scattered dark spots (NOAA Fisheries 2018l). These seals are generally gregarious and live in loose colonies while breeding (Jefferson et al. 2008). Though they spend most of their time in coastal waters, gray seals can dive to depths of 984 ft (300 m) and frequently forage on the OCS (Lesage and Hammill 2001, Jefferson et al. 2008). These opportunistic feeders primarily consume fish, crustaceans, squid, and octopus (Bonner 1971, Reeves 1992, Jefferson et al. 2008). They often co-occur with harbor seals because their habitat and feeding preferences overlap (NOAA Fisheries 2018l). Gray seals, as with all pinnipeds, are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall et al. 2007). Vocalizations range from 100 Hz to 3 kHz (DoN 2008).

Distribution

Gray seals are the second most common pinniped along the U.S. Atlantic coast (Jefferson et al. 2008). This species inhabits temperate and sub-arctic waters and lives on remote, exposed islands, shoals, and unstable sandbars (Jefferson et al. 2008). Gray seals range from Canada to New Jersey; however, stranding records as far south as Cape Hatteras (Gilbert et al. 2005) have been recorded. The eastern Canadian population of gray seals ranges from New Jersey to Labrador and is centered at Sable Island, Nova Scotia (Davies 1957, Mansfield 1966, Richardson and Rough 1993, Lesage and Hammill 2001). There are three breeding concentrations in eastern Canada: Sable Island, Gulf of St. Lawrence, and along the east coast of Nova Scotia (Lavigueur and Hammill 1993). In U.S. waters, gray seals primarily pup at four established colonies: Muskeget and Monomoy islands in Massachusetts, and Green and Seal Islands in Maine. Since 2010, pupping has also been observed at Noman's Island in Massachusetts and Wooden Ball and Matinicus Rock in Maine (Hayes et al. 2019). Although white-coated pups have stranded on eastern Long Island beaches in New York, no pupping colonies have been detected in that region. Following the breeding season, gray seals may spend several weeks ashore in late spring and early summer while undergoing a yearly molt.

The gray seal is primarily found in coastal waters and forages in OCS regions (Lesage and Hammill 2003). For this reason, studies such as the Geo-Marine (2010) did not observe gray seals offshore of New Jersey. However, the Marine Mammal Stranding Center (2020) documented 25 gray seal strandings in 2019. Other reported sightings of gray seal in waters off of New Jersey were found as bycatch in gillnets (Hatch and Orphanides 2017, Orphanides 2019). Gray seals are less likely than harbor seals to occur around the offshore ECC route or the WTA (Hayes et al. 2019).

<u>Abundance</u>

The gray seal is found on both sides of the North Atlantic, with three major populations: Northeast Atlantic, Northwest Atlantic, and Baltic Sea (Haug et al. 2013). The Western North Atlantic stock is equivalent to the Northwest Atlantic population, and ranges from New Jersey to Labrador (Mansfield 1966, Scott et al. 1990, Katona et al. 1993, Lesage and Hammill 2001). In U.S. waters alone, Hayes et al. (2021) estimated an abundance of 27,300. PBR for gray seals (1,458) was calculated based on the most recent stock assessment reports (Hayes et al. 2021).

<u>Status</u>

Gray seals are not listed as threatened or endangered under the ESA or the NJDEP, and they are not considered strategic under the MMPA.

Harbor Seals (*Phoca vitulina*)

Adult harbor seals are not sexually dimorphic and both males and females are light gray to dark brown in color and typically reach 4.9 ft (1.5 m) and 220 pounds in size with a 35-year lifespan (NOAA Fisheries Service 2017). Harbor seals forage in both shallow coastal waters and deeper offshore waters, diving to target prey within the water column or on the seafloor (Tollit et al. 1997). Primary food sources vary with seasonal abundances of fish and crustaceans in the north and Mid-Atlantic coastal region, with the most numerous prey species including sandlance, silver hake, Atlantic Herring, and redfish (NOAA Fisheries Service 2007).

Male harbor seals produce underwater vocalizations during mating season to attract females and defend territories. These calls are comprised of “growls” or “roars” with peak energy at 200 Hz (Sabinsky et al. 2017). Captive studies have shown that harbor seals have good (greater than 50%) sound detection thresholds between 0.1 and 80 kHz, with primary sound detection between 0.5 and 40 kHz (Kastelein et al. 2009).

<u>Distribution</u>

Harbor seals are found throughout coastal waters of the Atlantic Ocean and adjoining seas above 30° N and is the most abundant pinniped within the U.S. Atlantic EEZ (Hayes et al. 2019). Harbor seals are year-round inhabitants of the coastal waters of eastern Canada and Maine (Richardson and Rough 1993) and occur seasonally from southern New England to New Jersey coasts between September and late May (Schneider and Payne 1983, Barlas 1999, Schroeder 2000). The western North Atlantic stock may occupy southern waters of the Mid-Atlantic Bight during seasonal migrations from the Bay of Fundy in the late autumn and winter (NMFS 2009; (Palka et al. 2017)). In addition to coastal waters, harbor seals utilize terrestrial habitat as haul-out sites throughout the year, but primarily during the pupping and molting periods, which occur from late spring to late summer in the northern portion of their range.

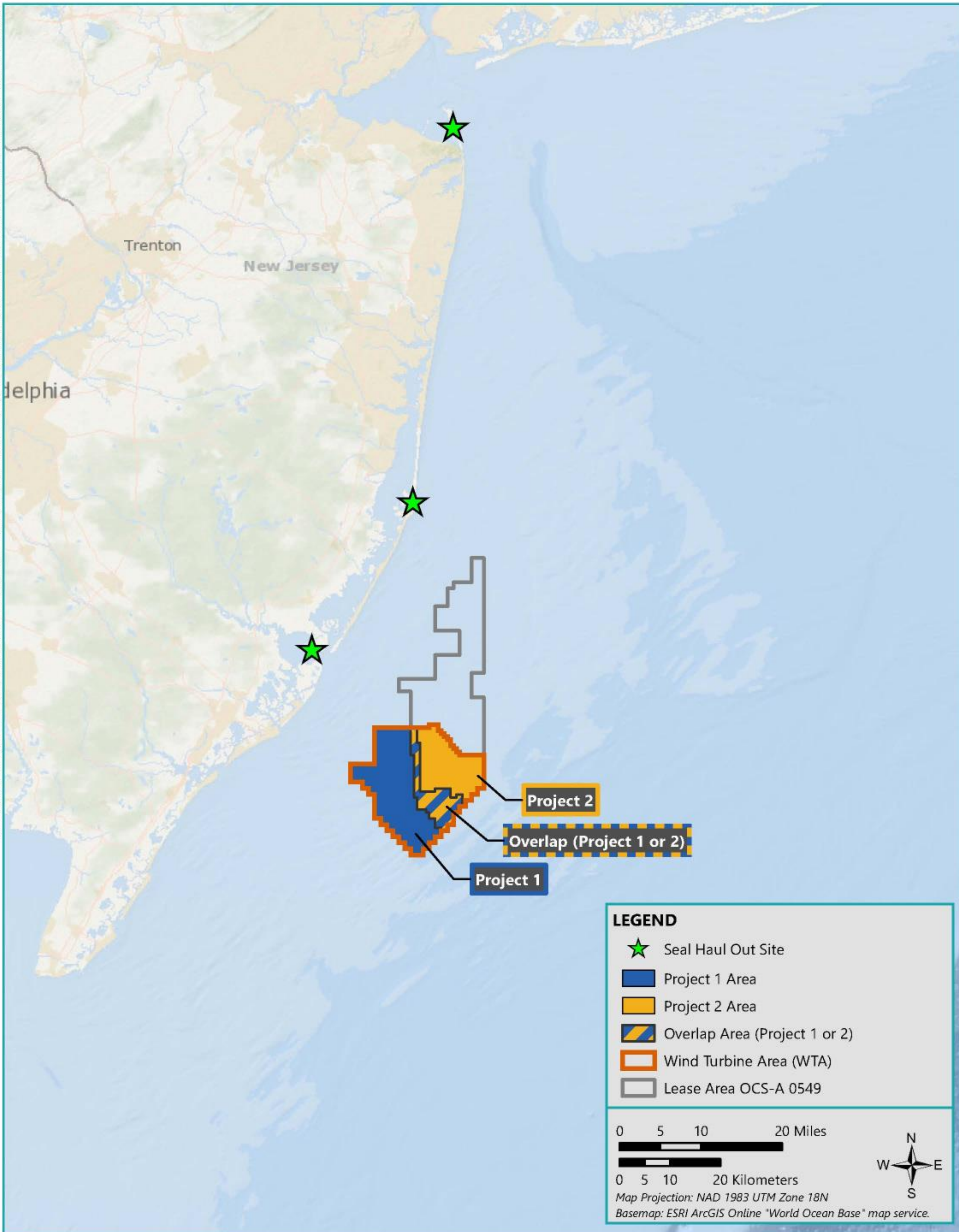
There are three major haul-out sites along the New Jersey coast, located in Great Bay, Sandy Hook, and Barnegay Inlet (Figure 4.7-14) (CWFNJ 2015). In the western North Atlantic, they are distributed from eastern Canada to southern New England and New York, and occasionally as far south as the Carolinas (Payne and Selzer 1989). A general southward movement from the Bay of Fundy to southern New England occurs in fall and early winter (Rosenfeld et al. 1988, Whitman and Payne 1990, Barlas 1999, Jacobs and Terhune 2000). A northward movement from southern New England to Maine and eastern Canada takes place prior to the pupping season, which occurs from mid-May through June along the Maine coast (Richardson 1976, Wilson 1978, Whitman and Payne 1990, Kenney 1994). Geo-Marine (2010) observed one harbor seal offshore of New Jersey during their survey effort.

Abundance

The best current abundance estimate for harbor seals is 61,336 individuals (CV = 0.08), estimated from survey results and analysis of abundance treads from 1993 to 2018 , (Hayes et al. 2021). Annual average estimated human-caused mortality and serious injury to harbor seals (from 2015 to 2019) is 339 seals (Hayes et al. 2021), with death due to fisheries interactions accounting for most of the mortality events. Harbor seal mortality through bycatch is highest in the Northeast Sink Gillnet fishery between Boston, Massachusetts, and Maine. Increased abundance of seals in the northeast region has also been documented during aerial and boat surveys of overwintering haul-out sites from the Maine/New Hampshire border to eastern Long Island and New Jersey (Payne and Selzer 1989, Rough 1995, Barlas 1999, Hoover et al. 1999, Slocum et al. 1999, deHart 2002).

Status

The Western North Atlantic Stock of harbor seals is not considered strategic under the MMPA (Hayes et al. 2020).



ATLANTIC SHORES offshore wind

Figure 4.7-14

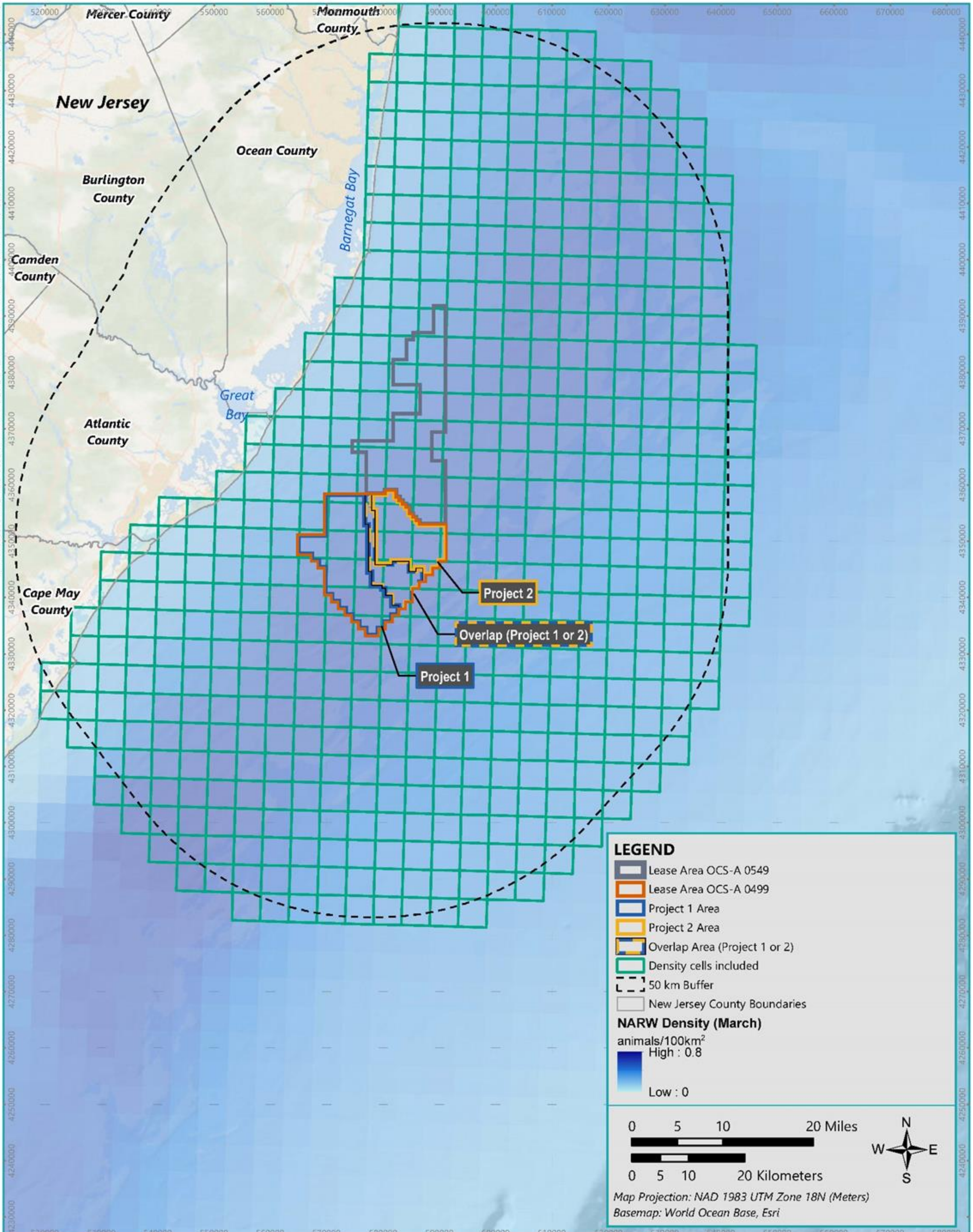
Major Seal Haul-Outs and Pupping Locations Near the WTA and ECC

4.7.1.5 Mean Monthly Marine Mammal Density Estimates

As the basis for assessing marine mammal exposure to Project-related activities, the mean monthly marine mammal densities (animals per 100 square kilometers) were estimated to understand what species, and at what density, occur in the WTA and ECCs. Mean monthly densities for all species except those categorized as rare, were calculated using a 27 nm (50 km) buffered polygon around the Lease Area, incorporating the WTA and ECCs, overlaid on marine mammal abundance maps from the Duke University Marine Geospatial Ecological Laboratory model results (Roberts et al. (2015, 2016a, 2017, 2018, 2020)). Figure 4.7-15 provides a spatial representation of the model used. The model also incorporates more sighting data than the Duke University data, including sightings from AMAPPS 2010 to 2014 surveys, which included some aerial surveys over the WTA (NEFSC and SEFSC 2011a, 2011b, 2012, 2014a, 2014b). Density estimates for pinnipeds were calculated using Roberts et al. (2018) density data.

The 27 nm (50 km) buffer defines the maximum area around OCS-A 0499 and the ECCs where there is the potential for noise exposure to result in marine mammal behavioral disturbance for all hearing groups using unweighted thresholds (HESS 1999, NOAA 2005). The use of a 27 nm (50 km) modeling field is consistent with recommendations of experts (Southall et al. 2016) who note that both the received levels and the distance from the source are known to influence the probability of behavioral response (Ellison et al. 2016a, Dunlop et al. 2017).

The mean density for each month was calculated using the unweighted mean of all 6.2 × 6.2 mi (10 × 10 km) or 3.1 × 3.1 mi (5 × 5 km) grid cells partially or fully within the buffer zone polygon (highlighted in Figure 4.7-15. Mean values from the density maps were converted from units of abundance (animals/38.6 square mile [mi^2] [100 square kilometers [km^2]) to units of density (animals/km^2). Densities were computed for the months coinciding with the anticipated pile-driving schedule (May to December). In cases where monthly densities were unavailable, annual (pilot whales) and seasonal (seals) mean densities were used instead. Table 4.7-2 shows the monthly marine mammal density estimates for each species evaluated in the acoustic analysis.



ATLANTIC SHORES offshore wind

Figure 4.7-15

Roberts et al. (2020) Grid Cells to Calculate Marine Mammal Densities in the Offshore Project Area

Table 4.7-2 Mean Monthly Marine Mammal Density Estimates for Species within a 3.8 km Buffer of BOEM Lease Area OCS-A 0499

Species		Monthly density (animals/100 km²) [a]												Annual mean	May to Dec mean
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
LF	Fin whale [b]	0.178	0.123	0.098	0.099	0.088	0.075	0.047	0.028	0.029	0.031	0.038	0.141	0.081	0.060
	Minke whale	0.051	0.049	0.049	0.737	0.810	0.202	0.054	0.026	0.015	0.066	0.016	0.042	0.176	0.154
	Humpback whale	0.093	0.065	0.084	0.101	0.091	0.058	0.011	0.006	0.020	0.065	0.086	0.121	0.067	0.057
	North Atlantic right whale [b]	0.069	0.074	0.062	0.046	0.010	0.003	0.001	0.001	0.002	0.004	0.010	0.042	0.027	0.009
	Sei whale [b]	0.026	0.016	0.034	0.074	0.027	0.006	0.001	0.001	0.002	0.008	0.026	0.042	0.022	0.014
MF	Atlantic spotted dolphin	0.001	0.000	0.001	0.003	0.006	0.012	0.028	0.133	0.109	0.147	0.113	0.008	0.047	0.070
	Atlantic white-sided dolphin	0.355	0.225	0.221	0.673	0.755	0.605	0.018	0.004	0.059	0.556	0.591	0.601	0.389	0.399
	Common dolphin	2.754	1.139	1.347	2.751	3.431	1.695	0.939	0.507	0.085	1.006	5.315	5.876	2.237	2.357
	Bottlenose dolphin, coastal [c]	2.917	1.024	2.053	8.290	20.869	27.429	29.272	31.415	32.096	29.744	30.414	16.667	19.349	27.238
	Bottlenose dolphin, offshore [c]	1.409	0.489	0.732	2.460	6.311	8.449	9.350	9.485	8.613	8.335	9.468	5.944	5.920	8.244
	Risso's dolphin	0.015	0.002	0.003	0.031	0.029	0.008	0.006	0.006	0.006	0.013	0.074	0.115	0.026	0.032
	Long-finned pilot whale [d]	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
	Short-finned pilot whale [d]	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
	Sperm whale [b]	0.004	0.002	0.001	0.007	0.010	0.005	0.003	0.000	0.000	0.000	0.003	0.004	0.003	0.003
HF	Harbor porpoise	3.968	3.756	3.091	4.161	1.025	0.033	0.023	0.016	0.003	0.007	0.029	2.891	1.584	0.503
PPW	Gray seal [e]	15.848	11.432	7.637	9.305	14.635	1.598	0.260	0.176	0.391	2.076	5.620	14.895	6.989	4.956
	Harbor seal [e]	15.848	11.432	7.637	9.305	14.635	1.598	0.260	0.176	0.391	2.076	5.620	14.895	6.989	4.956

[a] Density estimates are from habitat-based density modeling of the entire Atlantic Exclusive Economic Zone (EEZ) (Roberts et al. 2016, 2022).
[b] Listed as Endangered under the ESA.
[c] For bottlenose dolphins, the 3.9 km buffer was split at the 20 m isobath: coastal, <20 m; offshore >20 m.
[d] Long- and short-finned pilot whale densities are the annual pilot whale guild density scaled by their relative abundances.
[e] Gray and harbor seal densities are the Roberts et al. (2016, 2022) seals guild density scaled by their relative abundances.

4.7.2 Potential Impacts and Proposed Environmental Protection Measures

The potential IPFs that may affect marine mammals during the Projects' construction, O&M, and decommissioning are presented in Table 4.7-3. Marine mammals may also be affected by discharges from vessels and accidental releases; these potential impacts are considered to have a low likelihood of occurrence and are discussed in Section 9.2.3.

Table 4.7-3 Impact Producing Factors for Marine Mammals

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Vessel movements	•	•	•
Noise	•	•	•
Installation of new structures and cables	•	•	•
Electromagnetic fields		•	
Light	•	•	•
Presences of structures and cables		•	•

The maximum PDE analyzed for potential impacts to marine mammals is the maximum offshore build-out of the Projects (as defined in Section 4.11 of Volume I). Risk of impacts to marine mammals from Project activities can be significantly reduced, if not avoided, with the implementation of monitoring measures designed to detect marine mammals before they are impacted and mitigation techniques to lessen the potential for effects. Atlantic Shores is committed to a comprehensive mitigation program, summarized at the end of this section, to avoid and minimize impacts to marine mammals. To date, Atlantic Shores has demonstrated during the completion of its preconstruction surveys that adverse effects to marine mammals can be avoided.

For the purposes of the IPF assessment, potential effects on marine mammals have been categorized as either very low, low, moderate, or high based on the relative risk of exposure and the vulnerability of the marine mammal species to Project-related stressors. Relative risk is determined according to marine mammal species occurrence using existing literature on marine mammal distribution and presence/use of the Lease Area, information on the potential impacts of offshore wind farm construction and operations in both the U.S and globally, and studies that provide a general understanding of hearing, vessel collision risk, response to anthropogenic sound, and other factors that influence the potential impacts of offshore wind construction, O&M, and decommissioning activities on marine mammals. For example, exposure to a species that infrequently occurs in the Lease Area or is not sensitive to a particular IPF (e.g., noise) based on scientific literature, would be categorized as very low or low relative risk of impact to Project-related sound sources. Whereas exposure for an IPF to a species listed under the Endangered Species Act may be categorized as moderate risk.

4.7.2.1 Vessel Movements

Construction, O&M and decommissioning of the Projects will require the support of up to 16 types of vessels throughout the lifetime of the Projects (see Section 4.10, Table 4.10-1 of Volume 1). Atlantic Shores understands that vessel strikes are considered one of the primary threats to marine mammals and that presence of marine mammals within the Offshore Project Area will have to be monitored throughout all phases of Project development such that vessel interactions with these species can be avoided to the maximum extent practicable.

Studies suggest that vessel collisions pose a greater threat to baleen whales than to other marine species due to their size, mobility, and surface behavior (e.g., Kraus et al. 2005; Parks et al. 2011; Davies and Brilliant 2019). Vessel collision has also been documented as the leading cause of mortality for NARW since the 1970s (Moore et al. 2006). Research indicates that most vessel collisions with whales resulting in serious injury or death occur when a ship is traveling at speeds of over 14 knots (Laist et al. 2001).

The greatest potential for Project vessels to interact with marine mammals in the Offshore Project Area will be during transits to and from the WTA. Atlantic Shores estimates that approximately 550 to 2,050 vessel round trips to the Offshore Project Area will occur annually during Project operations, which is an average of two to six vessel trips per day. To minimize the potential for vessel interactions with marine mammals during vessel operations, Atlantic Shores will follow Federal guidelines to avoid vessel interactions with whales and adhere to all NOAA-mandated Seasonal Management Areas (SMA) or Dynamic Management Areas (DMAs). Currently, in the Mid-Atlantic, all vessels 65 ft (19.8 m) or greater operating within a SMA must travel at 10 knots or less between November 1 and April 30. For NOAA-established DMAs (which signify a grouping of three or more NARW) all vessels are encouraged to either avoid these areas or reduce speeds to 10 knots or less if transiting through.

Atlantic Shores will also monitor marine mammal activity during all Project phases to ensure that the chances for possible collisions are minimized. Specifically, Atlantic Shores will monitor NOAA notifications from the Right Whale Slow Zones Program, online or the "Whale Alert" app and the NOAA Right Whale Sighting Advisory System for NARW activity in the Offshore Project Area. Environmental training will also be provided to all vessel personnel responsible for operation, navigation, or lookout on marine mammal siting, avoidance, and reporting procedures. Atlantic Shores is also investigating the application of near real-time monitoring, autonomous underwater vehicles, and unmanned aerial systems to support the detection of marine mammals within the Offshore Project Area. With these monitoring measures and the implementation of vessel strike avoidance measures, the risk of marine mammal interactions with Project vessels is considered low to very low.

4.7.2.2 Noise

Noise, as defined as unwanted or disturbing sound, may result from Project activities during all phases of the Projects. However, the greatest potential for noise-generating activities will occur during the construction phase of the Projects. During construction, noise will be produced by vessels, vehicles, and equipment. Project-related noises produced during O&M activities are fairly limited to operating WTGs, infrequent surveys, and vessel traffic and are generally not considered a significant IPF for marine mammals. Atlantic Shores will implement a suite of marine mammal monitoring and mitigation measures to decrease the risk of exposures to marine mammals occurring in proximity to noise-inducing Project activities during construction.

Marine mammals use sound, either by actively producing or passively listening to sounds, for basic life functions such as communication, navigation, foraging, detecting predators, and maintaining social networks. Toothed whales (odontocetes) are known to produce echolocation sounds to image their surroundings and find prey. Additionally, marine mammals passively listen to sounds to learn about their environment by gathering information from other marine mammal species, prey species, and physical phenomena such as wind, waves, rain, and seismic activity (Richardson et al. 1995).

Marine mammals exposed to anthropogenic sound may experience impacts ranging in severity from minor disturbance to non-auditory injury (Southall et al. 2007, Wood et al. 2012, NMFS 2018, 2019). The severity of any noise-induced effect on marine mammals depends on the characteristics of received sounds (i.e., received level, frequency band, duration, rise time, duty cycle), the distance the sound travels and the biological context within which it occurs (Ellison et al. 2012, Ellison et al. 2016b, Ellison et al. 2018). The likelihood of a potential impact from an anthropogenic activity is dependent upon ambient conditions, the spatial and temporal co-occurrence of animals and the characteristics of the noise-producing activity.

Based on Project-specific modeling and pertinent findings in published scientific literature, the most likely impact on marine mammals from Project-related noise is the elicitation of changes in behavior. Behavioral responses of marine mammals to sound exposure can vary widely, from subtle responses, which may be difficult to observe and have limited implication for the affected animal, to obvious responses, such as avoidance, displacement, or panic reactions (Southall et al. 2016; Russell et al. 2016).

The potential for anthropogenic sounds to impact marine mammals is largely dependent on whether the sound occurs in frequency ranges within which a species can hear well. Southall et al. (2007) assigned the extant marine mammal species to functional hearing groups based on their hearing capabilities and sound production and other biological functions. This division into broad categories was intended to provide a realistic number of categories for which individual sound exposure criteria were developed. These groups were revised by NMFS (2018) but the categorization has proven to be a scientifically justified and useful approach in developing auditory weighting functions and deriving noise exposure criteria for the different marine mammal groups (Table 4.7-4).

Table 4.7-4 Marine Mammal Hearing Groups (NMFS 2018)

Hearing Group	Generalized Hearing Range[1]
Low-frequency (LF) cetaceans (mysticetes or baleen whales)	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans (odontocetes: delphinids, beaked whales)	150 Hz to 160 kHz
High-frequency (HF) cetaceans (other odontocetes)	275 Hz to 160 kHz
Phocid pinnipeds underwater (PPW)	50 Hz to 86 kHz
Phocid pinnipeds in air	50 Hz to 36 kHz

[1]The generalized hearing range is for all species within a group. Individual hearing will vary.

In 2018, NMFS issued voluntary technical guidance for assessing the effects of underwater human-made sound on marine mammals. The guidance recommends received thresholds when marine mammals are predicted to experience changes in hearing sensitivity (temporary or permanent threshold shifts [TTS or PTS] for incidental exposure to underwater man-made sound sources (NMFS 2018). The Technical Guidance document also recognizes two main types of sound sources: impulsive and non-impulsive. Impulsive sound sources generate intense and often repetitive noise (e.g., impact pile-driving). Non-impulsive sources consist of continuous or intermittent sources (e.g., propeller cavitation, sonar, vibratory hammering).

Table 4.7-5 provides the marine mammal injury and behavioral acoustic thresholds for impulsive sound sources used by NMFS and BOEM. NMFS also recommends the use of a dual criterion for assessing exposures to sound sources that can generate noise resulting in injury, including a peak (PK - unweighted/flat) sound level metric and a cumulative sound exposure level (SEL) metric with frequency weighting. Both acoustic criteria and weighting functions are divided into functional hearing groups (low-, mid-, and high-frequency) that species are assigned to, based on their respective hearing ranges and are intended to represent a species' ability to hear a sound (Nedwell and Turnpenny 1998, Nedwell et al. 2007). Sound levels thought to elicit changes in marine mammal behavior are described using the sound pressure level (SPL) metric (NMFS and NOAA 2005) or 160 dB re 1 μPa for impulsive sounds and 120 dB re 1 μPa for non-impulsive sounds for all marine mammal species (NMFS 2018), based on observations of mysticetes (Malme et al. 1983, 1984, Richardson et al. 1995, 1996).

Table 4.7-5 Marine Mammal Injury and Behavioral Acoustic Thresholds used by NMFS and BOEM for Impulsive Sound Sources

Hearing Group	Representative Species in The Offshore Project Area	Injury[1,2]		Behavior[1]
		L_{PK}	L_E	L_P
LF cetaceans	fin whale, sei whale, humpback whale, minke whale, NARW	219	183	160
MF cetaceans	Atlantic white-sided dolphin, short-beaked common dolphin, pilot whale, bottlenose dolphin, Risso's dolphin, sperm whale	230	185	
HF cetaceans	harbor porpoise	202	155	
PW	gray seal, harbor seal	218	185	

Notes:
L_{PK} – unweighted peak sound pressure (dB re 1 μPa).
L_E – hearing weighted sound exposure level (dB re 1 μPa^2·s).
L_p – unweighted root mean square sound pressure (dB re 1 μPa).
[1]NOAA (2005).
[2]Dual metric acoustic thresholds for impulsive sounds: The largest isopleth of the two criteria is used to calculate PTS onset.

The following sections address underwater sound that may be generated during activities conducted in the Offshore Project Area, including impulsive pile driving and other noise sources (e.g., HRG surveys, vessels, cable installation, vibratory pile driving for cofferdam installation, operational WTGs, operational offshore cables, and decommissioning) and assesses the potential effects noise generated from these activities may have on marine mammals. As described in the following sections, effects to marine mammals from underwater noise will be limited to radial distances from the source where sound levels are above regulatory thresholds. Pile driving noise during construction is the most likely to cause potential effects; however, noise mitigating measures (e.g., noise abatement systems such as bubble curtains and hydro-dampeners, soft starts and ramp up procedures, and ramp-down procedures, if necessary) will reduce the likelihood for exposure to harmful underwater sound levels.

Impact Pile-Driving Noise

To evaluate the potential risks to marine mammals from impact pile-driving noise, Atlantic Shores conducted an underwater acoustic and animal exposure modeling analysis. An overview of the modeling conducted is provided in Section 8.0 In-Air Noise and Hydroacoustics. The complete Underwater Acoustic and Animal Exposure Modeling of Construction Sound Report (Modeling Report) is provided as Appendix II-L1. This hydroacoustic assessment considered the proposed development for the Projects within the WTA in its entirety and thus evaluated the installation of up to 200 WTGs, up to 10 OSSs, and one permanent met tower.

To support the understanding of the potential exposure of marine mammals to pile-driving noise, the underwater acoustic analysis modeled the estimated radial distances (i.e., exposure ranges) to NMFS-recommended injury and behavioral thresholds (Table 4.7-5). The model evaluated distances to NMFS thresholds based on a range of operational conditions (e.g., foundation type, hammer type, pile-driving schedule) as well as levels of potential noise attenuation (ranging from 0 to 15 dB) that could potentially be achieved through the application of industry standard noise abatement systems (NAS). For the exposure assessment on marine mammals, the 10 dB attenuation level was conservatively chosen as the minimum sound reduction achievable with the application of a single NAS, such as a bubble curtain, during pile-driving (Bellmann et al. 2020). It is worth noting, however, that Atlantic Shores is investigating NAS options including, but not limited to, evacuated sleeve systems (e.g., IHC-Noise Mitigation System [NMS]), encapsulated bubble systems, and/or Helmholtz resonators (e.g., the AdBm NMS and HydroSound Dampers [HSDs]). These technologies may be capable of meeting or exceeding 10 dB attenuation during actual pile-driving, which could further decrease the radial distances away from the source of pile-driving noise.

Table 4.7-6 provides a summary of the representative modeling results for two pile-driving scenarios that represent the maximum potential exposure ranges (i.e., monopile and post-piled jacket foundations), inclusive of the assumed 10 dB attenuation. The full modeling results of all foundation types are provided in Appendix II-L1, Tables 14 – 16. The post-piled jacket foundation scenario is predicted to generate the maximum exposure ranges to regulatory-defined injury thresholds for all hearing groups. The monopile foundation scenario is predicted to generate the maximum exposure ranges to regulatory-defined behavioral threshold for all hearing groups.

It is important to note that the behavioral threshold (Table 4.7-5) currently used in impact assessment (NOAA 2005) are based on a SPL metric that does not account for species' frequency weighting or the duration of the exposure. However, the longer predicted distances from the pile-driving sound source to these accepted Federal behavioral response thresholds indicate that marine mammals would be exposed to levels of pile-driving noise that will induce changes in behavior before they are exposed to noise levels that could cause injury. For these Projects, the maximum exposure ranges to SPL thresholds (NOAA 2005) for all marine mammal species based on the two most conservative pile-driving scenarios (post-piled jacket and monopile) with 10 dB attenuation are 2.08 mi (3.34 km) and 2.48 mi (3.99 km), respectively (Table 4.7-6).

Table 4.7-6 Maximum Exposure Radial Distance (miles [km]) to Regulatory Injury and Behavioral Thresholds for Marine Mammals, Impact Pile-driving Noise from Post-piled Jacket and Monopile Foundation Installation with 10 dB Attenuation from a Noise Abatement System

Marine Mammal Hearing Group[1]	Metric	NMFS 2018 Thresholds	Post-Piled Jacket Foundation (16.4 ft [5 m] Diameter Piles) with 10 dB Attenuation Level	Monopile Foundation (49.21 ft [15 m] Diameter Piles) with 10 dB Attenuation Level
Injury				
Low Frequency (LF)[2]	L_{PK}	219	0	0
	L_E	183	1.18 mi (1.90 km)	1.12 mi (1.81 km)
Mid Frequency (MF)[3]	L_{PK}	230	0	0
	L_E	185	0.01 mi (0.01 km)	0
High Frequency (HF)[1]	L_{PK}	202	0.08 mi (0.13 km)	0.03 mi (0.05 km)
	L_E	155	0.92 mi (1.48 km)	0.16 mi (0.26 km)
Phocid Pinnipeds in Water (PPW)[1]	L_{PK}	218	0	0
	L_E	185	0.20 mi (0.32 km)	0.01 mi (0.02 km)
Behavioral				
All Hearing Groups[2]	L_p	160	2.09 mi (3.34 km)	2.48 mi (3.99 km)

Notes:
L_{PK} – unweighted peak sound pressure (dB re 1 μPa). NMFS 2018 Level A Threshold.
L_E – frequency weighted sound exposure level (dB re 1 μPa^2·s). NMFS 2018 Level A Threshold.
L_p – unweighted root mean square sound pressure (dB re 1 μPa). NOAA 2005 Level B Threshold.
[1]For additional species-specific information, please refer to Tables 34 through 37 in Appendix II-L.
[2]NMFS (2018)
[3]NOAA (2005)

To estimate the number of marine mammals that could be exposed to noise levels above Federal injury and behavior thresholds, important factors such as animal movement and marine mammal density estimates within the greater Lease Area were considered.[33] Forecasted animal movements (e.g., diving, foraging, surfacing) were included in the exposure modeling to account for real-life

33 For modeling purposes, marine mammal densities were calculated within a 31.1 mi (50) km buffered polygon around the Atlantic Shores Lease Area perimeter including the WTA and ECCs.

movements when estimating exposures by individual marine mammals. Species' distribution and densities were also accounted for because they play a significant role in the number of marine mammal exposure to pile-driving sounds. To account for these factors, the exposure model scales the number of potentially exposed species by their corresponding densities in the WTA (Roberts et al. 2016a, 2017, 2020). For example, habitat for harbor porpoises extends well beyond the WTA, and cetacean density estimates that numbers of baleen whales are lower in the WTA relative to preferred foraging habitats outside the area thus reducing the likelihood these species will be exposed to pile-driving noises in the WTA (LaBrecque et al. 2015).

Results of the marine mammal animal movement and exposure model based on the two most conservative pile-driving scenarios (OSS post-piled jacket and WTG/meteorological [met] tower monopile) with 10 dB attenuation are provided in Table 4.7-7. For endangered fin whales, sei whales and NARWs, modeled results suggest that, with minimal mitigation, small numbers of injurious level exposures are predicted during construction. The only species with exposures exceeding the injury (pk) threshold criteria with 10 dB noise attenuation were harbor porpoise (mean number exposed = 0.33; see Table 4.7-7). Appendix II-L provides additional information on marine mammal movement and exposure modeling.

The animal movement model also predicts behavioral level exposures for marine mammals expected to occur in the WTA. Probability of exposure to behavioral threshold levels of sound is highest for individuals of species that are considered common or regular, varying by month or season. The two most vulnerable species are NARWs and harbor porpoises for the reasons described above. Density models suggest that both species are seasonal in the WTA and predicted to occur in higher densities outside of the WTA, indicating suitable habitat is available for any displaced individuals. The model results predicted that fewer than five individual NARWs would be exposed to sound levels that could elicit a behavioral response.

Table 4.7-7 Mean Number of Marine Mammals Estimated to Experience Sound Levels Above Exposure Criteria for the Monopile and Post-piled Foundation Types with 10 dB of Noise Attenuation

	Monopile Foundation			Post-Piled Jacket Foundation		
	Injury Thresholds		Behavior Threshold	Injury Thresholds		Behavior Threshold
	L_E[1] (NMFS 2018)	L_{PK}[2] (NMFS 2018)	L_P[3] (NOAA 2005)	L_E[1] (NMFS 2018)	L_{PK}[2] (NMFS 2018)	L_P[3] (NOAA 2005)
Low-frequency cetaceans						
Fin Whale[4]	2.80	0	8.23	3.46	0	9.20
Minke Whale	10.07	0	135.38	16.27	0	141.72
Humpback Whale	2.20	0	8.33	3.02	0	9.82
North Atlantic Right Whale[4,6]	0.14	0	1.24	0.24	0	1.31
Sei Whale[4]	0.35	0	1.04	0.41	0	1.09
Mid-frequency cetaceans						
Atlantic White-Sided Dolphin	0.01	0	0	0.01	0	171.37
Short-Beaked Common Dolphin	0	0	159.94	0	0	0
Bottlenose Dolphin Northern Coastal	0	0	50.32	0	0	0
Bottlenose Dolphin	0	0	3,100.73	0	0	3,415.59
Risso's Dolphin	0	0	5.58	0	0	6.03
Pilot Whale[5]	0	0	0	0	0	0
Sperm Whale	0	0	0	0	0	0
High-frequency cetaceans						
Harbor Porpoise	1.38	1.93	49.85	12.52	0.33	39.23

Table 4.7-7 Mean Number of Marine Mammals Estimated to Experience Sound Levels Above Exposure Criteria for the Monopile and Post-piled Foundation Types with 10 dB of Noise Attenuation (Continued)

	Monopile Foundation			Post-Piled Jacket Foundation		
	Injury Thresholds		Behavior Threshold	Injury Thresholds		Behavior Threshold
	L_E[1] (NMFS 2018)	L_{PK}[2] (NMFS 2018)	L_P[3] (NOAA 2005)	L_E[1] (NMFS 2018)	L_{PK}[2] (NMFS 2018)	L_P[3] (NOAA 2005)
Pinnipeds in water						
Gray Seal	1.69	0	319.54	6.50	0	306.29
Harbor Seal	1.87	0	340.33	10.16	0	308.38

Notes:
A portion of an animal cannot be exposed during a project, so it is common practice to round mean number animal exposure values to integers using standard rounding methods. However, for low-probability events it is more precise to provide the actual values. For this reason, mean number values are not rounded.
The information provided within the table correlates with Tables 24 and 25 (Construction Schedule 2) within the March 28, 2023 *Updates to the Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization* (See Appendix II-L).
[1]L_E = sound exposure level (dB re 1 μPa^2·s).
[2]L_{pk} = peak sound pressure (dB re 1 μPa).
[3]L_p = root mean square sound pressure (dB re 1 μPa).
[4]Listed as Endangered under the ESA and NJDEP.
[5]Includes both long- and short-finned pilot whales.
[6]Exposure estimates for North Atlantic right whale are based on habitat-based whale densities that have since been revised by Roberts et al. (2020). An amendment to Appendix II-L1 Modeling Report containing revised exposure estimates for the North Atlantic right whale is pending completion.

As further explained in the Modeling Report (see Appendix II-L1), the modeled results should be interpreted with caution and not as absolute impact numbers because they are conservative and over-estimate both underwater sound propagation distances and the number of marine mammals exposed to potentially injurious or disruptive noises. The reasons for this conservatism are that the model does not account for environmental factors (e.g., ambient noise levels, physical variation of the marine environment), species-specific factors (e.g., animal aversion), and marine mammal monitoring and mitigation measures. These factors are expected to decrease the level of risk to marine mammals from impact pile-driving noise, as explained below:

- Ambient sound levels, mainly from other anthropogenic activities in the ocean, may mask Project-related noise and decrease the chance of exposure to marine mammals (Kraus et al. 2016; Hatch et al. 2012).
- Animal aversion is an important behavioral and mitigating factor likely decreasing the risk of marine mammal exposure from pile-driving and other construction sounds because received sound level generally decreases with distance. Moving away from sounds, or

aversion, is a common response of animals to sound, particularly at higher sound exposure levels (Ellison et al. 2012). Some level of aversion for all species is expected during construction. As shown in Section 4.3 of the Modeling Report (see Appendix II-L1), an estimation of the effect of aversion on exposure estimates for two representative species, harbor porpoise and NARW, indicates that when aversion is taken into account by the model, few numbers of porpoises and whales are exposed to noises above injury and behavior thresholds.

- Monitoring throughout construction activity is designed to detect marine mammals before they approach impact pile-driving close enough to be exposed to potentially injurious or disruptive sounds.
- Passive acoustic monitors will be deployed in combination with visual observations, performed by NOAA approved Protected Species Observers (PSOs). Current passive acoustic monitoring technologies include towed hydrophone arrays, stationary autonomous buoys, and autonomous underwater vehicles and gliders.
- Maintaining marine mammal protection zones during pile-driving and implementing operational controls to modify or halt potentially harmful activities when marine mammals are detected.
- Equipment operating procedures (e.g., soft starts, ramp-ups) to control the noise generated by pile-driving or survey equipment to prevent exposure of harmful sound levels to protected marine life.
- Prohibiting the beginning of impact pile-driving during low visibility/low conditions when marine mammals cannot be detected to decrease the overall risk of exposure. During nighttime activities and/or periods of inclement weather use of night vision devices such as night vision binoculars and/or infrared cameras will be implemented.

For all species, impacts resulting from sound exposure may affect individuals but have only very low to low risk of impact on marine mammal stocks or populations. The potential impact on the population will depend on the effect on the individual, the size of the species' population and the localized activity. There are 15 marine mammal stocks that may be present in the vicinity of the WTA during construction, O&M, and decommissioning. Five species (sei whales, Atlantic white-sided dolphins, pilot whales, Risso's dolphins, and sperm whales) are considered uncommon and thus have low exposure probability. For common and regular stocks, the potential exists for small numbers of marine mammals to experience sound level conditions at regulatory-defined injury and behavioral thresholds for impact pile-driving activities.

As with individual exposure estimates, Atlantic Shores modeled the number of injurious exposures predicted to occur as a percentage of species' abundance, the results of which confirmed that predicted injurious exposures are very low or low for all marine mammal species, with or without attenuation (see Tables 21 and 22 of the Modeling Report [Appendix II-L1]).

Behavioral responses for marine mammal species are likely limited to short-term disruption of behavior or displacement related to pile-driving noise. The estimated exposures to most species' stocks are expected to be significant over-estimates of the actual proportion of the stock potentially affected by pile-driving activities. That is because estimates of exposure do not account for animal aversion or the implementation of mitigation measures other than bubble curtains (e.g., clearance zones, additional NAS, pile-driving shutdown). Some marine mammals are well known for their aversive responses to anthropogenic sound (e.g., harbor porpoises). Other species in an area of exposure may move location depending on their acoustic sensitivity, life stage, and acclimation (Wood et al. 2012) and may or may not demonstrate behavioral responses.

Other Noise Sources

There are several other potential anthropogenic sound sources associated with offshore Project construction, O&M, and decommissioning. These sources were not quantitatively modeled because the potential acoustic impact of these noise sources is expected to be much less than impulsive pile driving. A qualitative assessment of possible impacts to marine mammals from other noise sources generated by Project activities, including high-resolution geophysical (HRG) surveys, vessels, cable installation, vibratory pile driving for cofferdam installation, operational WTGs, operational offshore cables, and decommissioning is summarized in this section.

High Resolution Geophysical (HRG) Surveys

As detailed in Sections 4.5.3 and 4.5.9 of Volume I, HRG surveys may be conducted to support pre-construction site clearance activities as well as post construction facilities surveys. HRG surveys use sound sources that output acoustic signals with frequency bandwidths and amplitudes best suited for the desired survey product. The acoustic signals often are impulsive, tonal, or chirp pulses (short duration signals that sweep through many frequencies). HRG sources can be grouped into three categories: (1) impulsive signals (e.g., boomers and sparkers) that are broadband with most energy at low frequencies; (2) chirp sonars, which are high-frequency sweeps with most energy at high frequencies; and (3) sonars (e.g., side-scan, multibeam), which are high-frequency tones or chirp signals (Halvorsen and Heaney 2018). The source level, beamwidth, pulse duration, and pulse repetition rate of such sources typically are adjustable.

The potential exists for small numbers of marine mammals to be exposed to underwater sound associated with HRG survey activities at levels correlated with behavioral responses. These sound levels may affect individuals but have only negligible effects on marine mammal stocks based on their seasonal density and distribution and their known reactions to exposure to impulsive, intermittent sound sources. A previous analysis by BOEM (2014) on the potential effects of sound associated with HRG surveys on marine mammals in the Mid- and South-Atlantic Planning Areas concluded that impacts are expected to be minor with the implementation of mitigation measures for sources operating at or below 200 Hz.

Atlantic Shores has completed several years of HRG surveys to date and successfully demonstrated that monitoring and mitigation during HRG surveys decreases the potential impacts to marine mammals. Many of the monitoring and mitigation strategies described for pile-driving are similar to those employed during HRG surveys. Standard mitigation employed during HRG surveys includes the use of protected species observers (PSOs), protective zones, ramp-up of active sound sources and shut down of sources should marine mammals enter the established shutdown zones. Because of the intermittent and short-term nature of HRG surveys, and the implementation of monitoring and mitigation measures, the effects of HRG noise on marine mammals are expected to be low.

Vibratory Cofferdam Installation

The installation and removal of cofferdams with vibratory pile driving of sheet piles will generate noise that will radiate into the marine environment. Vibratory pile driving generates non-impulsive or continuous sound that has a lower threshold for behavioral effects to marine mammals than for impact pile driving. Cofferdams will be installed at nearshore landing sites off the coast of New Jersey. The potential exists for small numbers of marine mammals to be exposed to noise from vibratory pile driving to install or remove cofferdams that may cause behavioral responses in a limited number of species, but no injurious effects on marine mammals are predicted from cofferdam installation nor removal.

Vessel Sounds

As discussed previously, Project vessel traffic will originate from one or more port facilities and arrive at the Offshore Project Area during construction, O&M, and decommissioning (see Sections 4.10.3 and 5.5 of Volume I). Ship engines, propellers, thrusters, and vessel hulls emit broadband, non-impulsive sound, which overlaps with the assumed or known hearing frequency ranges for all marine mammals. Presently, marine mammals occurring off of New Jersey are subjected to commercial shipping traffic and other vessel noise and could potentially be habituated to vessel noise (BOEM 2014). Because noise from Project-vessel traffic is likely to be the same, or similar to, background vessel traffic noise, the potential risk of impacts from vessel noise to marine mammals is expected to be low relative to the risk of impact from pile-driving sound.

Cable Installation and Cable Operation

As described in Section 4.5 of Volume I, cable installation activities generate non-impulsive, intermittent sounds when using mechanical or water jetting equipment. However, the dominant sound sources during cable installation are the thrusters on the dynamically positioned vessels that will be used. As discussed above regarding vessel noise, the impacts of noise exposure associated with this cable installation activity are expected to be low because noise from cable laying equipment activities is likely to be less than background vessel traffic noise.

High-voltage alternating current (HVAC) offshore cables are expected to produce non-impulsive low-frequency tonal vibration sound in the water. High voltage direct current (HVDC) cables do not produce a similar tonal sound because the current is not alternating. As previously explained in Section 4.6 Finfish, Invertebrates, and Essential Fish Habitat, the anticipated sound pressure level arising from the vibration of high voltage alternating current (HVAC) cables during operation are likely undetectable in the ambient soundscape of the WTA (Meißner et al. 2006). No effects on marine mammals are expected from low-frequency tonal vibration sound emitted during cable operations.

Aircraft

The Projects are likely to rely on aircraft for a variety of specific missions during construction, O&M, and decommissioning. Helicopters may be used for crew transfer or for visual inspection of equipment during installation activities. Atlantic Shores may also use fixed-wing aircraft to support monitoring and mitigation for protected marine species. Aircraft noise may be perceived by marine mammals at the ocean surface and cause temporary changes in behavior and localized displacement to the few individuals in the area (Richardson et al. 1985a, Richardson and Würsig 1997, Nowacek et al. 2007). In general, marine mammals may react to aircraft noise more often when the aircraft is lower in altitude, closer in lateral distance, and flying over shallow water (Richardson et al. 1985b, Patenaude et al. 2002). These reactions include short surfacing, hasty dives, aversion from the aircraft, or dispersal from the incoming aircraft (Bel'kovich 1960, Kleĭnenberg et al. 1964, Richardson et al. 1985a, Richardson et al. 1985b, Luksenburg and Parsons 2009). The response of marine mammals to aircraft noise largely depends on the species as well as the animals' behavioral state at the time of exposure (e.g., migrating, resting, foraging, socializing) (Würsig et al. 1998).

Helicopter and fixed-wing aircraft used during the Project construction phase will be in operation intermittently and maintain safe altitudes (usually 500 to 1000 ft [150 to 300 m]) above sea level. At these heights, aircraft noise may elicit short-term behavioral response in marine mammals. However, the risks of Project aircraft inducing adverse effects on marine mammals are considered low.

Wind Turbine Generators

Wind turbine generators (WTGs) produce sound in the nacelle that is transmitted from the topside to the foundation and then radiated into the water. Current literature indicates noise generated from the operation of wind farms is minor and does not cause injury or lead to permanent avoidance at distances greater than 0.5 nm (1 km) for the species studied (e.g., harbor porpoise, seals, and fish) (Wahlberg and Westerberg 2005, Stenberg et al. 2015), with potential to have minimal effects at much closer distances up to within a few meters of the WTG (Bergström et al. 2013). This operational noise from WTGs is generally low with sound pressure levels of around 151 dB [re 1 µPa] and frequency ranges of 60 to 300 Hz (Dow Piniak et al. 2012). Underwater noise level is related to WTG power and wind speed, with increased wind speeds creating increased underwater sound (Wahlberg and Westerberg 2005). Ambient noise within the 71 to 224 Hz frequency band in the MA WEA and RI/MA WEA was measured to be between 96 dB [re 1 µPa] and 103 dB [re 1 µPa] 50% of the time with greater sound levels 10% of the time (Kraus et al. 2016). Measurements at the Block Island Wind Farm determined that sound would likely decline to ambient levels at a distance of 0.5 nm (1 km) from the WTGs and average sound level was recorded to be between 112 to 120 dB [re 1 μPa] when wind speed was 6.5 to 39.4 feet per second (ft/s) (2 to 12 meters per second [m/s]) (HDR 2019).

Given the low level of sound generated by WTGs in relation to ambient sounds, no threat of injury to marine mammals is expected.

4.7.2.3 Installation and Maintenance of New Structures and Cables

The installation and maintenance of new foundation structures and offshore cables includes installation of associated scour and cable protection. These activities may have limited effect on marine mammals through direct seafloor disturbance and temporary increases in suspended sediment and deposition because the area of disturbance will be small relative to the total area of surrounding habitat (see Section 3.2 Water Quality). Moreover, as evident from environmental assessments and surveys performed in the Offshore Project Area, this area is dynamic in nature and experiences regular disturbance from natural (e.g., waves, storms, mobile sediment) and anthropogenic (e.g., fishing and vessel activity) sources. For example, marine mammal impact studies from dredging operations observed that marine mammals reside often in turbid waters and dredge-related plumes were localized and did not result in widespread or excessive turbidity that would impact marine mammals (Todd et al. 2015).

4.7.2.4 Electromagnetic Fields

This section addresses electromagnetic fields (EMF) generated during operation of the Projects and the localized effects on marine mammals. EMFs are invisible areas of electric and magnetic energy that occur both naturally and anthropogenically in the marine environment. Atlantic Shores conducted an EMF study to predict EMF levels from the Projects' submarine electrical system operation which includes a combination of HVDC and HVAC cables and OSSs (see Appendix II-I). The modeling results show that EMF levels are predicted to decrease exponentially with increasing distance from the cables and therefore do not pose a risk to marine mammals. Several studies have determined that cetaceans would likely not be affected by subsea cable EMFs, as the area of influence would be too small to alter their behavior (Normandeau Associates et al. 2011, Gill et al. 2014, Copping et al. 2016).

Potential EMF effects on marine mammal prey species (e.g., finfish, invertebrates) were evaluated in Section 4.6.2.4. Magnetic fields will be generated by the offshore cable system and multiple theories have been proposed for finfish detection of magnetic fields. Magnetosensitive fish species potentially occurring in the Offshore Project Area (e.g., sharks, rays and eels) may use magnetic fields for migration, navigation, and to locate food, habitat, and spawning grounds. Other finfish and pelagic invertebrate species of commercial or recreational value in the Offshore Project Area (e.g., flounder species, longfin squid, spot, scup, bluefish, hake species, black sea bass) likely lack the physiological components necessary to detect electric and magnetic fields and therefore are not expected to be adversely affected by EMF outputs from Project HVAC and HVDC export cables, HVAC inter-link cables, and HVAC inter-array cables. Most preferred marine mammal prey species fall into the latter category and are not expected to experience adverse effects from EMF.

4.7.2.5 Light

During construction, and O&M, vessels working or transiting during periods of darkness and fog will utilize lighting. During operations, Project structures will be lit in compliance with Federal Aviation Administration (FAA), U.S. Coast Guard (USCG), and BOEM guidelines for lighting and marking as described in Section 5.3 of Volume I. WTG aviation lights will likely be too high above sea level to penetrate the water surface. Navigation lighting on structures along the perimeter of the WTA will have lights close to sea level and could penetrate into the water. As discussed in Section 4.6.2.5, the artificial light from navigation lighting can attract or deter certain prey species of marine mammals (e.g., finfish, invertebrates). However, the amount of artificial Project lighting from vessels and structures that would penetrate the sea surface is expected to be localized and minimal and not likely to cause adverse effects to marine mammals or their prey species.

4.7.2.6 Monitoring Surveys

Monitoring surveys conducted during construction and operation of the Projects include otter trawl surveys, trap surveys, hydraulic clam dredge surveys, grab sampling, and underwater imagery. Based on the presence of these materials within the water column, survey gear could affect marine mammals through entanglement or entrapment. Trawl nets pose a discountable threat to mysticetes (NMFS 2016a), and the slow speed of mobile gear and the short tow times (less than 30 minutes) further reduce the potential for entanglements or other interactions. Fish traps and the anchoring lines and buoys used to secure them may pose an entanglement risk to marine mammals, although Atlantic Shores will minimize these risks through use of groundlines, ropeless gear, and biodegradable components. Therefore, impacts on marine mammals from traps are expected to be negligible based upon the limited number of associated buoy lines, the short duration of sampling events, and the fact that entanglement in gear is extremely unlikely to occur. Given the short-term, low-intensity, and localized nature of the impacts of gear utilization during monitoring surveys, as well as the proposed mitigation and minimization measures, Atlantic Shores does not anticipate effects on marine mammals associated with monitoring surveys.

4.7.2.7 Dredging

Dredge equipment used during construction of the Projects may include mechanical dredging (i.e., backhoe) or hydraulic dredging (i.e., trailing suction hopper or cutterhead). Dredging is unlikely to exceed marine mammal PTS thresholds, but if dredging occurs in one area for relatively long periods, TTS and behavioral thresholds could be exceeded and masking of marine mammal communications may occur (NMFS 2018b; Todd et al. 2015). Reported sound levels associated with mechanical dredging include 176 dB re 1 µPa LRMS at 1 meter (BC MoTI 2016) and 107 to 124 dB re 1 µPa at 154 meters from the source with peak frequencies of 162.8 Hz (Dickerson et al. 2001; McQueen et al. 2019). Noise produced by hydraulic cutterhead dredging ranges in frequency from approximately 1 to 2 kilohertz, with reported Lrms source levels of 172 to 190 dB re 1 µPa-m (McQueen et al. 2019; Robinson et al. 2011; Todd et al. 2015). Given that dredging sound levels do not exceed the PTS threshold and dredging associated with the Projects is not expected to occur for long periods of time, adverse impacts from dredging noise associated with the Projects on marine mammals are not anticipated.

Temporary increases in suspended sediments and subsequent sediment deposition may occur in the Lease Area and OECC associated with dredging activities. Limited dredging activity is expected during construction and potentially during during O&M if cables require dredging to facilitate repair or maintenance; however, any maintenance impacts would be expected to be far less than those from construction activities. Impacts from suspended sediments and deposition would be temporary and confined to a small area close to the location of the dredging activity. Areas affected by temporarily suspended sediments are likely to overlap with areas impacted by pile driving and offshore cable installation. Marine mammals are likely to avoid such areas as previously described and are likely to be absent in areas impacted by temporarily suspended sediments before sediments are settled at the bottom. Suspended sediment and deposition causing activities associated with dredging are not expected to pose a risk to marine mammals.

4.7.2.8 Unexpected/Unanticipated Events

While unlikely to occur, construction, O&M, and decommissioning activities associated with the Projects may result in unexpected / unanticipated releases of fuels, fluids, and hazardous materials and trash and debris. All Project vessels will comply with USCG regulations for the prevention and control of oil spills (33 CFR Part 155) (See Volume I, Appendix I-D), further reducing the likelihood of an accidental release. Atlantic Shores has also developed an OSRP with measures to prevent accidental releases and a protocol to respond to such a release (See Volume I, Appendix I-D). Potential impacts of unexpected / unanticipated events on marine mammals from exposure to accidental releases are expected to be sublethal due to quick dispersion, evaporation, and emulsification, which would limit the amount and duration of exposure.

4.7.2.9 Presence of Structures and Cables

Within the Offshore Project Area, the installation and presence of foundations, towers, cable protection, and scour protection are likely to result in the creation of hard-substrate habitat in what is currently, predominantly flat, sandy habitat. These changes may lead to temporary and localized shifts in limited areas of marine mammal habitat and changes to prey abundance, hydrodynamics, suspended sediment and deposition rates, and both invasive and non-invasive species attraction. Potential benthic and pelagic habitat effects from the presence of structures was previously discussed in Section 4.6.2.6. The overall negative impact of habitat alteration and prey availability is anticipated to be very low to low especially considering relatively large ranges of marine mammals and availability of habitat in other areas.

Although the presence of foundations and cable and scour protection could result in shifts to prey habitats and availability over time during the O&M phase of the Projects; foundations and cable and scour protection are expected to produce ecologically beneficial effects that could outweigh the risk of introducing hard structure to a small area of the vast flat, sandy habitat found in the Mid-Atlantic Bight. Once the Projects are decommissioned, the local environmental and ecological features of the area are expected to revert to pre-construction conditions. Potential impacts from decommissioning include the loss of Project-related hard structures, which are expected to be colonized at the time of decommissioning. Reef or structure-oriented marine mammal prey species (i.e., finfish, crustaceans) will be displaced during decommissioning as the foundations and scour protection are removed.

The presence of structures is not expected to impede marine mammal movements in an adverse way. During the O&M phase of the Projects, WTGs and OSSs will be positioned with sufficient distance between them (i.e., WTGs will be positioned in a grid with rows spaced 0.6 and 1 nm [1.1 and 1.9 km] apart, while the up to 10 OSSs will be placed on the same grid or between WTGs along the 1 nm [1.9 km] rows), so that marine mammals will not be impeded from natural use of the habitat, including migration and feeding.

4.7.2.10 Summary of Proposed Environmental Protection Measures

Atlantic Shores is committed to avoiding and minimizing Project-related impacts to marine mammals during all phases of the Projects. Atlantic Shores is developing a Marine Mammal Monitoring Plan in conjunction with key Federal, State and eNGO stakeholders that will inform Project activities and decision-making. In addition, Atlantic Shores will also be implementing a comprehensive program of best management practices (BMPs) to minimize and avoid Project impacts, while exploring new, innovative minimization/avoidance approaches. After mitigation measures are implemented, the residual risk of impacts to marine mammals is expected to be significantly reduced.

Throughout all phases of the Projects (pre-construction, construction, O&M, decommissioning) Atlantic Shores is committed to the implementation of the following key mitigation and monitoring strategies to reduce the risk of Project-related impacts to marine mammals:

- Vessel strike avoidance procedures will be implemented that reduce the potential risk of Project-related vessel collisions with marine mammals, including the following actions:
    - Adhere to marine wildlife viewing and safe boating guidelines (GARFO 2021) to the maximum extent practicable.
    - Train Project personnel in marine mammal spotting and identification, observation reporting protocols and vessel strike avoidance procedures, as applicable.
    - Adhere to applicable NOAA-established Seasonal Management Area and Dynamic Management Area speed restrictions for the NARW, which are currently 10 knots or less for vessels 65 ft [20 m] or greater during reported periods of high density.
    - Monitor marine mammal activity during all Project phases to ensure that the chances for possible marine mammal strikes are minimized. Specifically, Atlantic Shores will

monitor NOAA notifications from the Right Whale Slow Zones Program, online or the "Whale Alert" app and the NOAA Right Whale Sighting Advisory System for NARW activity in the Offshore Project Area.

- Marine debris caught on offshore Project structures will be removed, when safe and practicable, to reduce the risk of marine mammal entanglement.
- Atlantic Shores will implement the following measures in accordance with the Offshore Renewable Energy Credit (OREC) allowance that the New Jersey Board of Public Utilities (NJBPU) awarded to Atlantic Shores on June 30, 2021:
  - Maintain and update the Environmental Protection Plan (EPP) and Fisheries Protection Plan (FPP) at key Project milestones, including commencement of construction, completion of construction, and every 2 years thereafter, through decommissioning, or at other times as requested by NJDEP to ensure that impacts are being actively monitored and mitigated.
  - Update the EPP and FPP to ensure New Jersey's natural resources, including finfish and shellfish, sea turtles, marine mammals, avian species, bats and benthic populations are protected throughout the life of the Project from pre-construction through decommissioning and to ensure that any impacts are being actively monitored and mitigated as required by law.
  - Provide funding to the State of New Jersey for research initiatives and the regional monitoring of wildlife and fisheries related to the introduction of offshore wind projects. The funding will be administered by the New Jersey Department of Environmental Protection (NJDEP) and NJBPU, with stakeholder input to aid in the identification and prioritization of regional research and monitoring needs.
  - Report annually in writing to BPU and NJDEP beginning June 30, 2022, on actions taken to ensure environmental protection, fisheries protection, mitigation of environmental and/or fishing impacts. This report will specifically address how Atlantic Shores is enacting its plans for environmental and fisheries protection and mitigation of impacts as articulated in its Application to BPU. An appendix to the report will indicate the data collected in the reporting period, and will include an accessibly written, narrative description(s) of the dataset(s), the associated findings made based upon these data, and reference(s) to the data portal(s) where these data can be publicly accessed. This appendix will be made public.
  - Report annually in writing to BPU and NJDEP beginning June 30, 2022, on the policies and programs that may be adopted by BPU or NJDEP to help reduce future environmental or fisheries impacts or enhance the protection of natural resources. This report will detail any proposed future mitigation or protection measures that could be adopted, providing a description, proposed timeline, and expected outcomes of the recommended action.
  - Make public through appropriate data portals, all data collected in the development of the Project from pre-construction activities through decommissioning activities. All

collected information and scientific data not deemed confidential by statute or regulation will be made publicly available. Specifically, data with particular emphasis on natural resources including, but not limited to, finfish and shellfish, sea turtles, marine mammals, avian species, bat and benthic populations, as well as data regarding vessel strikes, avoidance, observations on habitat, and routine data collection on ocean conditions will be shared in a manner that is in keeping with best practices for the reporting of these types of data. Atlantic Shores will report annually to BPU and NJDEP beginning June 30, 2022, describing the type of data shared, and where the data is shared. Should a common database for New Jersey-related, scientific data generated in association with offshore wind development be created, Atlantic Shores will archive all data collected with the development of the Project in that data repositor.

Atlantic Shores will take additional precautions during activities that could generate underwater noises above regulatory-defined injury and behavior thresholds (e.g., impact pile-driving, HRG surveys), as follows:

- Marine mammal protection zones will be established and monitored to create sufficient opportunity to modify or halt Project activities potentially harmful to protected species, such as:
  - Shutdown Zones around activities that have the potential to harm marine mammals.
  - Clearance Zone (larger than an Shutdown Zone) around activities that have the potential to result in the harassment of marine mammals.
- Visual monitoring of Shutdown and Clearance Zones by NOAA Fisheries-approved PSOs will be conducted to alert the Projects' survey and/or marine construction teams to the presence of protected species, including:
  - Vessel-based and/or aerial monitoring of large Shutdown Zones and Clearance Zones.
  - Use of night vision devices such as night vision binoculars and/or infrared cameras, during nighttime activities and/or periods of inclement weather.
- Passive acoustic monitoring will be implemented to support the detection of vocalizing marine mammals during periods of inclement weather, low visibility and/or at night. Passive acoustic monitors will be deployed in combination with visual observations. Current passive acoustic monitoring technologies include towed hydrophone arrays, stationary autonomous buoys, and autonomous underwater vehicles and gliders.
- Pile-driving will follow a proposed schedule from May to December to minimize risk to NARW.
- Pile-driving will follow a proposed schedule that avoids the completion of pile-driving after dark.
- Equipment operating procedures will be implemented, as appropriate, to control the noise generated by pile-driving or survey equipment to prevent exposure of harmful sound levels to protected marine life.

- NAS will be implemented during impact pile-driving to decrease the propagation of potentially harmful underwater noises.
- Soft starts will be considered for activities such as impact pile-driving.
- Ramp-up procedures whereby the sound source level is increased gradually before full use of power will be used.
- A ramp-down, and if necessary, a shut-down of activities such as pile-driving and/or HRG survey equipment that has the potential to cause harm or harassment to marine mammals will occur if an animal is seen approaching or entering a Clearance Zone or Shutdown Zone.

Atlantic Shores is also evaluating additional innovative technologies and methods to improve the monitoring of marine mammals within the Offshore Project Area and to further inform regional efforts to understand cumulative impacts to these species. Through partnerships with universities, governmental agencies and environmental non-governmental organizations, Atlantic Shores is working with marine mammal experts to identify key knowledge gaps and to plan studies to advance the general understanding of marine mammals in the Mid-Atlantic Bight. Other innovations Atlantic Shores is currently investigating to further minimize impacts to marine mammal include:

- Near Real-Time Monitoring – Various acoustic technologies (e.g., passive underwater acoustic monitors, cable hydrophones) provide advantages for real-time monitoring of marine mammal vocalizations indicating species presence in an area.
- Autonomous Underwater Vehicles – Autonomous Underwater Vehicle technologies allow for remotely controlled data collection of the underwater environment without divers or intrusive methods to detect marine life and changing environmental conditions during certain Project activities (e.g., construction).
- Unmanned Aerial Systems – This effort will build on earlier trials conducted by RPS, AUV Flight Services and Advanced Aircraft Company, for which Federal regulatory agency approval was obtained. Atlantic Shores will conduct a field trial during an offshore wind survey using drone technology to monitor for protected species. The Unmanned Aerial Systems would be mounted with a high definition stabilized infrared camera system specifically designed for small, unmanned vehicles. A trial would be configured whereby a PSO team monitor high-definition drone camera footage in real time on shore, while a PSO team simultaneously monitored visually from a selected platform.

4.8 Sea Turtles

This section describes sea turtles that may be present within the Offshore Project Area, Project-related impact producing factors (IPFs), and anticipated environmental protection measures to avoid, minimize, or mitigate potential impacts to sea turtles during construction, operations and maintenance (O&M), and decommissioning. Sea turtles fill important roles in marine ecosystems by maintaining healthy seagrass beds, thus providing habitat for other marine life, balancing marine food webs, and facilitating nutrient cycling from sea to shore (Wilson et al. 2010). Sea turtles also provide a concentrated source of nutrients from their unhatched eggs to their nesting beaches and have been identified as important species for promoting vegetation growth and dune stabilization (Bouchard and Bjorndal 2000, Hannan et al. 2007). As discussed in this section, there are no documented seagrass beds or sea turtle nesting beaches in the Offshore Project Area or along the shoreline near the ECCs; however, sea turtles are generally known to occupy the Mid-Atlantic Bight with varying concentrations throughout the year (Greene et al. 2010).

To protect sea turtles that may occur in the Offshore Project Area, Atlantic Shores is implementing an assessment that considers how Project activities may affect sea turtles in the Offshore Project Area based on documented sea turtle distributions in the larger context of the Mid-Atlantic Bight. Atlantic Shores' assessment of sea turtles builds upon and fills data gaps from previously completed Federally and State funded research efforts. Relevant studies, both completed and ongoing, inform which species occupy the Offshore Project Area, and include state-of-the-art aerial digital surveys and underwater acoustic modeling coupled with animal movement and exposure modeling. In 2021, Atlantic Shores affixed two *Innovasea Vemco VR2W* receivers on separate metocean buoys installed in the WTA, which collected data on tagged sea turtles and highly migratory fish species that pass within the range of the receivers. Atlantic Shores also implemented Bureau of Ocean Energy Management (BOEM) and National Oceanic and Atmospheric Association (NOAA) approved mitigation measures during 2019 and 2020 pre-construction surveys to avoid vessel strikes and noise impacts on sea turtles. These efforts have informed Atlantic Shores Project design and construction planning to avoid or minimize possible Project-related impacts to sea turtles.

4.8.1 Affected Environment

Sea turtles that may occur in the Offshore Project Area during construction, O&M, and decommissioning may experience limited effects from certain Project activities. Descriptions, distributions, and abundances of sea turtles in the Offshore Project Area are based on reviews of existing technical reports, academic publications, and public reports (e.g., press releases). A number of aerial and shipboard studies in the region have recorded sea turtle observations and were included in this baseline characterization: Northwest Atlantic Marine Ecoregional Assessment (Greene et al. 2010), Northeast Fisheries Science Center (NEFSC) aerial surveys, NEFSC shipboard surveys, the North Atlantic Right Whale (NARW) Consortium database, and a multi-year series of seasonal aerial surveys conducted by Normandeau associates for the New York State Energy Research and Development Authority (NYSERDA) (Normandeau Associates Inc. and APEM Inc. 2018, 2019b, 2019a, 2019c, 2020).

In addition to these sources of information, Atlantic Shores conducted aerial digital surveys of the Offshore Project Area in 2020-2021. The results of these surveys and a detailed technical report provided in Appendix II-L2. In support of this COP and ongoing consultations with BOEM and NOAA regarding Federally protected species, Atlantic Shores has also completed an underwater acoustic and animal exposure modeling analysis for impact pile-driving noise based on hydroacoustic modeling analysis for the maximum Project Design Envelope (PDE), as described in Section 8.0 In-Air Noise and Hydroacoustics and the complete Underwater Acoustic and Animal Exposure Modeling Technical Report (see Modeling Report; Appendix II-L1). The relevant results of this analysis pertaining to potential Project-related noise impacts on sea turtles are discussed in Section 4.8.2.2.

Of the seven extant sea turtle species, six reside within U.S. waters. All six of these species are listed as threatened or endangered under the Endangered Species Act (ESA). While all six species of sea turtles may migrate through the Offshore Project Area and the Mid-Atlantic Bight for feeding opportunities during the summer and fall (Shoop and Kenney 1992, Shaver et al. 2005, McMichael et al. 2006, Rostal 2007, NMFS and USFWS 2014), the four species most likely to occur in the Offshore Project Area are loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), and Kemp's ridley (*Lepidochelys kempii*) sea turtles. Sightings of these sea turtles are less likely to occur in the Offshore Project Area when water temperatures are low during the winter and spring (Greene et al. 2010, BOEM 2012a).

Table 4.8-1 identifies the sea turtle species likely to occur in the Offshore Project Area including pertinent population characteristics derived from NOAA's periodic status reviews and other recent literature. Table 4.8-1 also indicates protection status, occurrence, and estimated abundance and categorizes species as common, regular, uncommon, and rare, based on their expected occurrence in the Offshore Project Area:

- Common – Occurring consistently in moderate to large numbers.
- Regular – Occurring in low to moderate numbers on a regular basis or seasonally.
- Uncommon – Occurring in low numbers or on an irregular basis.
- Rare – There are limited species records for some years; range includes the WTA but due to habitat preferences and distribution information, species are not expected to occur in the WTA. Records may exist for adjacent waters.

The following subsections provide information on the biology, distribution, habitat use, and abundance of the sea turtle species considered common, regular, and uncommon to the Offshore Project Area. The species categorized as rare, hawksbill and olive ridley, are not discussed in this section.

Table 4.8-1 Sea Turtles Species in the Western North Atlantic Ocean

Species	Scientific Name	Overlapping Distinct Population Segments (DPS)	Best Dps Abundance Estimate	Status Under Endangered Species Act (ESA)	Occurrence In Offshore Project Area[1]
Leatherback	*Dermochelys coriacea*	n/a - not listed with DPS[6]	34,000 to 94,000 adults (2006)[7]	Endangered	Common
Loggerhead	*Caretta caretta*	Northwest Atlantic[8]	68,000 to 90,000 nests per year in U.S.[9]	Threatened	Common
Green	*Chelonia mydas*	North Atlantic[2]	167,424 nesting females[2]	Threatened	Uncommon
Kemp's ridley	*Lepidochelys kempii*	n/a - not listed with DPS[4]	248,307 adults (2012)[5]	Endangered	Uncommon
Hawksbill	*Eretmochelys imbricata*	n/a - not listed with DPS[3]	3,600-= to 6,100 Atlantic nesting females[3]	Endangered	Rare
Olive ridley	*Lepidochelys olivacea*	Non-Mexican (Pacific Coast)[10]	2,606 nests (2002-2003) Western Atlantic ocean[11]	Threatened	No documented sightings

[1]From BOEM (2012a) EA using TNC NAM ERA (Greene et al. 2010) compiled data.
[2]NMFS (2015).
[3]NMFS and USFWS (2013).
[4]NMFS and USFWS (2015).
[5]Gallaway et al. (2013).
[6]NMFS and USFWS (2015).
[7]Turtle Expert Working Group (2007).
[8]Conant et al. (2009).
[9]NOAA Fisheries (2020).
[10]NMFS and USFWS (2014).
[11]da Silva et al. (2007).

Leatherback Sea Turtles

Leatherback sea turtles can grow to a maximum size of 8 feet (ft) (2.4 meters [m]) and 2,000 pounds (900 kilograms [kg]) and are distributed circumglobally between 47° south and 71° north latitude with nesting occurring on sandy beaches between 34° south and 38° north latitude (Eckert et al. 2012, USFWS 2018). U.S. nesting sites are not found north of Florida (Bräutigam and Eckert 2006). They are the most pelagic of the sea turtles, with migration patterns that vary by region. Atlantic leatherbacks tend not to cross the equator with Northern Atlantic individuals migrating between nesting sites and fertile feeding grounds in the Gulf of Maine, Gulf of Mexico, Canada, Europe, and West Africa, all north of the equator, where they consume mainly jellyfish but also feeding on sea urchins, squid, crustaceans, tunicates, fish, blue-green algae, and floating seaweed (Eckert et al. 2012, USFWS 2018). Juvenile leatherback sea turtles move offshore where they are believed to remain in warmer subtropical waters for a few years (Eckert 2002). Review of three years of aerial and shipboard surveys determined that between 100 and 900 leatherbacks utilize the Northwest Atlantic (Shoop and Kenney 1992). Leatherback turtle occurrence in the Offshore Project Area is more common in the summer and fall, but is possible all year (Geo-Marine 2010, BOEM 2012a).

Loggerhead Sea Turtles

Loggerhead sea turtles can grow to a maximum size of 9.2 ft (2.8 m) and 1,000 pounds (450 kg) and occur throughout the temperate and tropical waters in the Atlantic, Pacific, and Indian Oceans (Dodd 1988). Loggerheads typically consume invertebrates and fishes but are known to consume vegetation as well (Plotkin et al. 1993; (Bjorndal 1997)). Estimates of the age at first maturity vary. One estimate based on individuals in the Mediterranean Sea found maturity was reached between ages 24 to 29 years. While another study on turtles stranded in Georgia found that maturity was reached between ages 20 to 63 years (Casale et al. 2011). Nesting within the U.S. occurs on sandy beaches as far north as North Carolina (Conant et al. 2009). Recently hatched juveniles move offshore where they associate with sargassum habitats and other areas where debris and vegetation collect and provide food and shelter (Witherington 1997). Older juveniles and adults inhabit neritic waters, especially within large bays and other protected waters as far north as Cape Cod Bay along the east coast of the U.S. (Conant et al. 2009). Adults generally inhabit less protected neritic waters and are known to inhabit Mid-Atlantic shelf waters during summer months (Hawkes et al. 2007, Winton et al. 2018). A review of three years of aerial and shipboard surveys determined that between 2,200 and 11,000 loggerheads utilize the Northwest Atlantic (Shoop and Kenney 1992). Their occurrence in the Project Area is more common in the summer and fall but is possible all year (Geo-Marine 2010, BOEM 2012).

Green Sea Turtles

Green sea turtles can grow to a maximum size of 3.3 ft (1 m) in carapace length and weigh 441 pounds (200 kg) occurring throughout tropical, subtropical, and less frequently in temperate waters throughout the globe with nesting sites in more than 80 countries (Groombridge and Luxmoore 1989). Most juveniles spend their time in offshore pelagic habitats, specifically in and around sargassum mats, while adult turtles spend most of their lives in shallow coastal waters primarily consuming marine algae and seagrass with some populations consuming mainly invertebrates (Carballo et al. 2002). Estimates of age at sexual maturity range from 12 to 20 years up to 50 years with females nesting roughly three to 11 seasons throughout their life (Bell et al. 2005). Although uncommon, individual green turtles can be found in New Jersey waters in the summer and fall when water temperatures are highest. Most return to warmer waters during the winter or can succumb to cold-stunning (McMichael et al. 2006).

Kemp's ridley Sea Turtles

Kemp's ridley sea turtles can grow to a maximum size of 2.5 ft (0.75 m) and weigh a maximum of 110 pounds (50 kg) and are found primarily in the Gulf of Mexico with sightings as far north as the Grand Banks off Newfoundland and sporadic sightings off of the Azores and in the Mediterranean Sea (Conant 1975; Watson et al. 2004; Witt et al. 2007; Insacco and Spadola 2010). Adults typically remain in shallow waters consuming various organisms including mollusks, natural and synthetic debris, sea horses, cownose rays, jellyfish, fishes, and tunicates with seasonal migrations to nesting sites in the spring (Shaver et al. 2005, Rostal 2007, NMFS and USFWS 2014). Juveniles can spend the first two years of their life as pelagic individuals associated with sargassum before moving to neritic waters (Epperly et al. 2013). Neritic juveniles typically migrate to warmer waters during the winter (Lyn et al. 2012). Estimates of the age to maturity range from five to 12 years (Bjorndal et al. 2014) to 10 to18 years (Shaver and Wibbels 2007). In their northern range, which includes waters offshore of New Jersey, Kemp's ridley sea turtles primarily utilize nearshore coastal habitats in the summer and fall when water temperatures are warmest. Nesting is limited almost entirely to the Western Gulf of Mexico.

Seasonal Sea Turtle Density Estimates

Seasonal densities for all sea turtle species were derived from seasonal aerial abundance surveys conducted offshore New York (NYSERDA; Normandeau Associates Inc. and APEM Inc. 2018, 2019b, 2019a, 2019c, 2020). Four turtle species were reported as being present in the area during the NYSERDA surveys: loggerhead turtle, leatherback turtle, Kemp's ridley turtle, and green turtle. The NYSERDA study reported most of the sea turtles recorded in the region were loggerheads, by an order of magnitude. Leatherback and loggerhead sea turtles were also the most commonly observed turtle species during aerial surveys by Kraus et al. (2016) in the adjacent MA/RI and MA WEAs, with an additional six identified Kemp's ridley sea turtle sightings over five years.

The density numbers presented in (Table 4.8-2) were calculated using the maximum seasonal abundance from the NYSERDA reports for each sea turtle species. The abundance was corrected to represent the abundance in the entire Offshore Project Area then scaled by the full Offshore Project Area to obtain a density in units of animals per square kilometer. Two categories listed in the reports included more than one species: one combined loggerhead and Kemp's ridley turtles, and the other included turtles that were observed but not identified to the species level. The counts within the two categories that included more than one species were distributed amongst the relevant species with a weighting that reflected the recorded counts for each species. For example, loggerhead turtles were identified far more frequently than any other species, therefore more of the unidentified counts were assigned to them. The underlying assumption is that a given sample of unidentified turtles would have a distribution of species that was similar to the observed distribution within a given season.

Table 4.8-2 Seasonal Sea Turtle Density Estimates derived from NYSERDA Annual Reports

Species	Density (Animals/100 km^2)			
	Spring	Summer	Fall	Winter
Kemp's ridley sea turtle	0.050	0.991	0.190	0.000
Leatherback sea turtle	0.000	0.331	0.789	0.000
Loggerhead sea turtle	0.254	26.799	0.190	0.025
Green sea turtle	0.000	0.038	0.000	0.000

[1]Density estimates are derived seasonal abundance surveys conducted offshore New York (Normandeau Associates Inc. and APEM Inc. 2018, 2019b, 2019a, 2019c, 2020)

4.8.2 Potential Project-Related Impacts

The potential IPFs that may affect sea turtles during the Projects' construction, O&M, or decommissioning are presented in Table 4.8-3. Sea turtles may also be affected by discharges from vessels and accidental releases; these potential impacts are considered to have a low likelihood of occurrence and are discussed in Section 9.2.3.

Table 4.8-3 Impact Producing Factors for Sea Turtles

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Vessel movements	•	•	•
Noise	•	•	•
Installation of new structures and cables	•	•	•
Electromagnetic fields		•	
Light	•	•	•
Presences of structures and cables		•	•

The maximum PDE analyzed for potential impacts to sea turtles is the maximum offshore build-out of the Projects (as defined in Section 4.11 of Volume I). Risk of impacts to sea turtles from Project activities can be significantly reduced, if not avoided, with the implementation of monitoring measures designed to detect sea turtles before they are impacted and mitigation techniques to lessen the potential for effects. Atlantic Shores is committed to a comprehensive mitigation program, summarized at the end of this section, to avoid and minimize impacts to sea turtles. To date, Atlantic Shores has demonstrated during the completion of its preconstruction surveys that adverse effects to sea turtles can be avoided.

For the purposes of the IPF assessment, potential effects on sea turtles have been categorized as either very low, low, moderate, or high based on the relative risk of exposure and the vulnerability of the marine mammal species to Project-related stressors. Relative risk is determined according to sea turtle species occurrence using existing scientific literature values for distribution and presence/use of Offshore Project Area, information on the potential impacts of offshore wind farm construction and operations in both the U.S and globally, and studies that provide a general understanding of hearing, vessel collision risk, response to anthropogenic sound, and other factors that influence the potential impacts of offshore wind construction, O&M, and decommissioning activities on sea turtles. For example, exposure to a species that infrequently occurs in Lease Area OCS-A-0499 (Lease Area) (e.g., green turtle) or is not sensitive to a particular IPF (e.g., noise) based on scientific literature, would be categorized as having a low relative risk of impact to Project-related sound sources.

4.8.2.1 Vessel Movements

Construction, O&M and decommissioning of the Projects will require the support of up to 16 types of vessels throughout the lifetime of the Projects (see Section 4.10, Table 4.10-1 of Volume 1). Atlantic Shores understands that vessel strikes are considered a threat to sea turtles and that presence of sea turtles within the Offshore Project Area will have to be monitored throughout all phases of Project development such that vessel interactions with these species and can be avoided to the maximum extent practicable.

The greatest potential for Project vessels to interact with sea turtles in the Offshore Project Area will be during transits to and from the WTA. Atlantic Shores estimates that approximately 550 to 2,050 vessel round trips to the Offshore Project Area will occur annually during Project operations, which is an average of two to six vessel trips per day. As discussed in Section 4.7 Marine Mammals, Atlantic Shores will adhere to NOAA marine mammal requirements regarding vessel speed as well as guidance on vessel strike avoidance throughout all Project activities. These measures will also support efforts to minimize potential interactions with sea turtles.

Environmental training will also be provided to all vessel personal responsible for operation, navigation, or lookout on sea turtles siting, avoidance, and reporting procedures. The combination of these mitigation and monitoring, the risk of sea turtle interactions with Project vessels is considered low to very low.

4.8.2.2 Noise

Like other marine species, sea turtles have the potential to experience effects from increased levels of underwater sound. The following sections address underwater sound that may be generated during the Projects' construction, operations, and decommissioning along with their potential effects on sea turtles. These activities including impact pile-driving and other noise sources (e.g., HRG surveys, vessels, cable installation, vibratory pile driving for cofferdam installation, operational WTGs, operational offshore cables, and decommissioning). The Projects' construction phase will result in the most noise-generating activities. However, Atlantic Shores will be implementing mitigation and monitoring techniques (e.g., soft starts and ramp ups during impact pile-driving, protected species observers [PSOs], and noise abatement systems [NAS]) to decrease sea-turtle risk of exposures to noise-generating Project activities.

Impact Pile-driving Noise

To evaluate the potential risks to sea turtles from impact pile-driving noise, Atlantic Shores conducted an underwater acoustic and animal exposure modeling analysis. This hydroacoustic assessment considered the proposed development for the Projects within the WTA in its entirety and thus evaluated the installation of up to 200 wind turbine generators (WTGs), up to 10 offshore substations (OSSs), and one permanent met tower. An overview of the modeling conducted is provided in Section 8.0 In-Air Noise and Hydroacoustics. The complete Underwater Acoustic and Animal Exposure Modeling of Construction Sound Report (Modeling Report) is provided as Appendix II-L1.

Effects of anthropogenic sound from Project activities on sea turtles were assessed against the NOAA and BOEM accepted injury and behavioral acoustic thresholds criteria for impulsive and non-impulsive sounds. These threshold criteria are summarized in Table 4.8-4. Please note that injury and behavioral thresholds for sea turtles were developed for use by the US Navy (Finneran et al. 2017) based on exposure studies (e.g., McCauley et al. 2000a) and include dual acoustic thresholds (PK and SEL) for permanent threshold shift (PTS) and temporary threshold shift (TTS).

Table 4.8-4 Interim Sea Turtle Injury and Behavioral Acoustic Thresholds Currently used by NOAA NMFS Greater Atlantic Regional Field Office (GARFO) and BOEM for Impulsive and Non-impulsive Sounds

Hearing Group	Permanent Threshold Shift[1]		Temporary Threshold Shift[1]		Behavior[1,2]
	Impulsive Sounds				
	L_{PK}	L_E	L_{PK}	L_E	L_P
Sea turtles	232	204	226	189	175
	Non-Impulsive Sounds				
	L_E		L_E		L_p
	220		200		175

Notes:
LPK – peak sound pressure (dB re 1 μPa).
LE – sound exposure level (dB re 1 μPa2·s).
Lp – root mean square sound pressure (dB re 1 μPa).
Finneran et al. (2017).
McCauley et al. (2000a).

The hydroacoustic model estimated radial distances to regulatory-defined threshold levels based on a range of operational conditions (e.g., foundation type, hammer type, pile-driving schedule) as well as levels of potential noise attenuation (ranging from 0 to 15 decibels [dB]) that could potentially be achieved through the application of industry standard noise abatement systems (NAS). For the exposure assessment on sea turtles, the 10 dB attenuation level was conservatively chosen as the minimum sound reduction achievable with the application of a single NAS, such as a bubble curtain, during pile-driving (Bellmann et al. 2020). It is worth noting, however, that Atlantic Shores is investigating NAS options including, but not limited to, evacuated sleeve systems (e.g., IHC-Noise Mitigation System [NMS]), encapsulated bubble systems, and/or Helmholtz resonators (e.g., the AdBm NMS and HydroSound Dampers [HSDs]). These technologies may be capable of meeting or exceeding 10 dB attenuation during actual pile-driving, which could further decrease the radial distances away from the source of pile-driving noise.

Table 4.8-5 provides a summary of the representative modeling results to regulatory-defined sea turtle injury and behavioral thresholds for the monopile foundation pile-driving scenario. Of the pile-driving scenarios modeled, the monopile represents the maximum potential exposure ranges, inclusive of the assumed 10 dB attenuation. The full modeling results for all three foundation scenarios (i.e., monopile, pre-piled jacket, post-piled jacket) are provided in Appendix II-L1, Tables 23–25. When assuming impact pile-driving of a monopile (with 10 dB noise attenuation), the predicted maximum exposure radial distances for injury and behavior are less than 1 mi (1.6 km) from the source. No sea turtles are expected to be exposed to L_{PK} (peak sound pressure) exceeding the injury criteria threshold.

Table 4.8-5 Maximum Exposure Radial Distance (miles [mi]/ [km]) to Injury (Permanent Threshold Shift) and Behavior Thresholds for Sea Turtles due to Impact Pile Driving from Monopile Foundation (49.21 ft [15 m] diameter piles) with 10 dB Attenuation from a Noise Abatement System

Sea Turtles	Impact	Metric	Threshold	Monopile Foundation (49.21 ft [15 m] Diameter Piles) With 10 dB Attenuation Level
All species	Injury	L_{PK}	232	0
		L_E	204	0.11 mi (0.18 km)
	Behavior	L_p	175	0.87 mi (1.40 km)

L_{PK} – peak sound pressure (dB re 1 μPa).
L_E – sound exposure level (dB re 1 μPa^2·s).
L_p – root mean square sound pressure (dB re 1 μPa).

To estimate the number of sea turtles that could be exposed to noise levels above regulatory injury and behavior thresholds, important factors such as animal movement and sea turtle density estimates within the greater Lease Area, were considered.34 Forecasted animal movements (e.g., diving, foraging, surfacing) were included in the exposure modeling to account for real-life movements when estimating exposures to individual sea turtles. Species' distribution and densities were also accounted for because they play a significant role in the number of sea turtles predicted to be exposed to pile-driving sounds. To account for sea turtle occurrence in the WTA, the exposure model scales the number of potentially exposed species by their corresponding densities in the area (Table 4.8-2; Normandeau Associates and APEM 2018, 2019a, 2019b, 2019, 2020).

Results of the sea turtle movement and exposure model based on the most conservative pile-driving scenario (monopile installation) with 10 dB attenuation is provided Table 4.8-6. The modeling analysis predicts that over the two-year construction period less than two sea turtles would be exposed to sound exposure levels (L_E) above the regulatory-defined threshold for injury and no sea turtles are expected to be exposed to peak sound pressure levels (P_K) exceeding the injury criteria threshold. In fact, these results are consistent across all foundation types (see Tables 26 and 27 of Appendix II-L1). Potential sea turtle exposure to noise levels above the regulatory-defined behavior threshold with 10 dB attenuation under the maximum exposure scenario (i.e., monopile installation) would not exceed a total of 46 Kemp's ridley, 26 leatherback, and two green sea turtles over the 2-year construction period. Potential exposures to loggerhead sea turtles are predicted to be greater than other sea turtle species due to its higher seasonal presence in the WTA during the summer months (Table 4.8-2).

[34] For modeling purposes, sea turtle densities were calculated within a 31 mi (50) km buffered polygon around the Atlantic Shores Lease Area perimeter including the WTA and ECCs.

Table 4.8-6 Mean Annual Number of Sea Turtles Estimated to Experience Sound Levels Above Exposure Criteria for the Monopile Foundation - 49.21 ft [15 m] with 10 dB of Noise Attenuation

	Monopile Foundation - 49.21 ft [15 m]		
	Injury		Behavior
	L_E	L_{PK}	L_P
	10 dB Attenuation	10 dB Attenuation	10 dB Attenuation
Kemp's ridley Turtle[1]	0.98	0	23.57
Leatherback Turtle[1]	0.37	0	12.21
Loggerhead Turtle	4.51	0	407.8
Green Turtle	0.06	0	0.66

A portion of an animal cannot be exposed during a project, so it is common practice to round mean number animal exposure values to integers using standard rounding methods. However, for low-probability events it is more precise to provide the actual values. For this reason, mean number values are not rounded.
L_E = sound exposure level (dB re 1 μPa^2·s).
L_{pk} = peak sound pressure (dB re 1 μPa).
L_p = root mean square sound pressure (dB re 1 μPa).
[1] Listed as Endangered under the ESA.

As evidenced by the modeling assessments, the potential impacts to sea turtles associated with exposure to sound levels above regulatorily defined thresholds are expected to be low and limited to the seasons when sea turtles are present (i.e., primarily summer and fall). Because of their rigid external anatomy, it is possible that sea turtles are highly protected from impulsive sound effects such as pile-driving (Popper et al. 2014), and studies suggest that pile-driving activities are unlikely to result in long-term behavioral modification.

As further explained in the Modeling Report (see Appendix II-L1), the modeled results should be interpreted with caution and not as absolute impact numbers because they are conservative and over-estimate both underwater sound propagation distances and the number of sea turtles exposed to noises above the accepted regulatory thresholds. The reasons for this conservatism are that the model does not account for environmental factors (e.g., ambient noise levels, physical variation of the marine environment), species-specific factors (e.g., animal aversion), and sea turtle monitoring and mitigation measures. These factors are expected to decrease the level of risk to sea turtles from impact pile-driving noise, as explained in the following list:

- Ambient sound levels, mainly from other anthropogenic activities in the ocean, may mask Project-related noise and decrease the chance of exposure to sea turtles (Kraus et al. 2016).
- Animal aversion is an important behavioral and mitigating factor likely decreasing the risk of sea turtle exposure from pile-driving and other construction sounds because received sound level generally decreases with distance. Moving away from sounds, or aversion, is a

common response of animals to sound, particularly at higher sound exposure levels (McCauley et al., 2000a). Some level of aversion for all species is expected during construction.

- Monitoring throughout construction activity is designed to detect sea turtles before they approach impact pile-driving close enough to be exposed to potentially injurious or disruptive sounds.
- Visual observations performed by NOAA-approved Protected Species Observers (PSOs) through pile-driving activities.
- Maintaining protection zones during pile-driving and implementing operational controls to modify or halt potentially harmful activities when sea turtles are detected.
- Equipment operating procedures (e.g., soft starts, ramp-ups) to control the noise generated by pile-driving or survey equipment to prevent exposure of harmful sound levels to protected marine life.
- Prohibiting the beginning of impact pile-driving during low visibility/low conditions when sea turtles cannot be detected to decrease the overall risk of exposure. During nighttime activities and/or periods of inclement weather use of night vision devices such as night vision binoculars and/or infrared cameras will be implemented.

For all species, impacts resulting from sound exposure may affect individuals but have only very low to low risk of impact on sea turtle populations. The potential impact on the population will depend on the effect on the individual, the size of the species' population and the localized activity. There are four sea turtle species that may be present in the vicinity of the WTA during construction, O&M, and decommissioning. The likelihood any sea turtle species occurring in the WTA is dependent on season and may vary from year-to-year (Normandeau Associates and APEM 2018, 2019a, 2019b, 2019, 2020).

Other Noise Sources

There are several other potential anthropogenic sound sources associated with offshore Project construction, O&M, and decommissioning. These sources were not quantitatively modeled because the potential acoustic impact of these noise sources is expected to be much less than impact pile-driving. A qualitative assessment of possible impacts to sea turtles from other noise sources generated by Project activities, including high-resolution geophysical (HRG) surveys, vessels, cable installation, vibratory pile driving for cofferdam installation, operational WTGs, operational offshore cables, and decommissioning is summarized in this section.

High Resolution Geophysical (HRG) Surveys

As detailed in Sections 4.5.3 and 4.5.9 of Volume I, HRG surveys may be conducted to support pre-construction site clearance activities as well as post construction facilities surveys. HRG surveys use sound sources that output acoustic signals with frequency bandwidths and amplitudes best suited for the desired survey product. The acoustic signals often are impulsive, tonal, or chirp pulses (short duration signals that sweep through many frequencies). HRG sources can be grouped into three categories: (1) impulsive signals (e.g., boomers and sparkers) that are broadband with most energy at low frequencies; (2) chirp sonars, which are high-frequency sweeps with most energy at high frequencies; and (3) sonars (e.g., side-scan, multibeam), which are high-frequency tones or chirp signals. The source level, beamwidth, pulse duration, and pulse repetition rate of such sources typically are adjustable.

A previous analysis by BOEM (2014) on the effects of HRG survey noise on sea turtles in the Mid- and South-Atlantic Planning Areas concluded that impacts are expected to be minor with the implementation of mitigation measures for sources operating at or below 200 Hz. Modeled acoustic ranges to injury thresholds for active acoustic sources used in HRG surveys are generally within a small distance from the source. Sea turtles in the vicinity of an HRG survey are not expected to be exposed to sound levels that could cause hearing damage (BOEM 2014). HRG equipment may produce sound levels associated with behavioral response in sea turtles such as avoidance of the sound source, disorientation, and change in normal behaviors such as feeding (BOEM 2014).

Atlantic Shores has conducted several months of HRG surveys to date and have successfully demonstrated that monitoring and mitigation during HRG surveys decreases the potential impacts to sea turtles. Many of the monitoring and mitigation strategies described for pile-driving are like those employed during HRG surveys. Standard mitigation employed during HRG surveys includes the use of PSOs, protective zones, ramp-up of active sound sources and shut down of sources should sea turtles enter the established shutdown zones. Because of the intermittent and short-term nature of HRG surveys, and the implementation of monitoring and mitigation measures, the effects of HRG noise on sea turtles are expected to be low.

Cofferdam Installation

The installation and removal of cofferdams with vibratory pile driving of sheet piles will generate noise that will radiate into the marine environment. Vibratory pile driving generates non-impulsive or continuous sound that has a lower threshold for behavioral effects to marine mammals than for impact pile driving. Cofferdams will be installed at nearshore landing sites off the coast of New Jersey. The potential exists for small numbers of marine mammals to be exposed to noise from vibratory pile driving to install or remove cofferdams that may cause behavioral responses in a limited number of species, but no injurious effects on marine mammals are predicted from cofferdam installation nor removal.

Vessel Sounds

As discussed above, Project vessel traffic will originate from one or more port facilities and arrive at the Offshore Project Area during construction, O&M, and decommissioning (see Sections 4.10.3 and 5.5 of Volume I). Ship engines, propellers, thrusters, and vessel hulls emit broadband, non-impulsive sound, which overlaps with the assumed or known hearing frequency ranges for sea turtles. Presently, sea turtles occurring off of New Jersey are subjected to commercial shipping traffic and other vessel noise and could potentially be habituated to vessel noise (BOEM 2014). Because noise from Project-vessel traffic is likely to be the same, or similar to, background vessel traffic noise, the potential risk of impacts from vessel noise to sea turtles is expected to be low relative to the risk of impact from pile-driving sound.

As with impulsive sound from pile-driving, the most likely effect of vessel noise on sea turtles is behavioral response. Given the low model-predicted estimates of exposure to pile-driving sound for sea turtles and the lower sound levels associated with vessel transit and operation, the risk to sea turtles from Project vessel operation is assessed as very low to low.

Cable Installation and Cable Operation

As described in Section 4.5 Benthic Resources, cable installation activities generate non-impulsive, intermittent sounds when using mechanical or water jetting equipment. However, the dominant sound sources during cable installation are the thrusters on the dynamically positioned vessels that will be used. Published impact studies for various cable projects have concluded that sound related to subsea cable installation was not a significant issue as recorded sound levels were highly variable, ranging from 123 dB to 178 dB SPL at the source, which is below the non-impulsive acoustic thresholds for injury in sea turtles (Nedwell et al. 2003). As described above for vessel noise, the potential impacts of noise exposure on sea turtles associated with this cable installation activity are expected to be very low and dependent on season. Noises from cable-laying equipment activities are also likely to be less than background vessel traffic noise.

High-voltage alternating current (HVAC) offshore cables are expected to produce non-impulsive low-frequency tonal vibration sound in the water. High voltage direct current (HVDC) cables do not produce a similar tonal sound because the current is not alternating. As previously explained in Section 4.6 Finfish, Invertebrates, and Essential Fish Habitat, the anticipated sound pressure level arising from the vibration of high voltage alternating current (HVAC) cables during operation are likely undetectable in the ambient soundscape of the WTA (Meißner et al. 2006). No effects on sea turtles are expected from low-frequency tonal vibration sound emitted during cable operations.

Aircraft

The Projects are likely to rely on aircraft for a variety of specific missions during construction, O&M, and decommissioning. Helicopters are sometimes used for crew transfer operations and may also be used for visual inspection of equipment while vessels continue with installation activities. Atlantic Shores may also use fixed-wing aircraft to support monitoring and mitigation for protected marine species.

Helicopter and fixed-wing aircraft used during the Projects' construction phase will be in operation intermittently and maintain safe altitudes (usually 500 to 1000 ft [150 to 300 m]) above sea level. At these heights, aircraft noise is unlikely to elicit behavioral response in sea turtles based on acoustic thresholds. The risk of potential effects is considered low.

Wind Turbine Generators

A review of the sound characteristics of WTG noise on marine wildlife was presented in Section 4.7.2.2. The anticipated WTG underwater sound levels are well below both non-impulsive injury and behavioral response thresholds for sea turtles (see Table 4.8.4). Effects of noise from wind turbines on sea turtles are expected to be very low.

4.8.2.3 Monitoring Surveys

Atlantic Shores will conduct monitoring surveys for sea turtles in the Project Areas during construction. Sea turtles could be affected by these surveys through survey vessel traffic and interactions with survey gear. Survey vessels would produce underwater noise and potentially increase the risk of vessel strikes. The effects of vessel noise and increased strike risk would be similar to those discussed under the Noise and Vessel Movement sections above.

Additional impacts on sea turtles could result from interactions with mobile (e.g., trawl, dredge) or fixed (e.g., trap, hydrophone) survey gear. Atlantic Shores expects to use trawl surveys, among other methods, for Project monitoring and will implement mitigation measures during survey events, such as restricting tow times, to eliminate the risk of serious injury and mortality associated with forced submergence of sea turtles caught in bottom-trawl survey gear.

The vertical buoy and anchor lines associated with monitoring surveys using fixed gear, such as fish traps or baited remote underwater video, could pose a risk of entanglement for sea turtles. While there is a theoretical risk of sea turtle entanglement in trap and pot gear, particularly for leatherback sea turtles (NMFS 2016), the likelihood of entanglement would be negligible given the patchy distribution of sea turtles, the small number of vertical lines used in the surveys, and the relatively limited duration of each sampling event.

Hydrophone mooring lines for passive acoustic monitoring studies pose a theoretical entanglement risk to sea turtles, similar to trap and pot surveys. However, Atlantic Shores will utilize the best available technology to reduce any potential risks of entanglement. Therefore, passive acoustic studies are expected to pose a negligible risk of entanglement to sea turtles.

Monitoring surveys are expected to occur at short-term, regular intervals over the lifetime of a project. Though the potential extent and number of animals potentially exposed cannot be determined without project-specific information, impacts of gear utilization on sea turtles are expected to be negligible given the negligible risk of mortality, the negligible risk of entanglement, and the negligible effect on sea turtle prey availability.

4.8.2.4 Dredging

Impacts from dredging during construction, in addition to the noise discussed above, could affect sea turtles through impingement, entrainment, and capture associated with mechanical and hydraulic dredging techniques. Clamshell and suction dredging for the Project may occur both inshore and offshore within the WTA and export cable corridors. Additionally, dredging may also be required in the HDD pits at landfall and in shallow areas to allow vessel access for export cable installation. Based on the nature of the dredging activity, physical interaction between a mechanical dredge and sea turtles is extremely unlikely to occur. Further, dredging and material disposal is anticipated to occur during cold weather months when sea turtles are not anticipated to be present within the Project area. Finally, the Project would employ controlled/continuous rate of descent and lift which would decrease the rate of speed and potential to surprise an unsuspecting sea turtle on the seafloor. Furthermore, the Project would employ PSOs on landfall dredges, inshore where sea turtles are known to be more vulnerable to dredging, further decreasing the risk of impingement or entrainment of sea turtles during suction dredging activities. Given the short duration of dredging where sea turtles are most vulnerable, PSOs, and available information, the risk of injury or mortality of individual sea turtles resulting from dredging necessary to support the Projects are unlikely to occur.

The impact of suspended sediments is unlikely to be a high risk for sea turtles. Any increase in suspended sediments is likely to be primarily during construction activities, and impacts would be temporary and confined to a small area close to the location of the installation activity. Johnson (2018) suggested that any effects on sea turtle prey species from suspended sediments, sediment deposition, or turbidity may cause turtles to move to other areas and then return to the affected areas at some time in the future. Loggerhead, and Kemp's ridley forage across a wide range of habitats, including in turbid waters of estuaries and bays (Witzell and Schimid 2004; Thomson et al. 2013), and any potential impacts associated with increased turbidity associated with dredging are likely to be negligible.

Underwater noise generated by dredging activities could result in behavioral changes and auditory masking. Noise generated by dredging activities is transitory, and the sound levels are too low to cause death or injuries such as auditory threshold shifts (Finneran et al. 2017). It is conservative to assume that noise associated with dredging may elicit behavioral changes in individual sea turtles near the vessels. It is assumed that these behavioral changes, if they were to occur, would be limited to evasive maneuvers such as diving, changes in swimming direction, or changes in swimming speed to distance themselves from the dredging operation. Therefore, impacts to sea turtles from dredging activities would be negligible.

4.8.2.5 Installation and Maintenance of New Structures and Cables

The installation and maintenance of new foundation structures and offshore cables includes installation of associated scour and cable protection. These activities result in localized seafloor disturbances and temporary increases in suspended sediment and deposition that may alter limited areas of sea turtle habitat and cause short-term changes in sea turtle prey abundance. Few sea turtles are expected to be affected by these activities because the area of disturbance will be small relative to the total area of surrounding habitat (see Section 3.2 Water Quality). Moreover, as evident from environmental assessments and surveys performed in the Offshore Project Area, the affected area is dynamic in nature and experiences regular disturbance from natural (e.g., waves, storms, mobile sediment) and anthropogenic (e.g., fishing and vessel activity) sources. Temporary loss of prey species for foraging sea turtles is likely limited to the period of active construction with prey species expected to return when these activities cease (USCG 2006). Similarly, sea turtles are likely to avoid areas close to installation and maintenance activities, where sea floor disturbances and temporarily suspended sediments may occur.

4.8.2.6 Electromagnetic Fields

EMFs are invisible areas of electric and magnetic energy that occur both naturally and anthropogenically in the marine environment. Atlantic Shores conducted an EMF study to predict EMF levels from the Projects' submarine electrical system operation which includes a combination of HVDC and HVAC cables and OSSs (see Appendix II-I). The modeling results show that EMF levels are predicted to decrease exponentially with increasing distance from the cables and are therefore expected to cause minimal risk to sea turtles. Furthermore, the New Jersey Baseline Ecological Studies (Geo-Marine 2010) did not identify sea turtles as marine fauna that might be impacted by EMF.

Based on modeled EMF levels, sheathing and burial of cables, and limited time spent on the seafloor in proximity to cables, the risk of effects on sea turtles from EMFs is expected to be low. While sea turtles do forage on benthic species in the neritic zone, sea turtles spend most of their time near the sea surface (Smolowitz et al. 2015)(Burke et al. 1993).

4.8.2.7 Light

During construction, and O&M, vessels working or transiting during periods of darkness and fog will utilize lighting. During operations, Project structures will be lit in compliance with Federal Aviation Administration (FAA), U.S. Coast Guard (USCG), and BOEM guidelines for lighting and marking as described in Section 5.3 of Volume I. WTG aviation lights will likely be too high above sea level to penetrate the water surface. Navigation lighting on structures along the perimeter of the WTA will have lights close to sea level and could penetrate the water. As discussed in Section 4.6.2.5, the artificial light from navigation lighting can attract or deter certain prey species of marine mammals (e.g., finfish, invertebrates). However, the amount of artificial Project lighting from vessels and structures that would penetrate the sea surface is expected to be localized and minimal and not likely to cause adverse effects to sea turtles or their prey species. The risk of impact to sea turtles from Project-related artificial lighting on offshore structures is expected to be very low.

4.8.2.8 Presence of Structures and Cables

Within the Offshore Project Area, the installation and presence of foundations, towers, cable protection, and scour protection are likely to result in the creation of hard-substrate habitat in what is currently, predominantly flat, sandy habitat. These changes may lead to temporary and localized shifts in limited areas of sea turtle habitat and changes to prey abundance, hydrodynamics, suspended sediment, and deposition rates, and both invasive and non-invasive species attraction. Potential benthic and pelagic habitat effects from the presence of structures was previously discussed in Section 4.6.2.6. The overall negative impact of habitat alteration and declining prey availability is anticipated to be very low to low especially considering relatively large ranges of sea turtles, availability of habitat in other areas, and relatively low seasonal abundance of sea turtles in the Offshore Project Area.

During the O&M of the Projects, WTG and OSS foundations will be positioned with sufficient distance between them so that sea turtles will not be impeded from natural use of the habitat. Submerged foundations can create a "reef effect", providing additional habitat for marine species (Petersen and Malm 2006, Friedlander et al. 2014, Sammarco et al. 2014). Sea turtles are known to be attracted to reefs associated with artificial structures, likely because they are a source of both shelter and foraging habitat (Stoneburner 1982, Gitschlag et al. 1997). Loggerheads are commonly observed resting in and around artificial reefs and shipwrecks (Patterson 2010, Nuttall and Wood 2012). Artificial reefs contain greater densities and biomass of fish compared to surrounding sandy areas as well as adjacent natural reefs (Bohnsack 1989, Ambrose and Anderson 1990, Bohnsack et al. 1994, Arena et al. 2007, Gallaway et al. 2009, Lowe et al. 2009, Friedlander et al. 2014). For these reasons, foundations may have a long-term, positive impact on sea turtles.

Although the presence of foundations and cable and scour protection could result in shifts to prey habitats and availability over time during the O&M phase of the Projects; foundations and cable and scour protection are expected to produce ecologically beneficial effects that could outweigh the risk of introducing hard structure to a small area of the vast flat, sandy habitat found in the Mid-Atlantic Bight. Once the Projects are decommissioned, the local environmental and ecological features of the area are expected to revert to pre-construction conditions. Potential impacts from decommissioning include the loss of Project-related hard structures, which are expected to be colonized at the time of decommissioning. Reef or structure-oriented sea turtle prey species (i.e., finfish, crustaceans) will be displaced during decommissioning as the foundations and scour protection are removed.

The direct risk of entanglement from construction and operation of the infrastructure associated with wind turbines is extremely low for turtles. Lost fishing gear and other marine debris could possibly catch on foundations and present a secondary entanglement hazard to sea turtles. However, WTG/OSS foundations have large diameters without the protrusions on which lost fishing gear or other marine debris could become snagged, reducing the potential for gear entanglement. Regardless, Project vessels and personnel will remove any lost gear or marine debris encountered during regular inspections. Therefore, the potential for marine debris and other pollution as a direct result of the installation and presence of structures in the Offshore Project Area is considered very low and manageable.

4.8.3 Summary of Proposed Environmental Protection Measures

Atlantic Shores is committed to avoiding and minimizing Project-related impacts to sea turtles during all phases of the Projects. Atlantic Shores is developing a monitoring plan in conjunction with key Federal, State and eNGO stakeholders that will inform Project activities and decision-making to mitigate Project-related impacts on protected marine species, including sea turtles. In addition, Atlantic Shores will also be implementing a comprehensive program of best management practices (BMPs) to minimize and avoid Project impacts, while exploring new, innovative minimization/avoidance approaches. Atlantic Shores has taken a comprehensive approach in developing these impact avoidance and mitigation measures such that they cover standard construction activities while enabling flexibility to ensure protection of sea turtles should any unanticipated / unexpected situations arise. After mitigation measures are implemented, the residual risk of impacts to sea turtles is expected to be significantly reduced.

Throughout all phases of the Projects (pre-construction, construction, O&M, decommissioning) Atlantic Shores is committed to the implementation of mitigation and monitoring strategies to reduce the risk of Project-related impacts to sea turtles. The environmental protection measures adopted for marine mammals (Section 4.7.2.7) will also protect sea turtles. Several of these key strategies are listed as follows:

- Vessel strike avoidance procedures will be implemented that reduce the potential risk of Project-related vessel collisions with sea turtles, including the following actions:
    - Adhere to marine wildlife viewing and safe boating guidelines (NOAA 2018) to minimize vessel interactions to the maximum extent practicable.
    - Train Project personnel in sea turtle spotting and identification, observation reporting protocols and vessel strike avoidance procedures, as applicable.
        - Marine debris caught on offshore Project structures will be removed, when safe and practicable, to reduce the risk of sea turtle entanglement.
        - Atlantic Shores will implement the following measures in accordance with the Offshore Renewable Energy Credit (OREC) allowance that the New Jersey Board of Public Utilities (NJBPU) awarded to Atlantic Shores on June 30, 2021:
    - Maintain and update the Environmental Protection Plan (EPP) and Fisheries Protection Plan (FPP) at key Project milestones, including commencement of construction, completion of construction, and every 2 years thereafter, through decommissioning, or at other times as requested by NJDEP to ensure that impacts are being actively monitored and mitigated.
    - Update the EPP and FPP to ensure New Jersey's natural resources, including finfish and shellfish, sea turtles, marine mammals, avian species, bats, and benthic populations are protected throughout the life of the Project from pre-construction through decommissioning and to ensure that any impacts are being actively monitored and mitigated as required by law.Provide funding to the State of New Jersey for research initiatives and the regional monitoring of wildlife and fisheries related to the introduction of offshore wind projects. The funding will be administered by the New Jersey Department of Environmental Protection (NJDEP) and NJBPU, with stakeholder input to aid in the identification and prioritization of regional research and monitoring needs.

  - Report annually in writing to BPU and NJDEP beginning June 30, 2022, on actions taken to ensure environmental protection, fisheries protection, mitigation of environmental and/or fishing impacts. This report will specifically address how Atlantic Shores is enacting its plans for environmental and fisheries protection and mitigation of impacts as articulated in its Application to BPU. An appendix to the report will indicate the data collected in the reporting period, and will include an accessibly written, narrative description(s) of the dataset(s), the associated findings made based upon these data, and reference(s) to the data portal(s) where these data can be publicly accessed. This appendix will be made public.
  - Report annually in writing to BPU and NJDEP beginning June 30, 2022, on the policies and programs that may be adopted by BPU or NJDEP to help reduce future environmental or fisheries impacts or enhance the protection of natural resources. This report will detail any proposed future mitigation or protection measures that could be adopted, providing a description, proposed timeline, and expected outcomes of the recommended action.
  - Make public through appropriate data portals, all data collected in the development of the Project from pre-construction activities through decommissioning activities. All collected information and scientific data not deemed confidential by statute or regulation will be made publicly available. Specifically, data with particular emphasis on natural resources including, but not limited to, finfish and shellfish, sea turtles, marine mammals, avian species, bat and benthic populations, as well as data regarding vessel strikes, avoidance, observations on habitat, and routine data collection on ocean conditions will be shared in a manner that is in keeping with best practices for the reporting of these types of data. Atlantic Shores will report annually to BPU and NJDEP beginning June 30, 2022, describing the type of data shared, and where the data is shared. Should a common database for New Jersey-related, scientific data generated in association with offshore wind development be created, Atlantic Shores will archive all data collected with the development of the Project in that data repositor.

Atlantic Shores will take additional precautions during activities that could generate underwater noises above regulatory-defined injury and behavior thresholds (e.g., impact pile-driving, HRG surveys), as follows:

- Protection zones will be established and monitored to create sufficient opportunity to modify or halt Project activities potentially harmful to protected species, such as:
  - Shutdown Zones around activities that have the potential to harm sea turtles.
  - Clearance Zone (larger than an Shutdown Zone) around activities that have the potential to result in the harassment of sea turtles.

- Visual monitoring of Shutdown and Clearance Zones by NOAA Fisheries-approved PSOs will be conducted to alert the Projects' survey and/or marine construction teams to the presence of protected species, including:
    - Vessel-based and/or aerial monitoring of large Shutdown Zones and Clearance Zones.
    - Use of night vision devices such as, night vision binoculars and/or infrared cameras, during nighttime activities and/or periods of inclement weather.
- Pile-driving will follow a proposed schedule that avoids the completion of pile-driving after dark.
- Equipment operating procedures will be implemented, as appropriate, to control the noise generated by pile-driving or survey equipment to prevent exposure of harmful sound levels to protected marine life.
    - NAS will be implemented during impact pile-driving to decrease the propagation of potentially harmful underwater noises.
    - Soft starts will be considered for activities such as impact pile-driving.
    - Ramp-up procedures whereby the sound source level is increased gradually before use of full power will be used.
    - A ramp-down, and if necessary, a shut-down of activities such as pile-driving and/or HRG survey equipment that has the potential to cause harm or harassment to sea turtles will occur if an animal is seen approaching or entering a Clearance Zone or Shutdown Zone.

Atlantic Shores is also evaluating additional innovative technologies and methods to improve the monitoring of sea turtles within the Project Area and to further inform regional efforts to understand cumulative impacts to these species. Through partnerships with universities, governmental agencies and environmental non-governmental organizations, Atlantic Shores is working with sea turtle experts to identify key knowledge gaps and to plan studies to advance the general understanding of sea turtles in the Mid-Atlantic Bight. Other innovations Atlantic Shores is currently investigating to further minimize impacts to sea turtles include the use of unmanned aerial systems. This effort will build on earlier trials conducted by RPS, AUV Flight Services and Advanced Aircraft Company, for which Federal regulatory agency approval was obtained. Atlantic Shores will conduct a field trial during an offshore wind survey using drone technology to monitor for protected species. The Unmanned Aerial Systems would be mounted with a high definition stabilized infrared camera system specifically designed for small, unmanned vehicles. A trial would be configured whereby a PSO team monitor high-definition drone camera footage in real time on shore, while a PSO team simultaneously monitored visually from a selected platform.

5.0 VISUAL RESOURCES

This section describes visual resources within the Onshore Project Area and the Wind Turbine Area (WTA), which includes Project 1, Project 2, and the Overlap Area, associated impact-producing factors (IPF), and measures to avoid, minimize, or mitigate potential effects to these resources during construction, operations and maintenance (O&M), and decommissioning of the Projects.

The components of the WTA considered in this section include 200 wind turbine generators (WTGs)[35] and five offshore substations (OSS) which are the primary visible offshore components of the Projects, and three onshore substations and/or converter stations, which are the primary visible onshore components of the Projects (see Volume 1, Project Information).

5.1 Affected Environment

The visual studies conducted to evaluate the Projects involved characterization of the affected environment (including identification of visually sensitive resources and viewer groups), determination of the geographic extent of Projects' visibility (through viewshed analysis and field review), and evaluation of the potential visual effect of the offshore and onshore components of the Project and include the following:

- **Initial Visibility Modeling Study for Offshore Wind for New Jersey's Atlantic Shores Offshore Wind Project** (Appendix II-M1) prepared by the Rutgers School of Environmental and Biological Sciences (Rutgers Visibility Study), which provides relevant data regarding offshore visibility frequency and trends as influenced by meteorological conditions (included as part of Appendix II-M1).
- **Visual Impact Assessment** (VIA, Appendix II-M1) which addresses the offshore components of the WTA and evaluates their potential visual impact though the use of viewshed analysis, photosimulations, and a prescribed visual contrast rating system.
- **Visual Resource Assessments** As stated in Section 4.9 of Volume I, parcels for an HVAC onshore substation and/or HVDC converter station have been identified along the Larrabee Onshore Interconnection Cable Route and the Cardiff Onshore Interconnection Cable route. In Atlantic County, the Cardiff Onshore Interconnection Cable route includes a substation and/or converter station at the Fire Road Site. These components of the Projects are addressed in Appendix II-M2.

  In Monmouth County, the Larrabee Onshore Interconnection Cable route will include a new substation and/or converter station at the Lanes Pond Road Site or the Randolph Road Site or the interconnection to a substation and/or converter station at the Brook Road Site developed under the NJBPU's SAA. These components of the Projects are addressed in Appendix II-M3.

[35] The number of WTGs in Project 1, Project 2, and the associated Overlap Area will not exceed 200 WTG locations.

The proposed O&M facility will be located on an approximately 1.38-acre (0.56 ha) empty parcel at 801 North Maryland Avenue. The property occurs within Atlantic City's maritime waterfront area (Atlantic City Inlet Marine/Port Area) and is owned by Atlantic Shores. O&M activities include material storage, day-to-day management of inspection and maintenance activities, vehicle parking, marine coordination, vessel docking, and dispatching of technicians associated with the Atlantic Shores Offshore Wind Projects. This component of the Projects is addressed in Appendix II-M5.

- **Aircraft Detection Lighting System (ADLS) Efficacy Analysis,** (Appendix II-M4) was conducted to determine the likely activation time of the Federal Aviation Administration (FAA)-required lighting if lighting mitigation is implemented. This study reviewed information included in the FAA National Offload Program to determine when and for how long aircraft traverse the Projects' airspace during a given year, requiring the aviation obstruction warning lights to be activated.

The affected environment in the context of visual resources is defined by the geographic areas that could have visibility of some portion of the WTA as determined by viewshed analysis. This is completed by first defining a maximum radius of theoretical visibility. In the case of the WTA, the visual study area was defined as a 40-mile (mi) (64 kilometer [km]) radius around the Lease Area OCS-A 0499 (Lease Area) (see Figure 5.1-1).

Based on the effects of curvature of the earth and limits on human visual acuity it is anticipated that visibility of the proposed WTGs will diminish substantially (if not completely) at a distance of 40 miles (64 km) from ground-level vantage points. However, the visual study area identified for the Projects was expanded to include the Cape May Lighthouse since this is a prominent, elevated structure and includes a frequently visited viewing platform which offers commanding views of the landscape and ocean. Therefore, the visual study area was defined as the area extending 45.1 miles (72 km) from the WTA.

For the onshore components, a radius of 3 mi (5 km) was used to define the visual study area around the proposed Cardiff and Larrabee onshore substation and/or converter station sites. Once the visual study areas were defined, a visibility analysis was completed to determine the geographic areas of potential visibility within those areas. This analysis considers the maximum height of the visible Project components and the screening effect of curvature of the earth, topography, vegetation, and structures within the visual study area. This analysis defines what is referred to as the "zone of visual influence," which represents a reasonable and accurate determination of the areas within which visual effects resulting from the Project could occur.

5.1.1 Wind Turbine Area

The visual study area for the proposed WTA components includes approximately 6,657 square miles (mi^2) (17,242 square kilometers [km^2]) of open ocean and portions of Delaware Bay, and 2,196 mi^2 (5,688 km^2) of land (including inland water bodies) that extends inland to include the majority of Ocean, Atlantic, and Cape May Counties and portions of Monmouth, Burlington, Camden, Gloucester, and Cumberland Counties in New Jersey (see Figure 5.1-1).

Within this visual study area, the zone of visual influence (i.e., areas with potential views of the WTGs as determined by viewshed analysis) was defined by assessing all of the onshore areas with potential visibility of the WTGs. This was done by completing a desktop analysis which determined the availability of a direct line of sight to any of the WTGs from all areas within the visual study area. The resulting zone of visual influence includes approximately 13.1% of the total land area (see Figure 5.1-2) within the visual study area. The area within the zone of visual influence was evaluated to determine its landscape character, visually sensitive resources, and the distances at which potential views of the WTA could be available. The characterization of the zone of influence was supported by further desktop assessments, GIS mapping, field verification and photo documentation; the methodologies of which are detailed in Appendix II-M1.

To support the characterization of the existing visual setting based on patterns of landform, vegetation, water, land use, and user activity, Seascape Character Areas and Landscape Character Areas, collectively referred to as "Character Areas" were identified in accordance with established visual assessment methodologies including BOEM's, "Assessment of Seascape, Landscape, and Visual Impacts of Offshore Wind Energy Developments on the Outer Continental Shelf of the United States" (Sullivan 2021).

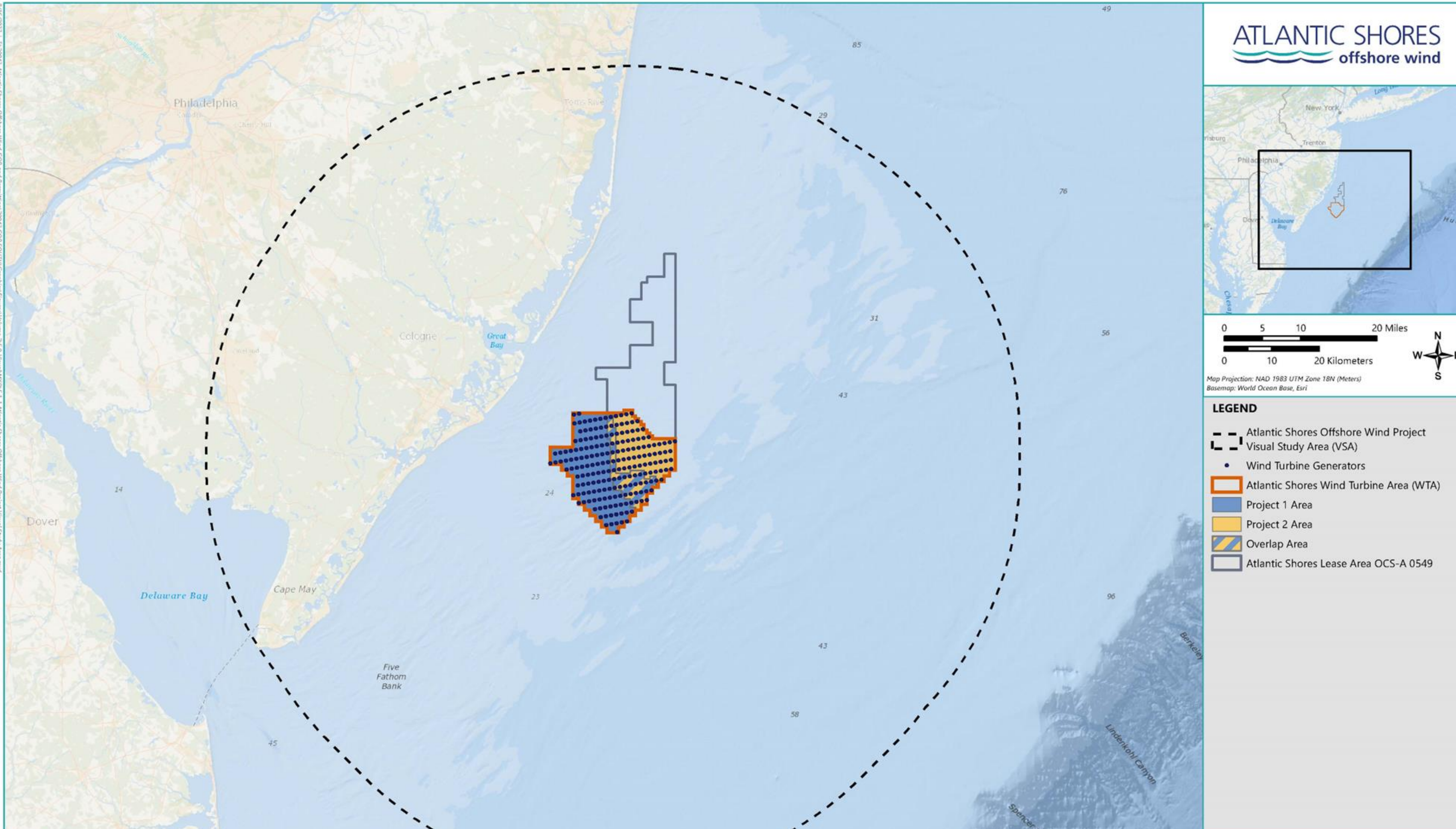


Figure 5.1-1

Atlantic Shores Offshore Wind Project Visual Study Area

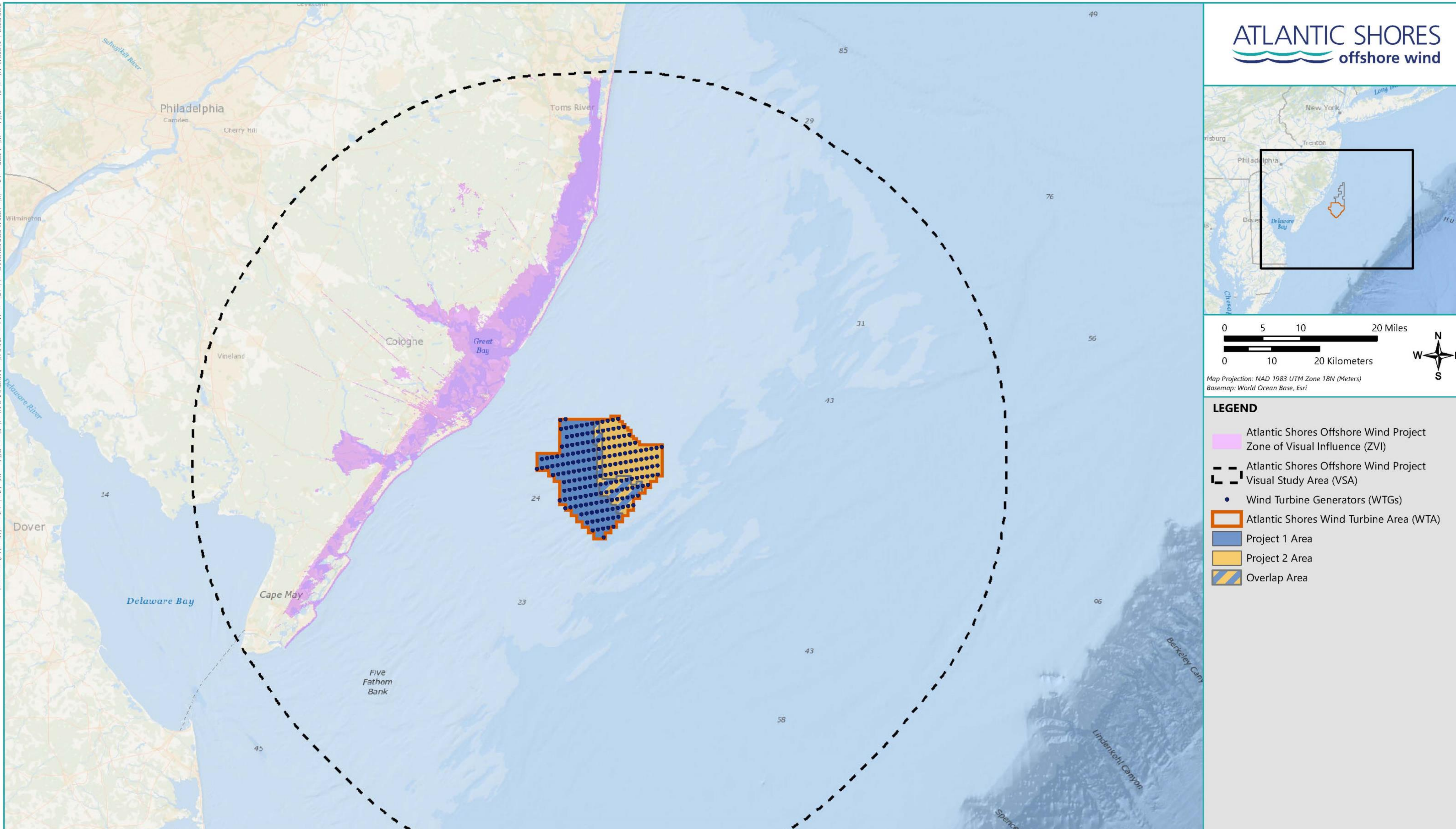


Figure 5.1-2

Atlantic Shores Offshore Wind Project Zone of Visual Influence

Character Areas were identified using a desktop analysis of the land use/land cover designations within the New Jersey Department of Environmental Protection (NJDEP) Land Use/Land Cover 2015 (as updated in 2019) dataset. Based upon this assessment 17 distinct Character Areas were identified within the zone of visual influence. The defining features and boundaries of these Character Areas were verified, photographed, and characterized through multiple field visits described in Appendix II-M1. This analysis determined that 98.3% of the Open Water/Ocean could have visibility of the Projects, which comprises 96% of the total zone of visual influence. Cumulatively, Undeveloped Bay and Salt Marsh make up approximately 93% of the landward zone of visual influence with the next two largest contributors including Oceanfront Residential (1.3%) and Undeveloped Beach (1.1%). The remaining 13 Character Areas have less than 1% of their land area within the landward zone of visual influence and cumulatively make up the remaining approximately 3.3% of the landward zone of visual influence. User groups within these zones broadly include local residents, through travelers, tourists and vacationers, and the fishing community. Detailed descriptions of each Character Area, general defining physical features, land use, viewer user groups, and types of views within the zone of visual influence are described in detail and illustrated in Appendix II-M1.

Visually sensitive resources within the zone of visual influence were also identified. These include resources that have been identified by national, State, or local governments, organizations, and the Tribes as important sites which are afforded some level of recognition or protection. A desktop inventory of visually sensitive resources was prepared for the entire visual study area and then cross referenced with the zone of visual influence to determine which of these sites could have potential views of the WTA. Additional resources were also identified through consultation with Project stakeholders and during the field verification process. The analysis resulted in the identification of 231 visually sensitive resources with some degree of potential visibility of the WTA (Table 5.1-1). The location of these visually sensitive resources within the visual zone of influence are depicted in Appendix II-M1, Figure 1.2-4.

To better understand the distances at which potential views of the WTA could be available within the zone of visual influence three distinct distance zones were assessed. Due to the large size of the WTGs, the distance zones were defined as follows:

- Foreground-Middle Ground (0-5 mi [0-8 km]), Within the foreground (0.5 mi [0.8 km]), a viewer is able to perceive details of an object with clarity. Surface textures, small features, and full intensity and value of color can be seen on foreground objects. Beyond the foreground (0.5-5mi [0.8-8 km]) a viewer can perceive individual structures and trees but not in great detail. This is the zone where the parts of the landscape start to join together; individual hills become a range, individual trees merge into a forest, and buildings appear as simple geometric forms. Colors will be clearly distinguishable but will have a bluish cast and a softer tone than those in the foreground. Contrast in color and texture among landscape/seascape elements will also be reduced.
- Background (5-15 mi [8-24 km]), The background defines the broader regional landscape/seascape within which a view occurs. Within this distance zone, the landscape

and features on the ocean are simplified; only broad landforms are discernible. Atmospheric conditions often render objects on the landscape/seascape an overall bluish color and they tend to appear unclear causing the objects to begin to blend with the background colors, giving them a fuzzy appearance. Objects on the ocean, such as boats, buoys, and platforms may become completely screened by curvature of the earth at distances greater than 5 mi (8 km).

- Extended Background (>15 mi [24 km]), At distances beyond 15 mi (24 km) curvature of the earth becomes a significant factor in visibility, and those objects that are visible become less prominent in the overall landscape and seascape due to their relative size, occupation of the horizon, and deterioration of visibility due to atmospheric perspective. For casual viewers, offshore features may be difficult to discern to under less-than-ideal viewing conditions. During high humidity, fog, and other weather events, visibility at these distances may be significantly diminished or completely eliminated.

Based upon this assessment, approximately 72% of the landward zone of visual influence occurs within the Extended Background zone, and the remainder 28% is in the Background zone. This suggests that curvature of the earth, atmospheric perspective, and weather conditions will be a significant factor influencing visibility within the majority of the zone of visual influence. It is important to note that all Foreground-Middle Ground views within the zone of visual influence would only be available to those travelling on the open ocean in commercial vessels, passenger boats, or pleasure craft.

Table 5.1-1 Visually Sensitive Public Resources Within the Zone of Visual Influence

Type of Resource	Occurrences of Resource Type within the Zone of Visual Influence
National Historic Landmarks	2
Properties Listed on the National or State Registers of Historic Places	15
Properties Determined Eligible for National or State Registers of Historic Places	43
National Natural Landmarks	1
National Wildlife Refuges	2
State Wildlife Management Areas	16
State Parks	3
State Nature and Historic Preserve Areas	12
State Forests	3
National or State Designated Wild, Scenic, or Recreational Rivers	1
Highways Designated or Eligible as Scenic	1
National Historic/Recreation/Heritage Trails	1
State Fishing and Boating Access Sites	9
Lighthouses (not NRHP-Listed or State Historic-Listed)	2
Public Beaches	35
Environmental Justice Areas (State and Federal)	86
TOTAL	**231**

5.1.2 Onshore Substations and/or Converter Stations

The only significant above ground facilities associated with the onshore components of the Projects are the onshore substations and/or converter stations. The potential options under consideration for the onshore substations and/or converter stations are addressed in separate VRAs included as Appendices II-M2 and M-3. The visual study area for each of the onshore substation and/or converter station options is defined as a 3-mi (4.8 km) radius (see Figures 5.1-3 and 5.1-4). The zone of visual influence within each of these study areas will be determined through viewshed analysis, similar to that described for the WTA.

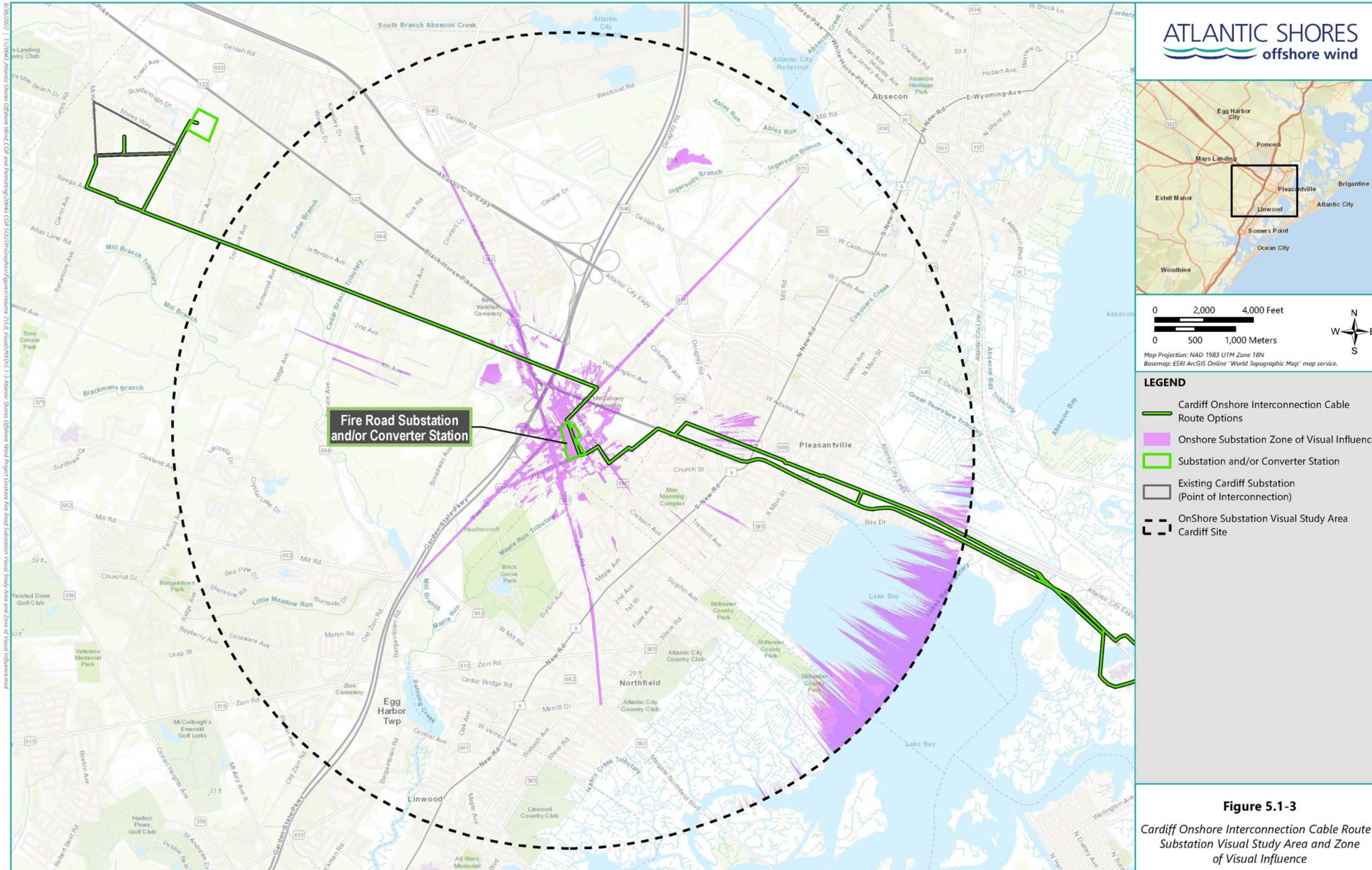
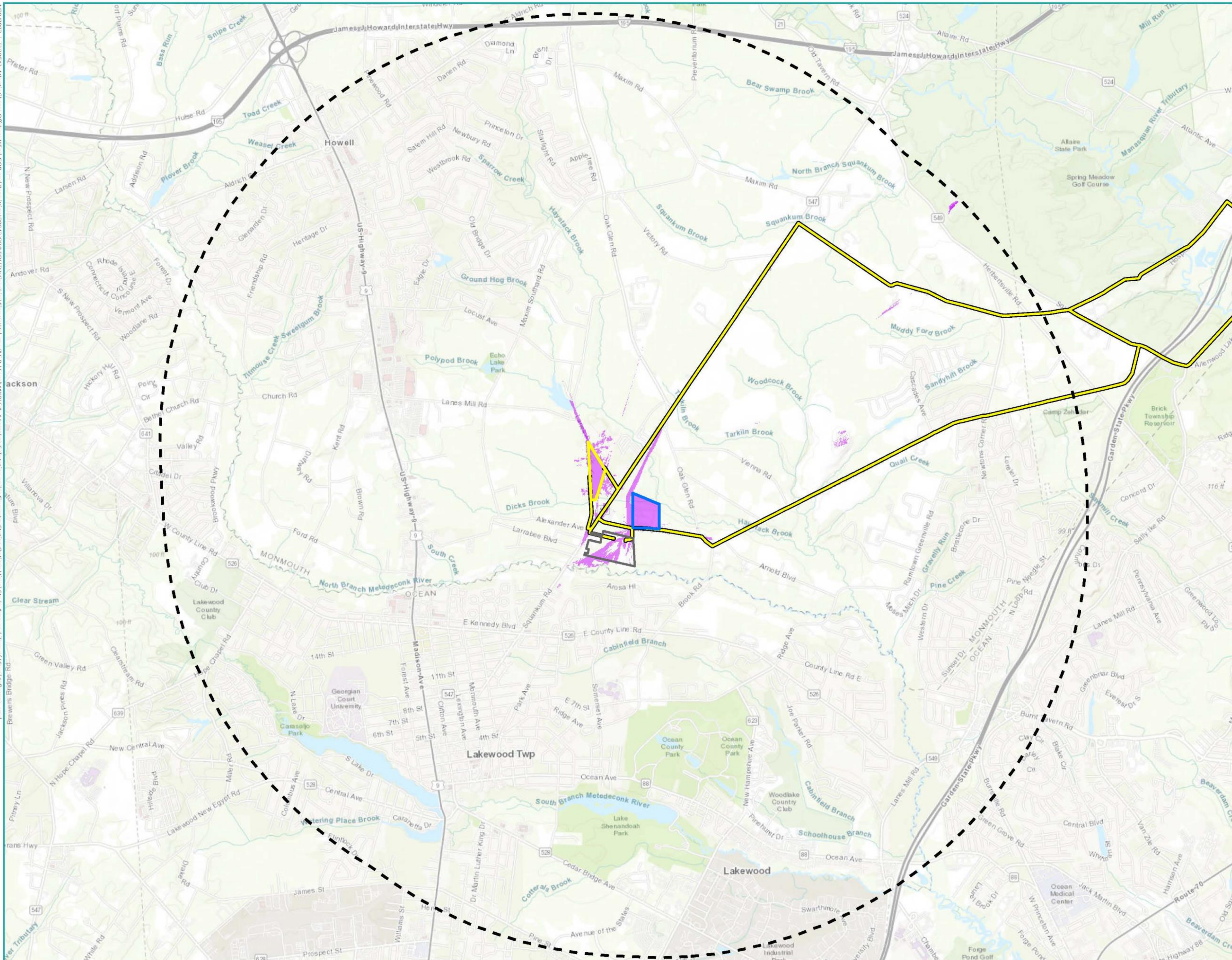


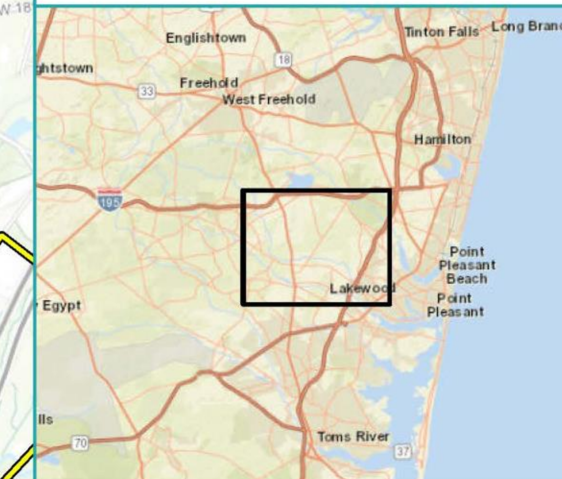
Figure 5.1-3

Cardiff Onshore Interconnection Cable Route - Substation Visual Study Area and Zone of Visual Influence

4/20/2023 | T:\20043 Atlantic Shores Offshore Wind COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\5.0_Visual\MXDs\5.1-4 Larrabee Substation and/or Converter Station Options Visual Study Area and Zone of Visual Influence.mxd



ATLANTIC SHORES offshore wind



0 2,000 4,000 Feet

0 500 1,000 Meters

N W E S

Map Projection: NAD 1983 UTM Zone 18N
Basemap: ESRI ArcGIS Online "World Topographic Map" map service.

LEGEND

- Cardiff Onshore Interconnection Cable Route Options
- Onshore Substation Zone of Visual Influence
- Lanes Pond Road Substation and/or Converter Station
- Randolph Road Substation and/or Converter Station
- Existing Larrabee Substation (Point of Interconnection)
- OnShore Substation Visual Study Area Larrabee Site

Figure 5.1-4

larrabee Onshore Interconnection Cable Route - Substation Visual Study Area and Zone of Visual Influence

5.1.3 Cardiff Visual Study Area

The Fire Road Site Visual Study Area, encompasses an area of approximately 30.6 mi^2 (79.3 km^2) and which includes portions of Egg Harbor Township, Pleasantville, Northfield, Absecon, and Linwood. The viewshed analysis results suggest that approximately 0.5% (97.7 acres [39.5 ha]) of the visual study area could have some level of visibility of the Fire Road Substation/Converter Station. In other words, 99.5% of the visual study area will not have visibility of the proposed Fire Road Substation/Converter Station. Additionally, 13.5% (13.9 acres [5.6 ha]) of the visible area indicated by the viewshed analysis is located on the Facility Site itself. Meaning that, beyond the Fire Road Site, approximately 0.4% of the visual study area is suggested to have some level of visibility of the Fire Road Substation/Converter Station. Locations beyond the Fire Road Site indicated to have visibility are most concentrated within the near-foreground distance zone and are typically limited to locations with open expanses of asphalt such as open parking lots at commercial sites and roadway corridors such as Tilton Road, Hingston Avenue, and Fire Road (County Road 651). Potential visibility in the near-foreground distance zone is also indicated in some residential areas such as the Harbor Crossing manufactured home park located north-northwest of the Facility Site, and the Tilton Club Condominiums located south of the Facility Site.

5.1.4 Larrabee Visual Study Area

The Larrabee visual study area is based on the location and extent of three site options, including new substation and/or converter stations at the Lanes Pond Road Site or Randolph Road Site or the interconnection to a substation and/or converter station Brook Road Site[36] developed under the New Jersey Board of Public Utilities (NJBPU) State Agreement Approach (SAA). This cumulative visual study area includes approximately 37.3 mi2 (96.5 km2). The majority of the visual study area falls within Howell and Lakewood Townships, and smaller portions fall within the Townships of Brick, Jackson, and Wall. The viewshed analysis results suggest that approximately 0.2% of the visual study area could have visibility of some portion of the substation and/or converter station if the Lanes Pond Road Site is selected and 0.3% if the Randolph Road Site is selected, (i.e., the substation and/or converter station would be entirely screened from 99.8% and 99.7%, of the visual study area, respectively, depending which site is selected). Additionally, a significant portion of substation and/or converter Station visibility occurs within the boundaries of the site boundaries themselves. Approximately 32% (16.3 acres [6.6 ha]) of areas with visibility are located within the Lanes Pond Road Site itself. Similarly, approximately 33.0% (24.7 acres [10 ha]) of areas with visibility are located within the Randolph Road Site. In other words, when visibility within the respective Sites are excluded from the results, visibility of the substation and/or converter station is indicated in approximately 0.1% (34.0 acres [13.8 ha]) of the visual study area if the Lanes Pond Road Site is selected and 0.2% (49.2 acres [19.9 ha]) of the visual study area if the Randolph Road Site is selected.

[36] The NJBPU's SAA is discussed in Volume I Section 4.9. While the Brook Road Site is included in the Visual Study Area, its effects are not included in this Section of the COP since the site will be developed under the NJBPU's SAA.

5.1.5 Operations and Maintenance (O&M) Facility

The proposed O&M facility collectively refers to a three-story building located on an approximately 1.38-acre (0.56 ha) empty parcel at 801 North Maryland Avenue. and a potential adjacent parking structure and an outdoor area located on an approximately 2.0-acre (0.8 ha) portion of the existing State marina parking lot at 600 Huron Avenue in Atlantic City, New Jersey. The O&M Facility will also include a communications tower which will facilitate offshore connectivity. The property occurs within Atlantic City's maritime waterfront area (Atlantic City Inlet Marine/Port Area) and is owned by Atlantic Shores. This will serve as the primary location for O&M, including material storage, day-to-day management of inspection and maintenance activities, vehicle parking, marine coordination, vessel docking, and dispatching of technicians associated with the Atlantic Shores Offshore Wind Projects. The maximum height of the parking structure will be 41.5 ft(12.6 m), the roof of the O&M building will have a maximum height of 55.8 ft (17 m), and the communications tower will extend to a maximum height of 120 ft (36.6 m). The proposed O&M facility may utilize the parking lot located on California Avenue at the Atlantic Landfall site or other existing surface lots in Atlantic City supported by shuttles to and from the O&M facility. Visibility was analyzed within a 3-mile (4.8 km) visual study area which encompasses portions of Atlantic City, Brigantine City, Margate, and Ventnor City. The study area includes 207 visually sensitive resources, 118 of which occur within the proposed O&M facility viewshed. A detailed visual resource assessment of the proposed O&M facility is provided in Appendix II-M5.

5.2 Potential Impacts and Proposed Environmental Protection Measures

An important consideration in visual impact assessment is to avoid the assumption that visibility of the Projects automatically equates to an adverse visual impact. The degree of Project visibility will vary greatly depending on the distance of the viewer from the Projects; meteorological conditions; degree of screening from structures, vegetation, and curvature of the earth; visual acuity of the viewer; and the ability of the viewer to recognize the components of the Projects.

The potential impact producing factors which may affect visual resources during construction, O&M, or decommissioning of the Projects are presented in Table 5-2.

Table 5-2 Impact Producing Factors for Visual Resources

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Presence of structures and cables		●	
Traffic	●		●
Light	●	●	●

To assess the potential visual effects associated with the IPFs identified in Table 5-2 a detailed visual impact assessment (VIA) was completed for the WTA (see Appendix II-M1). Visual Resource Assessments (VRAs) have been completed to assess the visual effects of the onshore facilities

(Appendices II-M2 through II-M3). The processes outlined in this section were developed in consultation with BOEM through the development of a Visual Impact Assessment Study Plan – Offshore (EDR, 2021).

The following sections provide a summary of the visual assessment methodologies used to support the assessment of visual impacts from Project facilities offshore and onshore. Sections 5.2.1 through 5.2.3 provide the results of the assessment as they pertain to the identified IPFs (presence of structures, traffic, and lighting) resulting from the construction, O&M and decommissioning of the Project.

The Project Design Envelope (PDE) analyzed for impacts to visual resources is the maximum onshore and offshore build-out of the Projects as defined in Section 4.11 of Volume I.

5.2.1 Offshore Project Area VIA Methodology

As stated in Section 5.1.1, a viewshed analysis was used to define the zone of visual influence associated with the WTA. This analysis was based on publicly available lidar data for the entire 45.1-mi (72.6 km) visual study area, 200 points representing the WTG locations, an assumed maximum blade tip height of 1,047 feet (ft) (319 meter [m]) above mean sea level (MSL), and an assumed viewer height of 6 ft (1.83 m). Viewshed analyses were also completed to assess the potential visibility of the aviation obstruction warning lights at a height of 607 ft (185 m).

Field verification was completed between July of 2020 and March of 2022. The exercise was performed for the following purposes:

- Verify the zone of visual influence through photography and field survey.
- Confirm the lack of visibility from outside the zone of visual influence boundaries though random sampling.
- Verify the boundaries and document the visual character of the various landscape similarity zones within the zone of visual influence.
- Obtain photographs from key observation points (KOPs) for subsequent use in the development of photosimulations.

Fieldwork was completed under a range of sky conditions (overcast to clear), but during the KOP photography, visibility was recorded as being 10 mi (16 km) or greater in all instances (meteorological visibility distances are reported to a maximum of 10 miles). At each of the KOPs, field crews selected an appropriate photo location based on the availability of an open view toward the WTA.

Specific KOPs were selected prior to, and during, the field verification process as representative locations for the development of photosimulations. In addition, Atlantic Shores discussed KOP selection with various agencies and stakeholders, including the NJDEP, Bureau of Ocean Energy management (BOEM), and several local stakeholders. Based on these consultations, a total of 22 unique KOP locations within the zone of visual influence were selected for the development of the photosimulations. The KOPs were selected based upon the following criteria:

- Identified as KOPs by Federal, State, or local officials/stakeholders as important visual resources, either in prior studies or through direct consultation.
- Provided clear, unobstructed views toward the WTA (as determined through field verification).
- Illustrated the most open views available from historic sites, designated scenic areas, and other visually sensitive resources and those views that will be available to representative viewer/user groups within the zone of visual influence.
- They are representative of a larger group of candidate KOPs of the same type or in the same geographic area.
- They illustrate typical views from character areas where views of the WTGs are most likely to be available.
- They illustrate typical views of the proposed Projects that will be available to representative viewer/user groups within the zone of visual influence.
- Illustrated typical views from a variety of geographic locations and under different lighting conditions to show the range of visual change that could occur with the WTGs and OSSs in place.

Locations of the selected KOPs are shown in Figure 5.2-1. Information regarding each of these selected KOPs is summarized in Table 5.2-1.

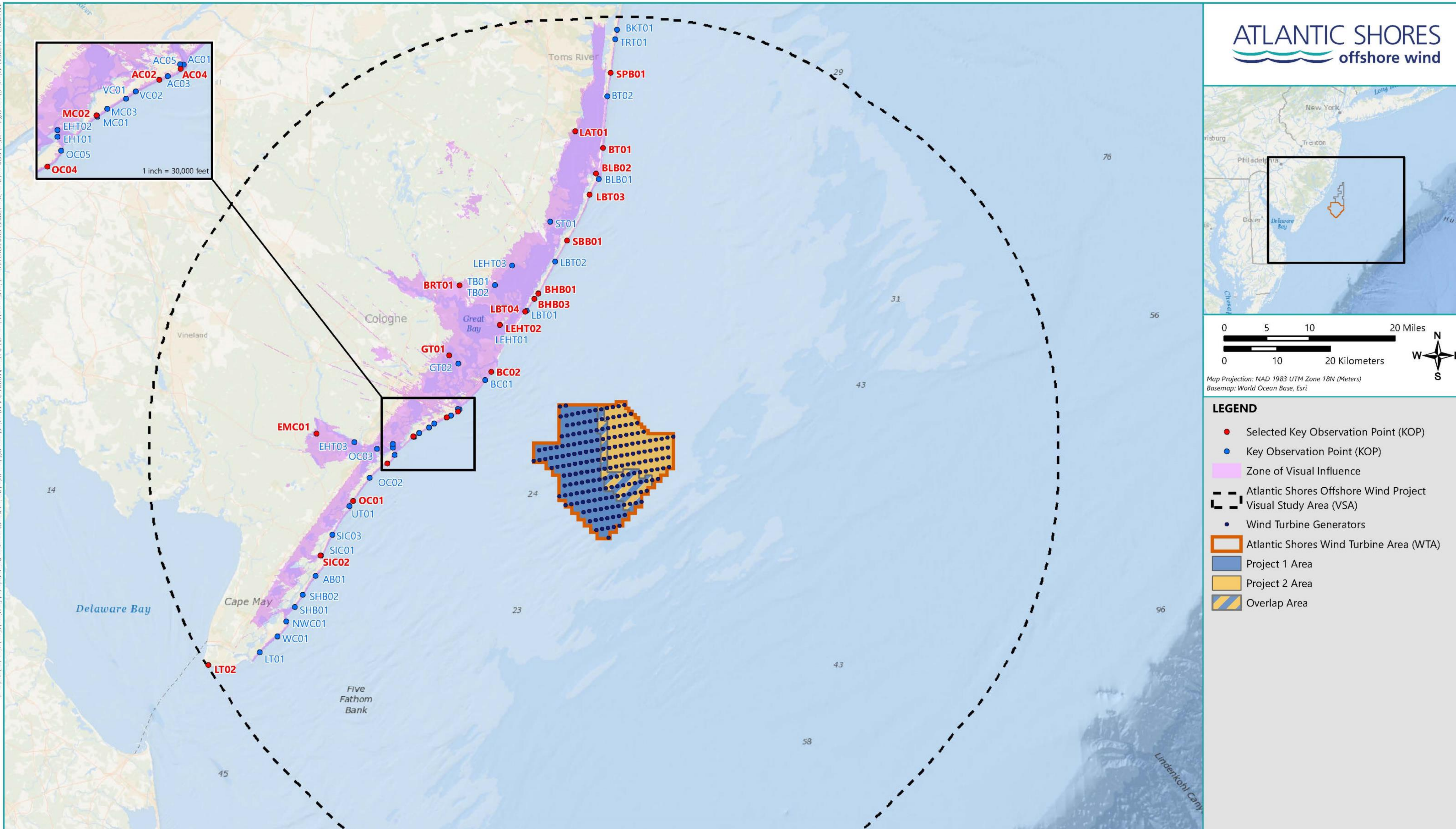


Figure 5.2-1

Atlantic Shores Offshore Wind Project Key Observation Points Selected for Visual Simulation

Table 5.2-1 Selected Key Observation Points

KOP Identifier	KOP Name	Location	Distance to the Nearest WTG (mi/km)
SPB01	Seaside Park Borough Boardwalk	Seaside Park Borough, Ocean County	39/62.8
LAT01	Edwin B. Forsythe NWR at the Woodmansee Estate	Lacey Township, Ocean County	32.2/51.8
BT01	Island Beach State Park	Berkeley Township, Ocean County, New Jersey	30.3/48.7
BLB02	Barnegat Lighthouse State Park	Barnegat Light Borough. Ocean County, New Jersey	27.3/44.0
LBT03	Beach at Long Beach Island Arts Foundation	Long Beach Township, Ocean County	24.9/40.1
SBB01	Ship Bottom Borough Municipal Beach	Ship Bottom Borough, Ocean County, New Jersey	19.4/31.1
BRT01	Bass River State Forest	Bass River Township, Burlington County	18.5/29.8
BHB01	Beach Haven Historic District	Beach Haven Borough, Ocean County	13.5/21.7
BHB02	Centre Street, Beach Haven	Beach Haven Borough, Ocean County, New Jersey	13.5/21.7
BHB03	Holyoke Avenue, Beach Haven	Beach Haven Borough, Ocean County, New Jersey	13.0/20.9
LBT04	Edwin B. Forsythe NWR, Holgate	Long Beach Township, Ocean County, New Jersey	11.8/19.1
LEHT02	Great Bay Boulevard WMA/Rutgers Field Station	Little Egg Harbor Township, Ocean County	11.9/19.2
GT01	Edwin B. Forsythe NWR, Galloway Township	Galloway Township, Atlantic County, New Jersey	14.3/23.1
BC02	North Brigantine Natural Area	Brigantine City, Atlantic County	9/14.5
AC04	Ocean Casino Resort – Sky Garden	Atlantic City, Atlantic County	10.5/16.9
AC02	Jim Whelan Boardwalk Hall (Atlantic City Convention Center NHL)	Atlantic City, Atlantic County, New Jersey	11.4/18.3

Table 5.2-1 Selected Key Observation Points (Continued)

KOP Identifier	KOP Name	Location	Distance to the Nearest WTG (mi/km)
MC02	Lucy the Margate Elephant NHL	Margate City, Atlantic County	14.4/23.2
EMC01	Tuckahoe WMA	Estell Manor City, Atlantic County, New Jersey	25.7/41.4
OC04	Gillian's Wonderland Amusement	Ocean City, Cape May County	17.2/27.7
OC01	Corson's Inlet State Park	Ocean City, Cape May County, New Jersey	21.7/35.0
SIC02	Townsend Inlet Bridge	Sea Isle City, Cape May County	27.4/44.1
LT02	Cape May Point State Park	Lower Township, Cape May County	45/72.4

To show anticipated visual changes associated with the proposed Projects, high-resolution, photographic simulations of the WTA were prepared for each of the KOPs. The photographic simulations were developed by constructing a three-dimensional computer model of the proposed WTG and OSS layout within the WTA, based on design specifications and coordinates provided by Atlantic Shores. For the purposes of the VIA and in accordance with FAA guidance, the color of the WTGs will be pure white (RAL 9010) and the WTG foundations will be yellow (RAL 1023). The VIA also assumes two L-864 aviation obstruction warning lights will be mounted to the nacelle, up to three L-810 aviation obstruction warning lights will be mounted to the tower midpoint, and up to two navigation lights will be added neat the WTG platform.

Three-dimensional virtual cameras were then created to match the geographic location and exact specification of the camera used to collect the photos during field review. The camera is aligned by matching field surveyed elements visible in the photograph with digital representations of these elements in the model. Once aligned, all elements in the scene (including the WTGs) are accurate to scale and position within the photograph. Each of the WTGs and OSSs were then individually positioned vertically by calculating the curvature of the earth and refraction value for each. With the WTGs positioned in the view, a lighting system was created to match the exact date and time of day represented in the photographs. The Projects were then rendered and superimposed within the existing conditions photograph to complete the photosimulation.

To prepare nighttime simulations, the requirements for aviation obstruction warning lights on WTGs were obtained by consulting FAA and BOEM guidance documents (BOEM, 2019). In addition, views of the operational Block Island Wind Farm were used to determine the appearance of the warning lights at night at distances beyond 20 mi (32 km) offshore. Computer modeling and camera alignment for the nighttime photos were conducted in the same manner described for the daytime simulations. It was assumed that all lights will flash in a synchronized manner, as currently set forth by FAA guidelines. Therefore, the nighttime simulations show all WTGs with their lights on. Due to the effects of the curvature of the earth and angle of refraction, U.S. Coast Guard (USCG) required navigation warning lights on the WTGs and OSS were also simulated. However, navigation lights were only added to the simulations in views that had a direct line of sight to the deck at the WTG base, which is approximately where the USCG lights would be located.

The potential visual impact of the offshore facilities was evaluated based on a determination of existing view sensitivity, the magnitude of visual effects resulting from the WTA, and the significance of visual impacts resulting from the Projects. The evaluation process is described in more detail in the following list:

- **Determine the scenic quality for the existing view** presented at each KOP by quantitatively evaluating the baseline (existing) scenic quality of various landscape features in the existing view. The sensitivity classifications are provided in Table 5.2-3.
- **Repeat the procedure described above** to evaluate the KOPs with the WTA in place (proposed view) to determine the proposed conditions score.
- **Compare the scores for the existing and proposed views** to quantify the degree of visual change (Table 5-5) associated with the operational Projects. Each of the visual impact scores were totaled and averaged across all four rating panel members. The delta between the existing and proposed view provides the degree of potential visual impact to viewers (see Table 5.2-4).
- **Evaluate compatibility of the Project** with the existing landscape by determining its degree of compatibility, scale contrast, and spatial dominance at each KOP.
- **Determine the visibility threshold level (VTL)** from each of the KOPs. The VTL is a measure of the visual dominance associated with the developed WTA in each of the photosimulations. The rating panel selects the most appropriate VTL number based on a scale of one to six, each with prescribed descriptions of the degree of visibility/visual prominence in the view associated with the developed WTA. The VTL descriptions are included in the VIA (see Appendix II-M1).

Table 5.2-3 Scenic Quality Classifications

Scenic Quality Classification	Description
Preserved	These areas are considered to be unique and to have the most distinct visual quality in the region. They often include significant views of the ocean, and the ocean is a significant contributor to the scenic quality of the view. Human development is minimal or subtle and does not detract from the scenic quality. These views and locations are highly valued and may be protected by federal and state policies and laws (Score of 17 or more).
Retained	These areas are regionally recognized as having distinct visual quality and likely include significant to secondary views of the ocean and seascape which also contribute significantly to scenic quality. Human development may be apparent, and some degree of modified landscape/seascape is expected (Score of 14 to 16).
Partially Retained	These areas are locally valued for above average visual quality. These areas may include views of the ocean and seascape, but human development and landscape modification is apparent and expected (Score of 11 to 13).
Modified	These areas are not noted for their distinct qualities and are often considered to be of average visual quality. Views of the ocean and seascape are partially screened or hampered by development and modification to the landscape (Score of 8 to 10).
Impaired	These areas are noted for their minimal visual quality and are often considered heavily modified by human development. Views of the ocean and seascape are secondary or non-existent (Score of less than 8).

Table 5.2-4 VIA Scores and Magnitude of Visual Change

Score Delta (Proposed minus Existing)	Effect on Scenic Quality	Description of Potential Impact to Scenic Quality
0 to 0.4	Regardless of Scenic Quality Description	Negligible impact to scenic quality. The presence of the SRWF has almost minimal to no impact on landscape, seascape and ocean, and the overall scenic quality is maintained.
0.5 to Minus 1.4	KOP Scenic Quality Description Remains the Same	Negligible impact to scenic quality. The presence of the SRWF minimally impacts the character defining features of the landscape, seascape and ocean, but the overall scenic quality is maintained.
	KOP Scenic Quality Description Changes	Minimal adverse impact to scenic quality. The presence of the SRWF somewhat effects the character defining features of the landscape, seascape and ocean and the overall scenic quality is reduced.
Minus 1.5 to Minus 2.4	KOP Scenic Quality Description Remains the Same	Minimal adverse impact to scenic quality. The presence of the SRWF somewhat effects the character defining features of the landscape, seascape and ocean and the overall scenic quality is reduced.
	KOP Scenic Quality Description Changes	Somewhat significant adverse impact to scenic quality. The presence of the SRWF competes with one or more landscape, seascape, and ocean attributes and results in an overall reduction in scenic quality.
Minus 2.5 to Minus 3.5	KOP Scenic Quality Description Remains the Same	Somewhat significant adverse impact to scenic quality. The presence of the SRWF competes with one or more landscape, seascape, and ocean attributes, but the overall scenic quality remains unchanged.
	KOP Scenic Quality Description Changes	Significant adverse impact to scenic quality. The SRWF begins to dominate certain landscape, seascape and ocean features and results in a reduction in scenic quality.
Greater than Minus 3.5	Regardless of Scenic Quality Description	Significant adverse impact to scenic quality. The SRWF becomes a dominant feature in the landscape, seascape, and ocean and results in a reduction in scenic quality.

5.2.2 Onshore Project Area Methodology

The viewshed analysis for the onshore substation and/or converter station sites was conducted using the same general methodology as described for the offshore Projects. The viewshed calculations were based on preliminary sample points, each with an assigned height of 100 ft (30.5m) to represent lightning masts (the tallest proposed structures). The sample point locations were conservatively placed over the entire parcel under consideration. The resulting geographic areas of potential Project visibility are referred to as the zone of visual influence.

As mentioned in Section 5.1.2 the zone of visual influence defines the geographic areas in which visibility of the onshore substation may be possible based on the availability of an unobstructed line of sight considering the screening effects of topography, vegetation, and built features in the landscape. The zone of visual influence will be used to determine the degree of visibility of the proposed substation within the previously defined visually sensitive resources and landscape character areas. Compatibility of the proposed substations with the surrounding landscape types, visually sensitive resources, and viewers will also be evaluated.

5.2.3 Presence of Structures

Offshore

Larger WTGs (1,047 ft [319 m]) are being proposed for the Projects than were evaluated in the following study (351 ft [107 m to 502 ft [153 m); therefore, the WTGs will be noticeable at greater distances during clear conditions. In a study of Offshore Wind Turbine Visibility and Visual Impact Threshold Distances (Sullivan et al. 2013) it was concluded that the predominant focus of visual attention occurs at distances up to 10 mi (16 km); facilities were noticeable to casual observers at distances of almost 18 mi (29 km); and were visible with extended or concentrated viewing at distances beyond 25 mi (40 km). The Rutgers Visibility Study (see Appendix II-M1) predicts that visibility over the water during July and August (the height of the tourism season when the most people will view the Projects) will typically range from 5 to 12 mi (8 to 19 km). This finding suggests that much of the Projects would be substantially obstructed from view at most times by weather/atmospheric conditions, even from those areas on the coast closest to the Projects. In the spring and early summer (April, May, and June) average visibility predictions suggest that visibility over the ocean will generally be 2.5 to 10 mi (4 to 16 km) suggesting that visibility to the Projects would be even more limited during this period (Brodie, 2020).

The viewshed analysis and field verification indicate that the Project has potential visibility from a relatively small portion of the land area within the visual study area. The lidar viewshed analysis suggests that views of the WTGs will be available from approximately 12.5 percent of the land area within the visual study area, which defines the zone of visual influence. Three percent of the landward visual study area (28 percent of the zone of visual influence) will only include views of the turbine blades which is generally the result of partial screening provided by the barrier islands from inland bay and mainland viewing locations. The majority of landward Project visibility (155 sq. mi.) occurs within 10-20 miles (16-32 km) of the Project over uninhabited inland bays. Visibility diminishes significantly between 30 and 40 miles (48-64 km), contributing only 44 sq. mi. to the zone of visual influence. The viewshed analysis also indicated potential visibility along the majority of the eastern shore of the barrier beaches. Variability in weather/atmospheric conditions (not considered in the viewshed analysis) will further reduce potential WTG visibility.

Field review largely confirmed that the lidar viewshed analysis is an accurate predictor of available open views towards the Projects and that in many areas intervening structures, human activity, and weather conditions could further obstruct or distract from views of the Project. It was also observed that open views from elevated locations, such as observation towers and the upper stories of tall buildings, may be available in areas where the viewshed analysis suggested partially screened or fully obstructed views (based on ground level viewer position).

The photosimulations prepared for each of the 22 daytime KOPs and three nighttime KOPs show the proposed Projects from a representative range of landscape settings, visually sensitive resources, and distances/directions within the zone of visual influence. A variety of lighting/sky conditions are illustrated, but all of the simulations show the Projects under optimal clear viewing conditions, unobstructed by haze, fog, precipitation, or other forms of atmospheric perspective. The simulations as a group represent the potential visual effect of the Projects throughout the zone of visual influence, ranging from a prominent new addition to the landscape to a minor change that would likely go unnoticed by a casual observer. Because the simulations show the Projects under high visibility, and often high contrast, viewing conditions they are considered to represent 'worst case' depictions of potential visibility of the Projects. A visibility study completed by Rutgers University suggests that the high visibility conditions represented in the photosimulations could occur over a period of less than 23% of daylight hours in a given year (Brodie, 2020). Additionally, in regard to the nighttime simulations, Atlantic Shores is proposing the use of mitigating technology that could reduce the activation time of the aviation obstruction warning lights to as little as 8.7 hours over the course of a given year (see Section 5.2.3).

As described in Section 5.2.1 and discussed in detail in Appendix II-M1, potential impacts to visual resources were evaluated by having a rating panel compare the scenic value of existing and proposed views from representative KOPs throughout the zone of visual influence. Rating panel results are summarized below.

Rating panel impact scores indicated that the Projects would result in significant visual impacts at 14 of the 22 KOPs under clear viewing conditions. The Project would result in somewhat significant visual impacts at three KOPs, one view would experience minimal visual impacts, and four views would experience negligible visual impacts.

KOPs expected to experience significant visual impacts resulting from the Projects during clear viewing conditions include the following:

KOP ID	Name	Distance (mi)	Distance (km)
BC02	North Brigantine Natural Area	9.0	14.5
AC04	Ocean Casino Resort – Sky Deck	10.5	17.0
AC02	Jim Whelan Boardwalk Hall NHL	11.4	18.4
LEHT02	Great Bay Boulevard WMA/Rutgers Field Station	11.9	19.2
BHB03	Holyoke Avenue	13.0	20.9
BHB02	Centre Street Beach Haven	13.5	21.7
BHB01	Beach Haven Historic District	13.5	21.7
OC04	Gillian's Wonderland Amusement	17.2	27.7
SBB01	Ship Bottom Borough Municipal Beach	19.4	31.1
OC01	Corson's Inlet State Park	21.7	35.0
LBT03	Beach at Long Beach Island Arts Foundation	24.9	40.0
LBT04	Wildlife Refuge on South Long Beach Boulevard in Holgate	27.3	44.0
SIC02	Townsend Inlet Bridge	27.4	44.0
BT01	Island Beach State Park	30.3	48.7

These KOPs are relatively close to the Projects (ranging in distance from 9.0 miles [14.5 km] to 30.3 miles [48.7 km]) and averaged 17.9 miles (28.8 km). These KOPs received visual impact scores ranging from minus 4.2 to minus 4.9. The scenic quality score of these views ranged between partially retained and retained. It is anticipated that the visual impacts presented by the Projects may result in adverse visual impacts to viewers when viewed under clear conditions such as those presented in the photosimulations. This conclusion is generally supported by the VTLs of 3 to 6 assigned to these KOPs. However, it is important to note the potential frequency of the viewing conditions presented in the photosimulations. For example, the KOP from BHB01 was taken during the month of August 2020. A meteorological study of 2019 visibility conditions suggests that this exceptionally clear condition would occur during approximately 5.2% of the month of August. Two variable conditions photosimulations were produced to illustrate more typical viewing conditions in August. The first condition occurred over approximately 19% of the month during which visibility is limited to 18 (29 km) miles. In this photosimulation, the WTGs become very difficult to see. It is anticipated that the visibility under this more representative condition can be characterized by a VTL of 1. The next condition occurred during 15% of the month and represents a maximum visibility distance of 20 (32 km) miles. During this atmospheric condition the simulation illustrates very faint WTGs on the horizon that would likely only be visible if the viewer is scanning the horizon. This visibility condition is characteristic of a VTL of 2. This variability in WTG visibility is expected to occur throughout the entire zone of visual influence, resulting in highly variable magnitude of visual change depending on atmospheric perspective and lighting conditions.

The effects on scenic quality will often be minimized by atmospheric conditions (e.g., haze, precipitation, and cloud cover) for all KOPs. Based on the results of the Rutgers Visibility Study, it is reasonable to conclude that the VIA presents worst-case visibility conditions. While it is very important to illustrate the greatest potential visibility and visual prominence in order to understand greatest potential visual impact associated with the Projects, the frequency of these viewing conditions is a relevant consideration. The average frequency of visibility to 10 mi (16 km) could occur during as little as 41% of daylight hours (Brodie, 2020). Only one of the photosimulations, and a very small portion of the zone of visual influence (3.8 mi^2 [9.8 km^2]) occurs within 10 mi (16 km) of the WTA. During up to 59% of the daylight hours in a given year (Brodie, 2020), it is anticipated that all, or the vast majority of, Project WTGs will not be visible from onshore locations.

From the selected KOPs, distance to the nearest WTG in the view ranges from approximately 9 mi (15 km) to 45 mi (61 km), while distance to the most distant WTG in the view ranges from approximately 24 mi (38 km) to 55 mi (88 km). These KOPs, and their associated distances to the Projects, are representative of points along the entire New Jersey coast within the Project's zone of visual influence and include the areas of most concentrated viewership. When considering all of the selected KOPs, the average distance to the nearest WTG is 14 mi (22 km), and the average distance to the most distant WTG is 40 mi (65km). The results of the Rutgers Visibility Study indicate that under "very clear" conditions viewers can see up to 20 mi (32 km) in offshore views. Longer distance views over the water are typically obscured by atmospheric perspective. The Rutgers study further indicates that only approximately 23% of daylight hours are categorized very clear (Brodie, 2020). This suggests that from many viewpoints along the coast that neither Project would be visible (i.e., all WTGs would be beyond 20 mi [32 km]), and that from the vast majority of sites substantial portions of the full WTG array would not be visible, even during the relatively rare occurrence of very clear viewing conditions. Under less clear conditions, which are estimated to occur during 75% of the daylight hours, a smaller portion of the WTA and WTGs would be visible.

Epsilon Associates also analyzed the data collected by Rutgers to characterize visibility over the entire year using the hourly visibility data. The results suggest that from many of the KOPs, atmospheric perspective will have a significant effect on visibility of the Projects from each of the KOPs. The visibility data for 13 of the 22 KOPs was compiled for each of the 12 months in 2019 and then delineated by morning, midday, afternoon, and evening to illustrate how visibility changes throughout the seasons and throughout the day. Cumulatively, these data suggest that January was the month during which visibility was the highest and April had the lowest frequency of visibility of the Projects. These trends are likely due to the presence of higher moisture content in the ambient air during spring resulting from a large air/water temperature differential along with increased events such as rain which are typical during this time. In winter, the air/water differential is still significant, but colder air has less capacity to hold moisture and therefore, less dissipation and refraction of light and the resulting visibility. Monthly Project obscuration from each KOP is presented in Figure 5.2-2. It is important to note that low visibility conditions do not necessarily suggest poor weather conditions. In fact, this portion of the New Jersey coast has a high percentage of sunny days and visual assessment field observers often encountered bright, sunny conditions with exceptionally low visibility over the water and high visibility over land.

These observations are supported by the study completed by Rutgers, which found that between the Atlantic City Airport and the OCS, visibility extending to 10 miles decreases from 78% over land to 41% over water. This significant decrease in visibility is attributable to the temperature difference between the air and ocean water, which results in high moisture content (Rutgers, 2021).

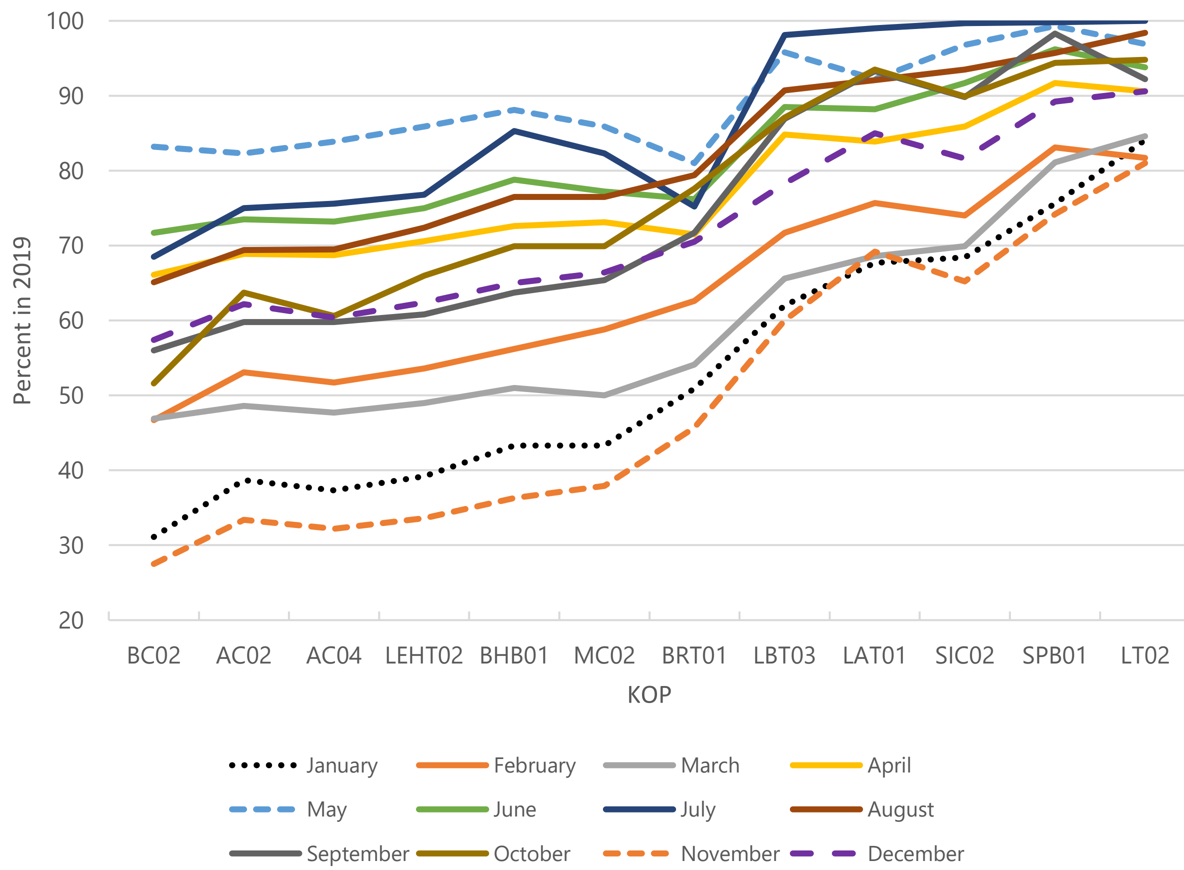


Figure 5.2-2 Percentage of Time the Projects Were Obscured by Atmospheric Perspective From KOPs

This data suggests that the photosimulations and resulting visual impact determinations presented in this VIA provide a very conservative assessment. Field photography specifically targeted high visibility conditions over the water and multiple field photography attempts (during which high visibility and fair weather was predicted) resulted in unsuitable conditions for the photographing a conservative case. In reality, the duration and frequency of Project visibility is expected to be minimal and therefore the visual impacts associated with the Project's should be tempered in anticipation of the mitigating effects of atmospheric perspective.

Onshore – Cardiff Project Area

Visibility of the proposed Fire Road Site will generally be limited to transit corridors and commercial parking lots in the near-foreground distance zone of the Site. The viewshed analysis results suggest that visibility could occur over an area measuring approximately 97.7 acres (0.4 km2). Based on these results, the Site will be screened from view in 99.5% of the visual study area, and from 83 (83%) of the 100 identified visually sensitive resources within the visual study area (see Appendix II-M2 for a full list of visually sensitive resources). As such, almost the entire visual study area and most of the visually sensitive resources will not have views of the proposed Fire Road Site. In addition, presence of visually sensitive resources within the zone of visual influence does not necessarily indicate that the facility will result in adverse visual impacts to that resource. As confirmed during field review, in areas outside the near-foreground distance zone, the Fire Road Site visibility is predominantly limited to the upper portions of the lightning masts due to screening provided by adjacent structures and vegetation. These structures are likely to be lost amongst the existing commercial, industrial development, along with existing roadside utilities which characterize the landscape character areas in and around the Site. Similarly, in areas where visibility of the Site is indicated to include views beyond the lightning masts, visibility is still likely to be limited to the upper portions of the Site components which will be difficult to distinguish from other structures on the horizon. As indicated by the viewshed analysis results, areas where the Fire Road Site may be visible generally occur within the Commercial character area, with less substantial views also occurring in the Forest, High Density Residential, and Industrial landscape character areas. Visibility in other landscape character areas will occur over less than 11 acres of their cumulative land area. Within the Commercial landscape character area visibility generally occurs in open parking areas in proximity to the Fire Road Site, and visibility within the Forest landscape character area is attributed to locations within the Site which are not currently and will not be accessible to viewers. Views from the High Density Residential landscape character area will be available, particularly when directly adjacent to the Site when viewers are oriented in the direction of the Site. In High Density Residential landscape character area, it is likely that these users will have elevated sensitivity to changes in the landscape and for those that live and/or work directly adjacent to the Fire Road Site, adverse visual effects are anticipated. To minimize and reduce these visual effects, a landscape buffer is being proposed along Fire Road. While this mitigation will become more effective as the vegetation matures, it is likely that viewers directly adjacent to the site will experience adverse visual effects.

The photosimulation produced from Hingston Avenue represents the most open, unobstructed view of the proposed Fire Road Site (see Appendix II-M2). Visibility in this area will be available to residents directly adjacent to the Fire Road Site and they will likely be affected by the visual changes introduced by the Site. The greatest degree of visual contrast results from the vegetation clearing occurring at Fire Road Site, but the addition of a large industrial substation to the view also results in a significant character shift in this location. Drivers will likely be less affected by the change due to the fleeting nature of the views along this road, but stationary residents in their homes or pedestrians will experience this industrial character shift on a regular basis. The proposed vegetative mitigation along Hingston Avenue provides a visual buffer of the lower elements within the Fire Road Site as well as some visual interest resulting from the variable textures and colors presented. Additionally, the proposed mitigation breaks up the long fence line, thus reducing its scale and color contrast. While the proposed plantings effectively mitigate the visual contrast of the Fire Road Site, they fall short of returning the sense of enclosure present in the existing view. While this type of land clearing and development is certainly not without precedent within the visual study area, the change to the Site is substantial. For the few that live or work directly adjacent to the site, the Fire Road Site will result in adverse visual effects. However, considering the majority of viewers within the visual study area who are not directly adjacent to the Facility, they are unlikely to notice the changes to the landscape. This conclusion is supported by the photosimulation from Tilton Road (see Appendix II-M2). In this view, located only 548 feet from the Site, the Fire Road Site is almost completely obscured from view and only a lightning mast is visible. Due to the lightning masts similar appearance size and appearance to light poles and other streetscape elements, it blends into the existing visual landscape present in this view and throughout the Commercial LCA. The vegetation clearing, while noticeable from this KOP, results in minimal change to the landscape suggesting that the visual impacts associated with the Fire Road Site will be very localized.

Onshore – Larrabee Project Area

Based on results of the viewshed analysis completed for the Larrabee Project Area, the proposed substation and/or converter station will be screened from view in 99.8% of the visual study area if the Lanes Pond Road Site is selected and 99.7% of the visual study area if the Randolph Road Site is selected. The Site will also be screened from 181 (93.7%) of the 193 identified visually sensitive resources within the visual study area regardless of which site is selected. If either the Lanes Pond Road Site or the Randolph Road Site are selected visibility of the Site would be screened from 188 (97.4%) of the visually sensitive resources (see Appendix II-M3 for a full list of visually sensitive resources). Thus, the vast majority of the visual study area and visually sensitive resources will not have views of the proposed substation and/or converter station site, regardless of the site ultimately selected. As described in the viewshed analysis results discussion, potential visibility is concentrated within the near-foreground distance zones and within the sites themselves. However, presence in the zone of visual influence, which indicates where any portion of the Site could be visible, does not necessarily indicate that visibility of the Site will result in adverse visual impacts. In most locations, particularly areas outside of the near-foreground distance zone, visibility will be limited to only the upper portions of the proposed lightning masts due to screening provided by existing adjacent structures and vegetation. From these locations where visibility of the Site is limited, it is likely that the visible components will be difficult to distinguish from other structures on the horizon.

The photosimulations (see Appendix II-M3) support the conclusions that the Randolph Road would increase the presence of visual clutter resulting from the new, large-scale forms introduced to an already visually blighted area.

For the Randolph Road Site, because the proposed substation and/or converter station would be replacing an existing, albeit smaller, industrial building, the visual change is less obtrusive and appears to minimally change the visual character of the view. As mentioned previously, vegetative mitigation along Randolph Road could be effective in reducing visibility for passersby, but from the selected KOP, this mitigation would have minimal effectiveness.

Considering the photosimulation of the Lanes Pond Site, the distinct and separate visual character of this area, despite its proximity to industrial uses, is adversely impacted by the proposed substation and/or converter station. Again, from this KOP, the conservative case visibility is illustrated, but this type of view would be experienced by up to three residents that currently view an empty field. These users, in addition to passersby would experience a significant visual change from a rural residential, pastoral setting to one of industrial character. Although the views are extremely localized, the viewer sensitivity is high and the sensitivity of the character areas, because they are a rare reprieve from mounting industrial and residential development, are also sensitive to visual change. As such, both the character areas and the viewers will experience adverse visual effects. Due to the proximity of these users to the Lanes Pond Road Site, vegetative mitigation, color treatment, and alternative site material could marginally reduce the adverse visual effects but would not change the dramatic character shift resulting from the development.

Other onshore facilities are limited to transmission cable vaults and duct banks that will be buried underground at the Atlantic and Monmouth Landfall Sties and along the entire interconnection cable route to the onshore substations and/or converter stations and the POIs. As they will be underground, these project components will not be visible to the public and have no impacts on visual resources.

Onshore – Operations and Maintenance Facility

Based on the results of the viewshed analysis, widespread visibility of the O&M Facility will occur within the VSA. The viewshed analysis results suggest that approximately 34.1% (10.0 square miles or 6,409.6 acres) of the VSA could have some level of visibility of the O&M Facility while the remaining 65.9% of the VSA will be screened from view. The viewshed analysis suggests that 118 (57%) of the 207 VSRs (including 32 out of 42 EJAs and 16 out of 16 DACs) occurring within the 3-mile radius VSA could have potential visibility of the proposed O&M Facility.

The photosimulations suggest that the O&M Facility visual impacts will be much more localized than suggested by the viewshed analysis. Three simulations ranging from approximately 60 feet up to 0.9 miles from the proposed O&M Facility were produced and a strong correlation between the viewed distance and the potential visual impacts was identified. The range of visual impacts will be minor to Major. Major impacts are anticipated when existing views of Clam Creek experienced by highly sensitive viewers will be screened by the O&M Facility. This is a very localized impact that may be experienced differently for individuals travelling down the road directly adjacent to the Facility.

Based on the result of the photosimulations, it can be reasonably and conservatively concluded that VSR occurring within 1,000 ft (304 m) of the proposed O&M Facility may experience moderate to major visual impacts depending on how much of the Facility can be viewed from the VSR. The

VSR analysis suggests that 10 of the 118 VSRs with potential O&M Facility visibility fall within this zone. Examples of these resources include Dwayne E Harris Memorial Park, Atlantic City, Clam Creek, Senator Frank S. Farley State Marina, three EJAs, and one DAC (including the O&M Site itself).

VSRs that occur between 1,000 ft (304 m) and 3,500 ft (1,067 m) may experience minor to moderate visual impacts. The moderate range of impacts is anticipated for those resource that occur on the water's edge and have a direct of the O&M Facility. Resource on land within this zone are anticipated to experience minor to moderate visual impacts. The VSR analysis suggests that 39 of 118 VSRs with potential visibility of the O&M Facility fall within this zone. Examples of these VSRs include Garders Basin Park and USCG Station Atlantic City in the moderate impact category and Uptown Park in the minor impact category.

VSRs beyond 3,500 ft (1,067 m) are likely to experience negligible to minor visual impacts. Again, minor impacts are anticipated for VSR that occur on the water's edge and have a direct view into the O&M Facility, while inland resources will experience no impacts to minor impacts. The VSR analysis suggests that 69 of 118 VSRs with potential visibility of the O&M Facility fall within this zone. Examples within the minor impact range include waterfront VSRs such as Cove Beach in Brigantine and Absecon Bay. Inland VSRs, such as Oscar E McClinton Waterfront Park and Altman Park. Absecon Lighthouse, a highly elevated inland resource, may experience minimal visual impacts.

VSRs that will not be impacted by the O&M Facility will not have any degree of visibility. Eighty nine resources will not have any degree of visibility of the O&M Facility.

5.2.4 Traffic

Offshore

Marine traffic associated with construction of the Projects is not anticipated to have significant visual impacts. During the construction phase, the increased presence of ships on the horizon could result in temporary visual impacts, drawing attention to the modern vessels and associated construction equipment as they install the WTGs and OSSs, and as they move to and from the Projects. This would have the secondary effect of drawing attention toward the WTGs as they are being erected. However, views of distant boats on the horizon are not uncommon, and these visual impacts would be temporary in nature, only lasting for the duration of the construction period.

Onshore

During construction and decommissioning of the onshore facilities (e.g., onshore substations and/or converter stations and buried duct banks), vehicular traffic will increase, and construction equipment will be present at the landfall site, along the buried interconnection cable route, at the proposed onshore substations and/or converter stations and at the POIs. While this activity would result in short term visual effects, it would be largely confined to roads and previously disturbed/developed sites, and therefore would not be out of place in the visual setting of the Projects.

5.2.5 Light

Offshore

The WTGs and OSSs and their associated foundations will be equipped with marine navigation lighting and marking in accordance with USCG and BOEM guidance. To aid mariners navigating within and near the WTA, each WTG position will be maintained as a Private Aid to Navigation and will include yellow flashing lights on each foundation which will be visible in all directions. In accordance with USCG regulations, it is anticipated that the marine navigation lights on structures along the perimeter of the WTA will be visible at a range of 3 or 5 nautical miles (nm) (depending on the structure's location), whereas lights on interior structures will be visible at a range of 2 nm. Additional information on marine navigation lighting and marking can be found in the Navigation Safety Risk Assessment (NSRA, see Appendix II-S).

All of the WTGs will also be equipped with aviation obstruction warning lights in accordance with FAA and/or BOEM guidance to aid aircraft operating in the airspace of the WTA. Based on current guidance in FAA Advisory Circular (AC) 70/7460-1M, the aviation obstruction warning lighting system on the proposed WTGs will include red flashing lights on the nacelle and an additional level of flashing red lights on the tower. The lights will be arranged so that they are visible by a pilot approaching from any direction. If the height of the OSSs exceeds 200 ft (61 meters [m]) above MSL or any obstruction standard contained in 14 CFR Part 77, the OSSs will include an aviation obstruction warning lighting system in compliance with FAA and/or BOEM requirements.

The lidar viewshed analysis suggests that views of the aviation obstruction warning lights on the WTGs will be available from approximately only 9% of the land area within the visual study area. This reduction in visibility is largely the result of the lower height of the lights (as compared to the blade tips), combined with the screening effects of curvature of the earth at distance between 30 and 40 mi (48-64 km). The analysis indicated that potential views of aviation obstruction warning lights from ground-level vantage points on the barrier islands would be unavailable at distances beyond 35 mi (56 km) due to curvature of the earth. Weather/atmospheric conditions are likely to further reduce the visibility of the aviation obstruction warning lights at closer distances.

Visual simulations of the Projects at nighttime were prepared for three of the selected KOPs ranging from 10.5 mi (16.9 km) to 32.2 mi (51.8 km) from the closest WTGs. The rating panel indicated that the aviation obstruction warning lights would become the focus of viewer attention and could change the character of the nighttime skies at each of these locations. Of the three KOPs evaluated, two (BHB01- Beach Haven Historic District and AC04- Ocean Casino Resort) received scores indicating high magnitude of change, resulting in adverse visual impacts and one (LAT01-Edwin B. Forsythe NWR at the Woodmansee Estate) received scores indicating moderate magnitude of change resulting in potential adverse visual impacts.

Atlantic Shores is proposing the use of an ADLS, subject to FAA and BOEM approval, which could substantially reduce the amount of time that the aviation obstruction warning lights are illuminated. An ADLS automatically activates all aviation obstruction warning lights when aircraft approach the WTA; at all other times, the lights are off. Atlantic Shores conducted an ADLS Efficacy Analysis to determine the likely activation time of the FAA lights if ADLS is implemented (see Appendix II M-4). Based on this analysis, the aviation obstruction warning lights would be activated for a total of approximately 8.7 hours over a one-year period. The maximum monthly activation time would occur during November when past flight data suggest activation times would be approximately 2 hours and 40 minutes over the entire month. April, May, June, August, September, and October had the lowest activation frequency with average activation time of 14 minutes per month. Considering the low frequency of light activation, nighttime visual impacts associated with the Projects' aviation obstruction warning lights would become intermittent and minor with an ADLS in a place.

Other temporary lighting (e.g., helicopter hoist status lights) may be utilized on the WTGs for safety purposes when necessary. Similarly, some outdoor OSS lighting (in addition to any required aviation or marine navigation lighting) will be necessary for maintenance that may occur at night. Atlantic Shores anticipates using controls to ensure that outdoor OSS lights will be illuminated only when the OSS is manned. When unmanned, general outdoor lighting will be turned off.

Onshore

General lighting will be manually engaged on an as-needed basis at the O&M facility and the substations and/or converter stations if examination of equipment occurs at night. The expected use of lighting will be daily during construction, start-up, and commissioning, and several times per year for repairs or detailed inspections during normal operations. Light fixtures will be LED floodlights mounted on dedicated poles or lightning masts (likely 40 to 50 ft [12 to 15 m] high) to illuminate the general substation area. Illumination levels are expected to be no more than 22 lux (2 foot candles [fc]).

In addition to general lighting at the substations and/or converter stations, one photocell-controlled pole-mounted LED streetlight-style fixture will be placed at the entrance gate. The fixture will be hooded to minimize glare and off-site light trespass. Light fixtures will also be placed at entrance doors to the control buildings and other buildings. These fixtures will be wall-mounted and equipped with hoods to direct and limit the illumination. Atlantic Shores will coordinate with local officials to ensure the lighting scheme complies with any applicable municipal requirements.

5.2.6 Summary of Potential Effects and Proposed Environmental Protection Measures

Atlantic Shores understands the importance of scenic ocean views to local residents, tourists, and visitors to New Jersey's shore communities and is committed to minimizing adverse visual impacts to the maximum extent practicable. To that end, Atlantic Shores has developed the following proposed environmental protection measures to effectively reduce the potential visual impacts, as practicable given the nature of the technology and the location of the Projects:

Offshore

- The Projects will be located in a designated offshore wind development area that has been identified by BOEM as suitable for the proposed type of development.
- The larger of the OSSs under consideration for the Projects are proposed to be placed further offshore in order to reduce potential visibility.
- The WTGs will be painted no lighter than Pure White (RAL 9010) and no darker than Light Grey (RAL 7035) to eliminate the need for daytime warning lights or red paint marking of the blade tips.
- WTGs, MET towers, and OSS will be marked and lit in accordance with the minimum FAA, BOEM and USCG requirements necessary to maintain navigation and aviation safety.
- The photosimulations, which illustrate the appearance of the WTG, OSSs, and proposed MET tower suggest that the MET tower is a relatively minor component of the WTA and did not significantly contribute to the potential visual impacts associated with the WTG array.
- ADLS, will be used if practicable and permitted, to reduce the time the aviation obstruction lighting on WTGs is illuminated.

Onshore

- Onshore interconnection cables will be installed underground rather than on aboveground structures.
- All materials for onshore facilities (O&M Facility, Onshore Substations/Converter Stations) will utilize materials with a mitigated specular profile to reduce visibility and glare. This includes the use of chemically dulled galvanized steel.
- Vegetative screening will be installed to provide a screening/softening buffer between the substation and/or converter station sites and sensitive users/land uses.
- All infrastructure will be decommissioned at the end of the Projects' life cycle.
- The O&M facility will utilize low emission and full cutoff lighting fixtures to maintain site security and safety while maintaining minimal offsite light pollution.
- Guidance and standards will meet the requirements set forth by the applicable local regulations for the substation and/or converter station sites and O&M facility. Additional mitigation, if necessary, will be drawn from the National Park Service Sustainable Outdoor Lighting best practices and BLM Technical Note 457 Night Sky and Dark Environments: Best Management Practices for Artificial Light at Night on BLM-Managed Lands.

6.0 CULTURAL RESOURCES

This section provides a detailed description of the above-ground historic properties, terrestrial archaeological resources, and marine archaeological resources within the Onshore and Offshore Project Areas. The Onshore Project Area includes the Atlantic and Monmouth Landfall Sites, onshore interconnection cable routes, proposed substations and/or converter stations, and the points of interconnection (POI). The Offshore Project Area includes the Wind Turbine Area (WTA, including Project 1, Project 2, and the Overlap Area) and the export cable corridors (ECCs).

To facilitate BOEM's Section 106 review, Atlantic Shores prepared the *Preliminary Area of Potential Effects (PAPE) Memorandum* to describe and illustrate the Preliminary Area of Potential Effects (or PAPE) for the Projects (see Volume I Appendix I-A). The PAPE includes all locations where construction or operation of the proposed Projects has the potential to affect historic properties. The information used to define the PAPE therein was summarized from and references the Project Design Envelope (PDE) described in Volume I of the COP. According to BOEM (2020), "A PDE approach is a permitting approach that allows a project proponent the option to submit a reasonable range of design parameters within its permit application, allows a permitting agency to then analyze the maximum impacts that could occur from the range of design parameters, and may result in the approval of a project that is constructed within that range." The PDE approach allows Atlantic Shores design flexibility and an ability to respond to advancements in industry technologies and techniques.

Based on review of BOEM's *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585* (BOEM, 2020), Atlantic Shores has proposed the PAPE to include the following geographic areas:

- the viewshed from which renewable energy structures, whether located offshore or onshore, would be visible, constituting the viewshed portion of the PAPE
- the depth and breadth of terrestrial areas potentially impacted by any ground-disturbing activities, constituting the terrestrial archaeological resources portion of the PAPE
- the depth and breadth of the seabed potentially impacted by any bottom-disturbing activities, constituting the marine archaeological resources portion of the PAPE
- any temporary or permanent construction or staging areas, both onshore and offshore, which may fall into any of the above portions of the PAPE.

The final Area of Potential Effects (APE) will be formally determined by BOEM as part of the Section 106 consultation process. The process for identifying and evaluating effects on historic properties resulting from the construction and operation of the Project will involve consultation with BOEM, the New Jersey Historic Preservation Office (NJHPO), Tribal Historic Preservation Officers (THPOs), and other consulting parties with a demonstrated interest in the historic properties (e.g., historic preservation organizations).

6.1 Aboveground Historic Properties

This section describes aboveground historic properties within the PAPE, associated impact producing factors (IPF), and measures to avoid, minimize, or mitigate potential adverse effects to these properties during construction, operations and maintenance (O&M) and/or decommissioning of the Projects.

Aboveground historic properties are defined as districts, buildings, structures, objects, or sites that are listed in, or determined eligible for inclusion in, the National Register of Historic Places (NRHP), or which have been designated as National Historic Landmarks (NHL). Aboveground historic properties can include residential, commercial, and industrial sites, natural landscapes, and traditional cultural properties.

Aboveground historic properties that may be affected by the Projects were evaluated in accordance with BOEM's *Guidelines for Providing Archaeological and Historic Property* Information pursuant to 30 CFR Part 585 (BOEM, 2020a, Section 106 and Section 110 of the NHPA, NEPA), Special Requirements for Protecting National Historic Landmarks (36 CFR Part 800.10), Section 7:4 of the New Jersey Administrative Code, the State of New Jersey Executive Order #215 (NJHPO 2008), and Part II, Article III, Section 148-11 of the Atlantic City Code (Atlantic City 2021).

The evaluation of the Projects' potential effect on aboveground historic properties is described in the Onshore Interconnection Facilities Historic Resources Effects Assessment (HREA), which is included as Appendix II-N1,[37] and the Onshore Operations and Maintenance (O&M) facilities and Offshore Historic Resources Visual Effects Assessment (HRVEA) reports, which are included as Appendices II-N2 and II-O, respectively. The purpose of the HREA and HRVEA reports is to evaluate the Projects' potential visual effects on the qualities that make aboveground historic properties eligible for listing in the NRHP. The results of the HREA and HRVEAs for the Offshore and Onshore facilities are summarized in the following sections.

6.1.1 Affected Environment

A standard study area for evaluating potential effects to aboveground historic properties resulting from offshore wind farms has not been expressly defined by BOEM or in guidance from other regulatory agencies. However, BOEM's *Information Guidelines for a Renewable Energy Construction and Operations Plan* (COP) indicates that visual impacts, including potential impacts to aboveground historic properties should be evaluated using photo simulations from locations within "the onshore viewshed from which renewable energy structures, whether located offshore or onshore, would be visible" (BOEM 2020a).

[37] Atlantic Shores previously submitted a memorandum to BOEM in August 2022 with information on eight potential locations (Parcel Areas) for the proposed Larrabee Onshore Substation and/or Converter Station. Design decisions since the transmittal of that memorandum have resulted in the removal of six of the previously identified locations (Parcel Areas 1-6), and the addition of one location (Randolph Road Site). The designation of Parcel Areas 7/Binyan Site has been updated to the Lanes Pond Road Site. Parcel 8/100 Acre Site has been updated to the Brook Road Site which will be developed under the NJBPU's State Agreement Approach (SAA).

The assessment of effects on aboveground historic properties was coordinated with the Visual Impact Assessment (VIA) prepared for the Projects (see Appendices II-M1, II-M2, and II-M3). The VIA included a viewshed analysis that informed the selection of the aboveground historic properties recommended for evaluation in the HREA and HRVEA reports, and which were subsequently included as a type of visually sensitive receptor in the VIA. Based on the visibility analysis included in the VIA, Preliminary Areas of Potential Effects (PAPE) were defined for the Projects. The areas that could potentially have views of the offshore, onshore, and O&M facilities were determined by the viewshed analysis developed as part of the VIA. The viewshed analysis is based upon a highly detailed digital surface model (DSM) generated from lidar data that includes the elevations of land features, buildings, trees, and other objects large enough to be resolved by lidar technology. The PAPEs for the offshore and onshore facilities of the Projects include the following:

- **Offshore/Wind Turbine Area (WTA) PAPE:** In order to develop a PAPE for the WTA, viewshed analysis was completed as part of the VIA in area within 45.1 miles (72.6 km) of the WTA generated from lidar data,[38] which includes the elevations of land features, buildings, trees, and other objects large enough to be resolved by lidar technology. A bare-earth digital elevation model (DEM), representing topography only, was also created in order to make corrections to the digital surface model (DSM) and to the initial viewshed result. The DSM and DEM were both created with a horizontal resolution of 3 meters (m) to allow direct comparison of ground elevation with the elevation of surface features (such as buildings and vegetation). This analysis was used to determine the PAPE for the offshore components of the Projects. Based on ongoing consultations with BOEM, and as detailed in Section 2.3 of the offshore HRVEA, Atlantic Shores elected to extend the 40-mile (64.4 km) WTA PAPE viewshed buffer to 45.1 miles (72.6 km) in order to assess the Projects' potential visual effects on aboveground historic properties located in Cape May, New Jersey. A map of the WTA PAPE is included as Figure 6.1-1.
- **Onshore Facilities Visual PAPE**: To determine the geographic areas of potential visibility (and therefore potential visual effects) of the onshore substation/converter station options included in the Project Design Envelope (PDE), a lidar-based viewshed analysis was conducted. This analysis considers the height of proposed aboveground components of the facility as anticipated by preliminary site plan designs along with a DSM representing existing ground-level elevations, vegetation, and structures present in the VSA. The DSM was derived from 2014 and 2018 United States Geological Survey (USGS) lidar data with a horizontal resolution of one meter. A GIS analysis of this data was conducted to determine whether a direct line of sight would be available from ground level vantage points to the tallest proposed substation components. If a direct line of sight is available, the position (1-meter grid cell) is coded as visible. The viewshed calculations used sample points with an assigned height of 80 feet (24.4 m) to represent the lightning masts (the tallest

[38] Lidar data availability varies throughout the 45.1-mile (72.6 km) viewshed radius, requiring the use of more than one data source. The following four lidar datasets were incorporated into the DSM: NOAA 2014, USGS 2015, Cumberland County 2008, and American Recovery and Reinvestment Act (ARRA) 2010.

proposed structures). Sample points were spaced 200 feet (61 m) apart in a grid pattern across each of the Sites. The sample point locations were determined using a preliminary site plan illustrating the proposed Larrabee Substation/Converter Station options and Fire Road Substation/Converter Station layouts. The resulting geographic areas of potential visibility are referred to as the Onshore Facilities PAPEs. The Onshore Facilities PAPEs include all areas within 1 mile (1.6 km) of the proposed facilities with potential visibility (based on a viewshed analysis) of the substation and/or converter station sites. Based on the relatively low-profile of the proposed onshore components, a 1-mile (1.6 km) radius was defined around the property boundary associated with the proposed onshore components within which to assess potential visual effects based on a viewshed analysis (the PAPE). A 1-mile (1.6 km) area for each of these facilities is considered the maximum limit within which aboveground historic properties could be subject to adverse visual effects given size of the proposed facilities and the screening provided by existing topography, building/structures and/or adjacent developed areas, and vegetation. While visibility beyond 1 mile (1.6 km) is possible, the nature and degree of potential visual impacts will be minimal beyond 1 mile (1.6 km) due to the density of existing modern development and infrastructure located within the PAPE. Maps of the Onshore Facilities PAPEs are included as Figure 6.1-2, 6.1-3, 6.1-4, and 6.1-5.

- **O&M Facility PAPE**: To determine the geographic areas of potential visibility (and therefore potential visual effects) of the O&M facility, a lidar-based viewshed analysis as described above was conducted. The O&M facility PAPE includes all areas within 1 mile (1.6 km) of the proposed O&M facility with potential visibility (based on a viewshed analysis) of the facility. Based on the relatively low-profile of the O&M facility, a 1-mile (1.6 km) area is considered the maximum limit within which aboveground historic properties could be subject to adverse visual effects given size of the proposed O&M facility and the screening provided by existing topography, building/structures and/or adjacent developed areas, and vegetation. While visibility beyond 1 mile (1.6 km) is possible, the nature and degree of potential visual impacts will be minimal beyond 1 mile (1.6 km) due to the density of existing modern development and infrastructure located within the O&M facility PAPE. A map of the O&M facility PAPE is included as Figure 6.1-6.

Within the PAPEs established for the Projects, an inventory of aboveground historic properties was developed by reviewing current public data sources including the following:

- The New Jersey Department of Environmental Protection (NJDEP) Look Up Cultural Resources Yourself (LUCY) website (NJDEP, 2022)
- The Atlantic County Division of Parks and Recreation Historical Sites webpage (Atlantic County, 2021)
- The Monmouth County Parks System (MCPS) Monmouth County Historic Sites Inventory (MCHSI) website (MCPS, 2021)

- Multiple Property Documentation Forms for relevant aboveground historic properties located within the PAPE
- Aboveground historic properties identified as part of studies conducted by BOEM in 2012 in order to prepare a GIS database of known aboveground cultural resources/historic properties that could be affected by the introduction of offshore energy facilities along the east coast of the United States[39]
- Publicly available historic resources studies for offshore wind projects
- Municipal-level (i.e., county, town, city, or village) historian's offices and associated online databases
- Privately run local and regional historical societies.

As mentioned above, the final APE for aboveground historic properties will be formally determined by BOEM as part of the Section 106 consultation process. The process for identifying and evaluating visual effects to aboveground historic properties resulting from the construction and operation of the Projects will involve consultation with BOEM, the NJHPO, Native American Tribes/Nations, and other consulting parties with a demonstrated interest in the historic properties (e.g., historic preservation organizations). The following sections describe the inventory of aboveground historic properties located within the Offshore and Onshore Facilities Visual PAPEs.

6.1.1.1 Offshore Facilities

Aboveground historic properties in the Offshore Facilities Visual PAPE are summarized and enumerated in Table 6.1-1. The NRHP eligibility of potential historic properties was assessed through documentary, GIS, and field investigations. The assessments are conservative and intended to provide robust support for ongoing Section 106 consultations and input from the consulting parties. For the purposes of the Offshore HRVEA, potential aboveground historic properties without a previous determination of NRHP eligibility are considered potentially NRHP-eligible pending consultation with BOEM and the NJHPO under Section 106 of the NHPA. A detailed list of all identified aboveground historic properties is provided in Appendix II-O, Table 3.2-1 and illustrated in Appendix II-O, Figure 3.2-1.

[39] Klein, J.I., M.D. Harris, W.M. Tankersley, R. Meyer, G.C. Smith, and W.J. Chadwick. 2012. Evaluation of visual impact on cultural resources/historic properties: North Atlantic, Mid-Atlantic, South Atlantic, and Florida Straits. Volume I: Technical report of findings. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2012-006. 24 pp., and Klein, J.I., M.D. Harris, W.M. Tankersley, R. Meyer, G.C. Smith, and W.J. Chadwick. 2012. Evaluation of visual impact on cultural resources/historic properties: North Atlantic, Mid-Atlantic, South Atlantic, and Florida Straits. Volume II: Appendices. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2012-007. 10 appendices.

Table 6.1-1 Aboveground Historic Properties Identified within the Offshore Facilities Visual PAPE

Property Designation	Occurrences of Aboveground Historic Properties Within The PAPE
National Historic Landmark (NHL) properties	2
Aboveground Historic Properties and Historic Districts Listed in the National Register of Historic Places	19
Aboveground Historic Properties and Historic Districts Determined Eligible for Listing in the National or State Register of Historic Places[a]	66
Aboveground Historic Properties and Historic Districts Recommended Eligible for Listing in the National or State Register of Historic Places[b]	15
Total	**102**

[a] This includes properties formally determined NRHP-eligible by NJHPO or BOEM whose NRHP eligibility was confirmed as part of the field surveys.

[b] This includes properties previously inventoried without a formal determination of NRHP eligibility that have been recommended by EDR to meet NRHP eligibility, including properties contributing to NRHP-eligible historic districts.

Following a review of the field survey results, a total of 102 aboveground historic properties were identified within the Offshore Facilities Visual PAPE for assessment of potential adverse effects, including two NHLs, 19 individual properties and historic districts listed in the NRHP, 66 individual properties and historic districts formally determined eligible for the NRHP, and 15 individual properties and historic districts recommended to meet NRHP eligibility. Potential effects to historic districts within the PAPE were considered to the entirety of the district as one property, rather than to each of the contributing properties, as not all contributing properties within historic districts are located in the PAPE. This approach is considered to be conservative as far as addressing potential impacts to historic districts as a whole.

6.1.1.2 Onshore Facilities

Following the desktop review and field survey, three of the parcels reviewed are considered aboveground historic properties. Two aboveground historic properties were identified in the Fire Road Site PAPE and one aboveground historic property was identified in the PAPE for two Larrabee substation and/or converter station sites (the Lanes Pond Road Site and the Randolph Road Site PAPEs). The aboveground historic properties are identified in Table 6.1-2.

Table 6.1-2 Aboveground Historic Properties Identified within the Onshore Facilities Visual PAPEs

Aboveground Historic Property Name	NRHP Designation	Associated PAPE
New Jersey Southern Railroad Historic District	NRHP-Eligible (NJHPO-Determined)	Lanes Pond Road Site, Randolph Road Site
West Jersey and Atlantic Railroad Historic District	NRHP-Eligible (NJHPO-Determined)	Fire Road Site
Garden State Parkway Historic District	NRHP-Eligible (NJHPO-Determined)	Fire Road Site

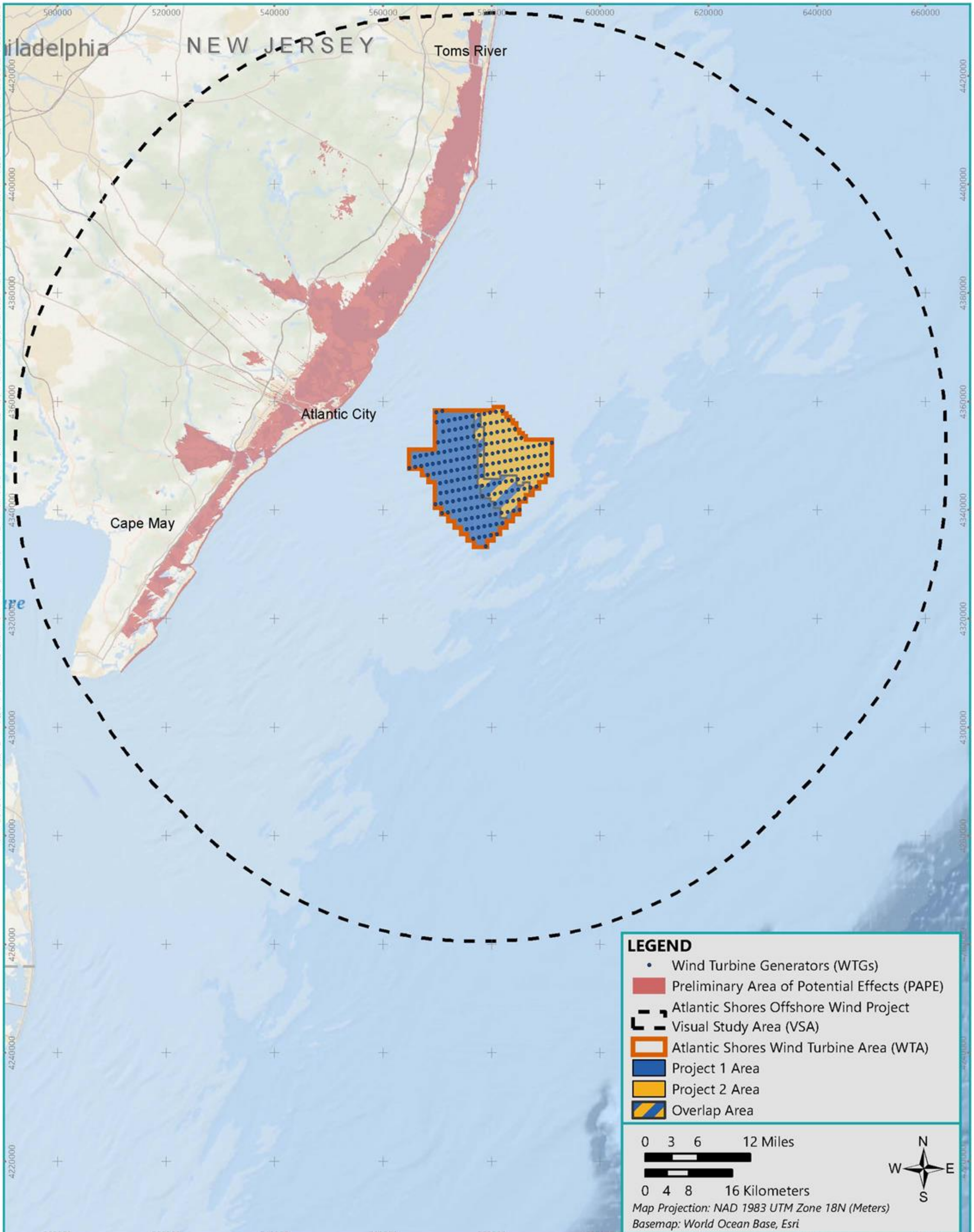
6.1.1.3 O&M Facility

Following the desktop review and field survey, five of the parcels reviewed in Atlantic City are considered aboveground historic properties. The aboveground historic properties are identified in Table 6.1-3.

Table 6.1-3 Aboveground Historic Properties Identified within the Onshore Facilities Visual PAPEs

Property Name	Address	NRHP Designation
Residence at 419 Carson Avenue	419 Carson Avenue	NRHP-Eligible (NJHPO-Determined)
Absecon Lighthouse	301 Pacific Avenue	NRHP-Listed
Atlantic City Armory	1008 Absecon Boulevard [Atlantic Boulevard and New York Avenue]	NRHP-Eligible (NJHPO-Determined)
Atlantic City Beautiful Historic District	N/A	NRHP-Eligible (NJHPO-Determined)
USCG Station Atlantic City	900 Beach Thorofare	NRHP-Eligible (NJHPO-Determined)

Atlantic Shores recognizes that Traditional Cultural Properties (TCPs) associated with Native American communities may be present within the PAPEs and may be sensitive to visual impacts from construction, O&M, or decommissioning of the Projects. Although Atlantic Shores is not aware of the existence of any TCPs in the PAPEs, Atlantic Shores also recognizes that government-to-government consultations between BOEM and tribes under Section 106 of the National Historic



ATLANTIC SHORES offshore wind

Figure 6.1-1. Offshore Facilities Visual PAPE

Lease Area OCS-A 0499

Offshore New Jersey

4/20/2023 | \\edr-alb-01\jobs\alb\20043_Atlantic Shores Offshore Wind_COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\6.1_Above Ground Historic Properties\MXD\Figure 6.1-2. Lanes Pond Road Site Onshore Facilities Visual PAPE.mxd

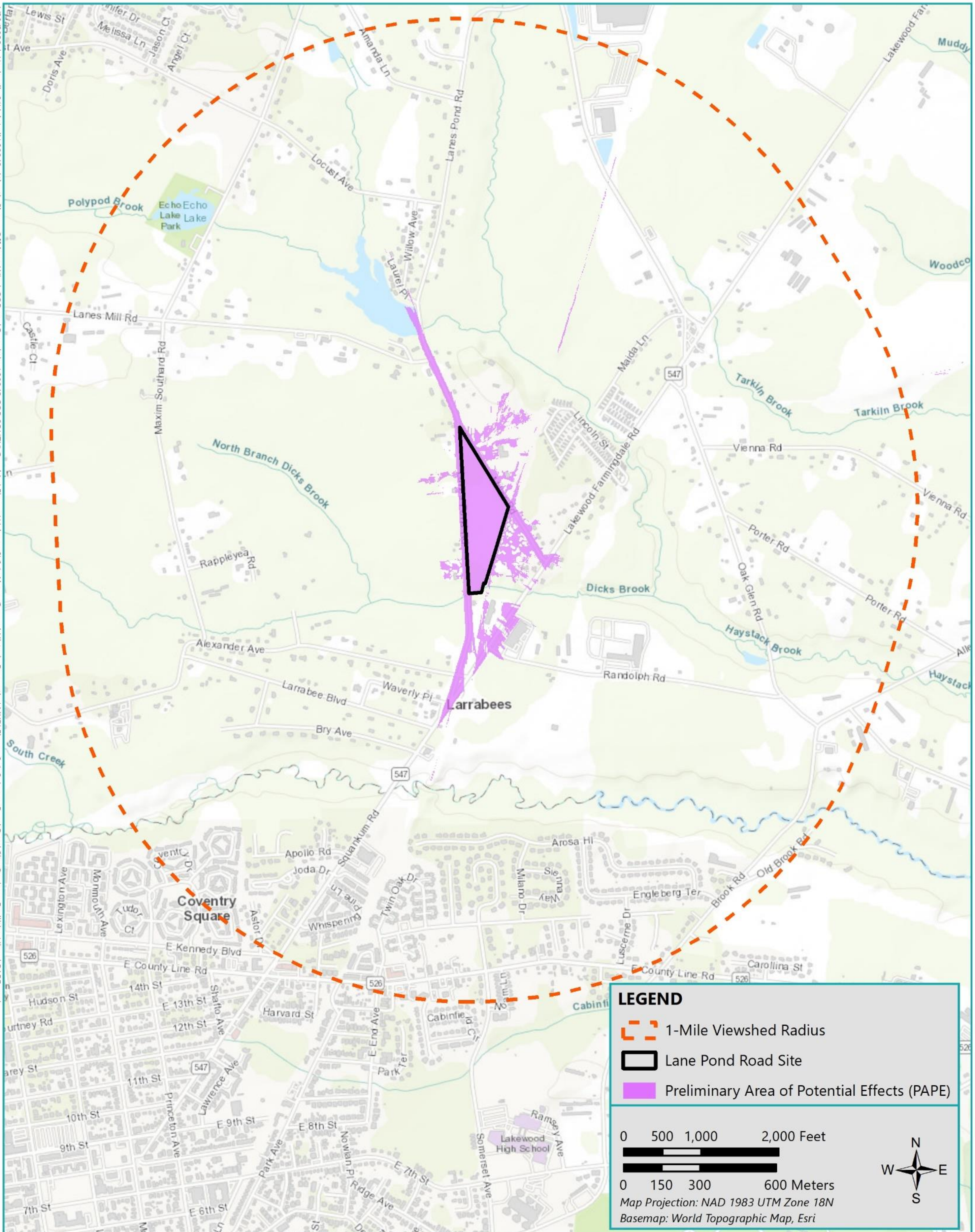
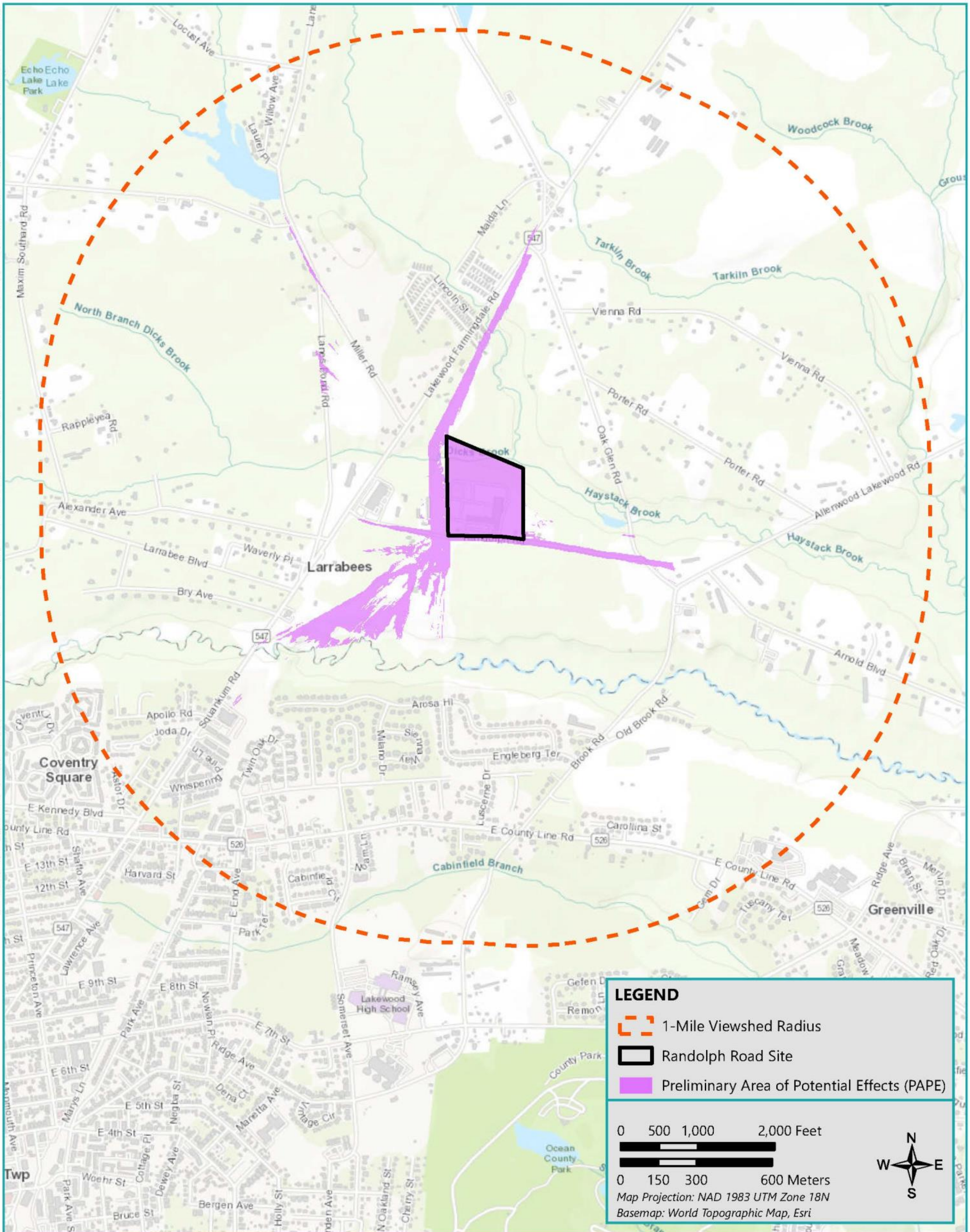


Figure 6.1-2. Onshore Facilities Visual PAPE

Lanes Pond Road Substation and/or Converter Station Site

Howell Township, New Jersey



ATLANTIC SHORES offshore wind

Figure 6.1-3. Onshore Facilities Visual PAPE

Randolph Road Substation and/or Converter Station Site
Howell Township, New Jersey

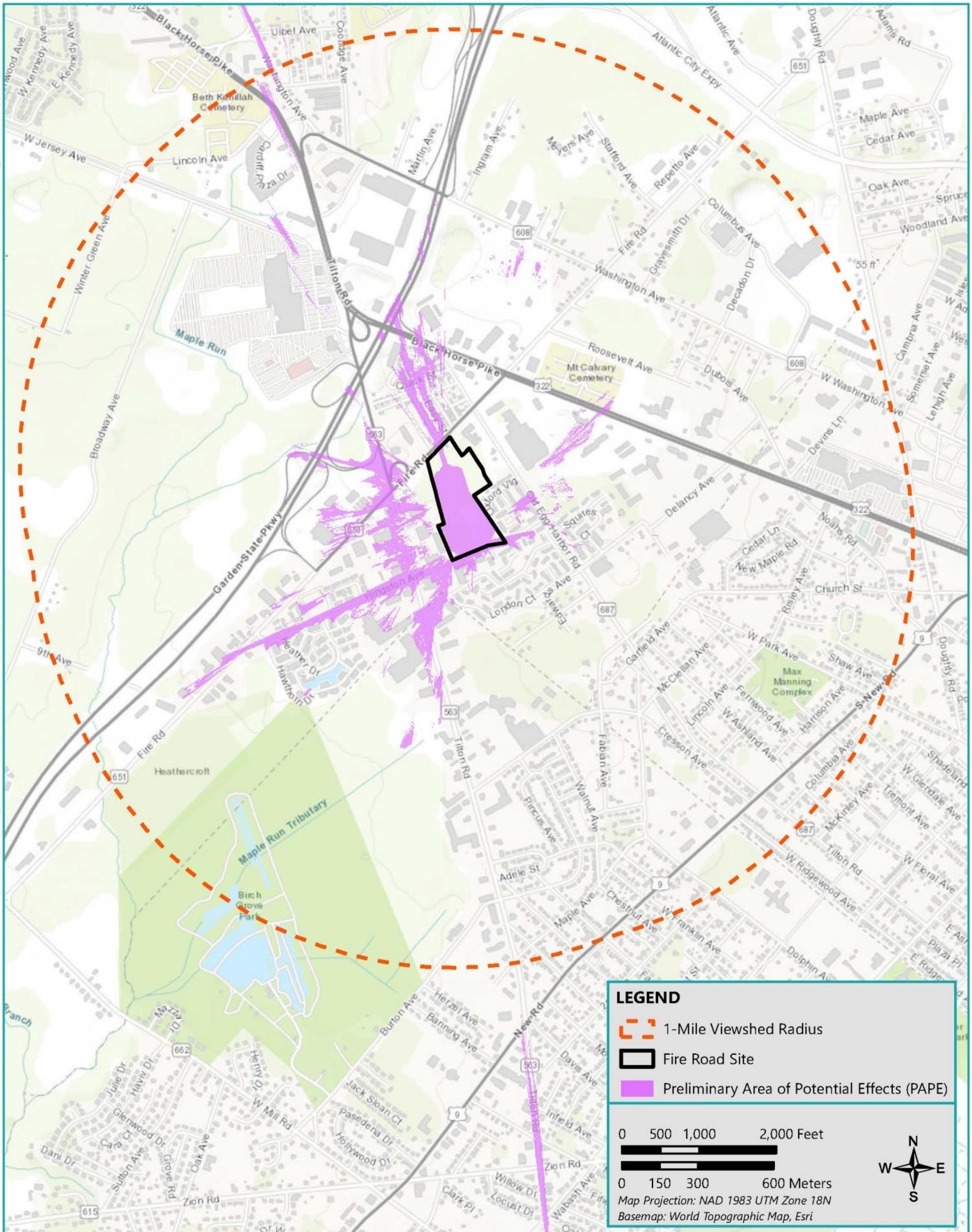
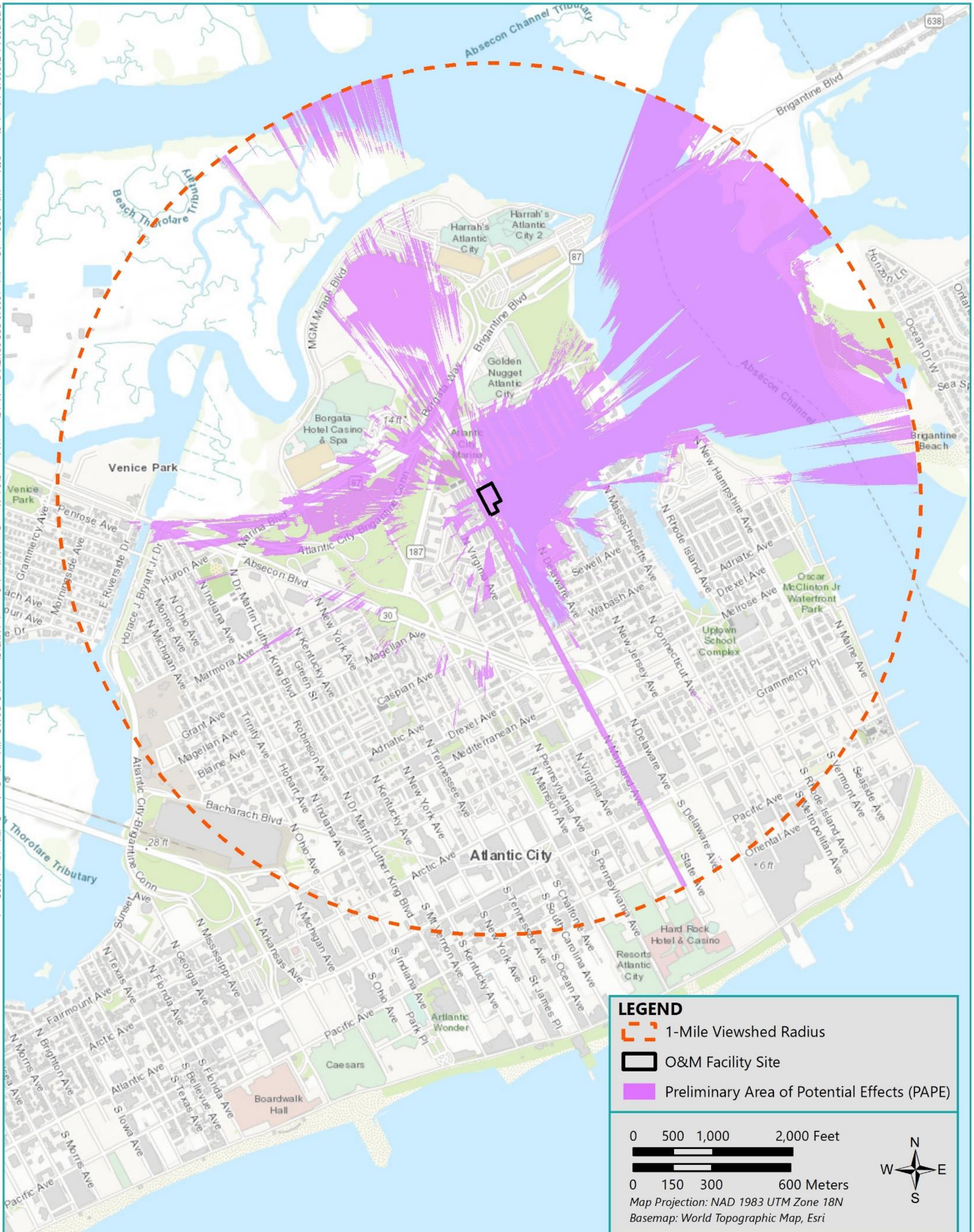


Figure 6.1-4. Onshore Facilities Visual PAPE

Fire Road Substation and/or Converter Station Site

Egg Harbor Township, New Jersey

ATLANTIC SHORES offshore wind



ATLANTIC SHORES offshore wind

Figure 6.1-5. Onshore Facilities Visual PAPE

Operations and Maintenance Facility Site

Atlantic City, New Jersey

Preservation Act may be beneficial to the consideration of such properties and the potential impacts of the Projects.

6.1.2 Potential Impacts and Proposed Environmental Protection Measures

In accordance with 36 CFR Part 800.5 an effect on an aboveground historic property occurs when an activity or action alters, directly or indirectly, any of the characteristics of the historic property that qualified it for inclusion in the NRHP. Construction of the Projects is not anticipated to require the demolition or physical alteration of any historic buildings or other potential aboveground historic properties. The Projects' effect on a given aboveground historic property would be a change (resulting from the introduction of offshore or onshore facilities) in the aboveground historic property's visual setting.

The potential impact producing factors that may affect aboveground historic properties during the Projects' lifecycles are presented in Table 6.1-3 and summarized in the following sections. A detailed assessment of the aboveground historic properties identified in the Projects' PAPEs and evaluation of effects are presented in Appendices II-N1, II-N2 and II-O.

Table 6.1-3 Impact Producing Factors for Aboveground Historic Properties

Impact Producing Factor	Construction & Installation	Operations & Maintenance	Decommissioning
Presence of structures and cables		●	
Lighting	●	●	●
Noise	●	●	●
Traffic	●	●	●

In addition to these IPFs, construction of the Projects may result in temporary intrusions (such as traffic, noise, and lights) to the visual setting of aboveground historic properties within the Onshore, O&M, and Offshore Facilities Visual PAPEs. However, these activities are temporary and are not anticipated to effect or diminish the characteristics for which aboveground historic properties within the Onshore, O&M, and Offshore Facilities Visual PAPEs were listed in, determined eligible for listing in, or may be potentially eligible for listing in the NRHP. Temporary intrusions during construction activities are not anticipated to result in significant effects on aboveground historic properties and are therefore not addressed further in this section.

The maximum PDE analyzed for impacts to aboveground historic properties is the maximum onshore and offshore build-out of the Projects as defined in Section 4.11 of Volume I.

6.1.2.1 Presence of Structures and Cables

In accordance with 36 CFR Part 800, the presence of large numbers of modern structures (such as WTGs, O&M facilities, or onshore substations and/or converter stations) may result in a change to the integrity of the historic setting of aboveground historic properties by introducing new vertical elements on the ocean horizon in historic maritime contexts or in onshore historic contexts. This IPF section focuses on the potential effects posed by the presence of structures introduced by the Projects' offshore and onshore facilities. Installation of buried cables will have no visual effect on aboveground historic properties as they will be buried underground and within the seabed; therefore, they are not discussed further.

6.1.2.1.1 Offshore Facilities

As described in Table 6.1-1, the inventory of aboveground historic properties within the Offshore Facilities Visual PAPE includes two NHLs, 19 individual properties and historic districts listed in the NRHP, 66 individual properties and historic districts formally determined eligible for the NRHP, two local historic properties, and 15 individual properties and historic districts recommended to meet NRHP eligibility. Potential visual effects to aboveground historic properties were assessed by considering both qualitative and quantitative factors. The qualitative factors used to assess potential visual effects included the following:

- those characteristics of an aboveground historic property that qualify it for listing in the NRHP (i.e., the rationale for the property's historical significance)
- whether or not an aboveground historic property has a maritime setting – and the integrity of that setting, including the presence of existing modern features or other visual elements that post-date a property's period of significance
- the degree to which an aboveground historic property's maritime setting contributes to the historical significance of the property
- the distance separating the aboveground historic property from the components of the Projects (i.e., wind turbines and OSS) – which determines the scale of the turbines relative to a viewer's location
- the magnitude and nature of visual changes to existing views introduced by the proposed facilities, in terms of visual dominance, orientation of potential views, and density of new visual elements.

Criteria for assessing significant maritime settings are defined in the *Evaluation of visual impact on Cultural Resources/Historic Properties: North Atlantic, Mid-Atlantic, South Atlantic, and Florida Straits* (BOEM 2012) which states:

> "*Resources within this category derived their importance, in whole or in part, from their proximity to the sea. They included TCPs, coastal fortifications, parks and seashores,*

residential estates, lighthouses, life-saving stations, breakwaters, marinas, fishing and resort communities, and shore lodgings of all kinds, including hotels, motels, inns, seasonal cottages, and permanent residences" (BOEM 2012).

The quantitative factors used to assess potential visual effects include measures of distance, viewshed analyses based on four specific height measurements on the WTGs, and three measurements of areas of potential visibility. The viewshed analyses indicate the portion of WTGs visible above mean sea level. These quantitative measures included the following:

- Distance from the nearest visible WTG
- Blade tip elevation
- WTG aviation light elevation
- Mid-tower aviation light elevation
- USCG light elevation
- Total acreage of aboveground historic property
- Total acreage of visibility within the aboveground historic property
- The portion of the aboveground historic property (percent of acreage) from which the Projects would be potentially visible.

The results of this analysis of potential effects on the 102 aboveground historic properties in the Offshore Facilities Visual PAPE is presented in greater detail in the Offshore HRVEA (see Appendix II-O and associated Attachments A-D).

The assessment of potential adverse visual effects to aboveground historic properties in the HRVEA was intentionally conservative and intended to identify possible effects that may warrant further consideration through consultations with agencies and other stakeholders during the Section 106 consultation process. Significant views to the sea were assessed by desktop review of the viewshed analysis, online mapping systems, reference to visual simulations, and field observation to determine whether the aboveground historic property has clear, unobstructed views of the sea and whether or not this view contributes to the historic significance of a given aboveground historic property. Visual simulations were prepared to provide representative views of the Projects from within the Offshore Facilities Visual PAPE, as well as to assist in the assessment of impact to these views.

Based upon the PDE (see Section 4.0 of Volume I), the nearest proposed WTGs are located between 9.8 mi (15.8 km) and 45.2 mi (72.7 km) away from the aboveground historic properties located within the Offshore Facilities Visual PAPE. The proposed WTGs would be a new feature occupying a relatively large portion of the visual setting and views toward the ocean for some historic properties. Due to their scale and form, the WTGs are likely to attract viewer attention; however, most aboveground historic properties within the Offshore Facilities Visual PAPE will have somewhat obstructed views of the Projects due to screening provided by intervening topography, vegetation, and/or buildings and structures. Depending on the viewer position relative to and distance from the Projects, some locations (such as the southern tip of Cape May) are likely to experience minimal visibility of the Projects.

Actual visibility of the Projects will also be limited by several factors including weather conditions, waves on the ocean surface, humidity, and air pollution (for further discussion, see Brodie and Frei 2020). The visibility of the Projects from specific viewpoints within the Offshore Facilities Visual PAPE will be variable over time due to frequent changes in atmospheric conditions. Based on analyses completed for the Projects, it is anticipated that relatively common atmospheric conditions will render WTGs difficult to discern or will extinguish visibility from many areas within the Offshore Facilities Visual PAPE. However, the assessment of potential adverse visual impacts to historic properties is based on clear viewing conditions, as represented in the majority of visualizations prepared for the Projects. Atmospheric perspective (see Section 5.1.1) remains relevant to understanding of the duration, frequency, and intensity of visual impacts that may be expected at historic properties.

As demonstrated by the viewshed analysis, the greatest potential for effect on the visual setting of aboveground historic properties are associated with those properties located along the shoreline. For these locations, the Projects' overall impact on the visual settings associated with aboveground historic properties will persist for the period of operation. Representative visual simulations illustrating the appearance of the Projects are included as Attachment E to the Offshore HRVEA (see Appendix II-O: Attachment E).

Applying the Criteria of Adverse Effect per Section 106 § 800.5, of the 102 aboveground historic properties located within the PAPE, 29 properties were recommended as having a potential adverse effect. For these 29 aboveground historic properties, the presence of the Projects was anticipated to have an adverse effect on properties with a maritime setting that contributes to their significance, those with unobstructed and specific views of WTGs, those that were historically designed and used for maritime activities, and those with a medium to high level of sensitivity for visual effects. The complete analysis of potential effects on aboveground historic properties is presented in the Offshore HRVEA (see Appendix II-O and Attachments A-D).

The Projects will minimize potential impacts from the presence of the offshore structures associated with the Projects during O&M by painting the WTGs no lighter than Pure White (RAL 9010) and no darker than Light Grey (RAL 7035) as recommended by BOEM and the FAA. Turbines of this color white generally blend well with the sky at the horizon and eliminate the need for daytime warning lights or red paint marking of the blade tips.

A meteorological study completed by Rutgers University indicated that visibility from shore during July and August will typically range from 5 to 12 mi (8 to 19 km) (Rutgers, 2020). The average frequency of visibility to 10 mi could occur during as little as 41% of daylight hours throughout the year. Consequently, during up to 59% of the daylight hours in a given year, it is anticipated that all, or the vast majority of Projects' WTGs will not be visible from onshore resources. Therefore, the analysis of the Projects' visibility included in the HRVEA is conservative and overstates potential impacts in that it assumes unobstructed visibility of the Projects, even when viewed from longer range distances (further discussion in Section 3.3.2 of Appendix II-M1).

6.1.2.1.2 Onshore Facilities

Atlantic Shores completed a HREA for the proposed onshore interconnection facilities (see Appendix II-N1).

The potential effect of the onshore components on a given aboveground historic property would be a change in the property's visual setting resulting from the introduction of new structures/buildings. Within the Onshore Facilities PAPEs, the substations and/or converter stations will be the only visible components of the Projects during operation that have the potential to affect the visual setting of aboveground historic properties. The proposed Larrabee substation and/or convertor station sites evaluated in this section include: the Lanes Pond Road Site and the Randolph Road Site in Howell Township, New Jersey and the Fire Road Site in Egg Harbor Township, New Jersey. The visual settings of the proposed facilities are as follows:

- The Lanes Pond Road Site is located in a predominantly forested area with light density residential, industrial and agricultural properties.
- The Randolph Road Site is located in a predominantly wooded area, with dense forestation to the immediate north, east, and south.
- The proposed Fire Road Substation/Converter Station is located on a vacant wooded lot in a densely developed area with commercial and high-density residential development with a mix of freestanding commercial structures and condominium housing immediately adjacent to the parcel.

Three aboveground historic properties were identified in the Onshore Facilities PAPEs: the New Jersey Southern Railroad Historic District, the West Jersey and Atlantic Railroad Historic District, and the Garden State Parkway Historic District. Due to the linear nature of each of the aboveground historic properties, the proposed facilities are anticipated to be visible from very small portions of each historic district (see Table 6.1-4).

Table 6.1-4 Impact Producing Factors for Aboveground Historic Properties

Proposed Location	Percent of PAPEs Visible Within Property Boundary
Lanes Pond Road Site	1.35
Randolph Road Site	0.11

In addition, the significances of the properties are not derived from their settings, but their association with transportation and the development of New Jersey; therefore, the proposed

Onshore Facilities will not adversely affect the New Jersey Southern Railroad Historic District, the West Jersey and Atlantic Railroad Historic District, or the Garden State Parkway Historic District.

6.1.2.1.3 O&M Facility

Atlantic Shores completed a HREA for the proposed O&M facility (see Appendix II-N2). The proposed O&M facility is located in a densely developed neighborhood in Atlantic City. Directly to the north of the O&M facility are major thoroughfares of Huron Avenue and Brigantine Boulevard; further north is the Borgata Casino, Clam Thoroughfare and Absecon Bay; to the east is Clam Creek and the State Marina, as well as a residential neighborhood located around Delta Basin, Snug Harbor and Gardner's Basin; to the south is the Delta Basin and a mixed-use neighborhood and to the west is predominantly multi-family residential development.

Construction of the O&M facility will not require the demolition or physical alteration of any historic buildings or other aboveground historic properties. No direct physical effects to aboveground historic properties will occur as a result of the O&M facility. The O&M facility's potential effect on a given aboveground historic property would be a change in the aboveground historic property's setting resulting from the introduction of new buildings or structures. As stated above in Section 6.1.1.3, five aboveground historic properties were identified within the O&M facility PAPE: 419 Carson Avenue, the Absecon Lighthouse, the Atlantic City Armory, the Atlantic City Beautiful Historic District, and the USCG Station Atlantic City. Due to the dense built environment surrounding the O&M facility, as well as the distance between the aboveground historic properties and the facility, no adverse effects are anticipated by the construction, O&M, or decommissioning of the O&M facility.

6.1.2.2 Light

Per 36 CFR Part 800, lighting produced by the Projects could result in a change to the integrity of the historic setting of aboveground historic properties by introducing new sources of light into historic contexts, both onshore and offshore. Depending on the existing conditions in which an aboveground historic property is located, the introduction of an additional light source may be disruptive, or not noticeable at all. This IPF section describes the potential impacts to aboveground historic properties caused by light sources related to the Projects.

6.1.2.2.1 Offshore Facilities

All of the WTGs will be equipped with aviation obstruction warning lights in accordance with FAA, and/or BOEM guidance to aid aircraft operating in the airspace of the Projects. To evaluate the potential effects associated with lighting produced by the offshore facilities, an Aircraft Detection Lighting System (ADLS) Efficacy Analysis was completed to determine the likely activation time of the FAA light if ADLS is implemented (see Appendix II-M4). The analysis indicates that under typical conditions, the ADLS would be activated for a total of approximately 10.9 hours over a 1-year period. Considering the low frequency of light activation, the potential visual effects associated with the aviation obstruction lights would be intermittent and minor.

In addition, other temporary lighting (e.g., helicopter hoist status lights) may be utilized on the WTGs for safety purposes, when necessary. Similarly, some outdoor OSS lighting (in addition to any required aviation or marine navigation lighting) will be necessary for maintenance that may occur at night. Atlantic Shores anticipates using controls to ensure that outdoor OSS lighting will be illuminated only when the OSS is manned. When unmanned, general outdoor lighting will be off.

The Projects will mitigate to the maximum extent practicable potential impacts from lighting from offshore facilities during O&M by ensuring that the offshore facilities will be lit and marked in accordance with FAA, BOEM and USCG requirements for aviation and navigation obstruction lighting, respectively, and by using ADLS or related means (e.g., dimming, shielding) to limit visual effects, pursuant to approval by the FAA and BOEM, commercial and technical feasibility at the time of FDR/FIR approval, and dialogue with stakeholders.

6.1.2.2.2 Onshore and O&M Facilities

Operational lighting will be required for the safe and secure operation of the onshore substations and/or converter stations. However, the lights associated with the onshore and O&M facilities will have minimal visibility from aboveground historic properties. Due to the developed nature of the PAPEs, the lights are not expected to contribute significantly to the sky glow resulting from existing light sources present in each of the respective areas. Therefore, it is not anticipated that the lighting from the onshore facilities would have an effect on aboveground historic properties.

Plantings to create screening will be installed at the onshore substation and/or converter station sites to the maximum extent practicable to reduce potential visibility and thereby avoid impacts from lighting from the onshore and O&M facilities during O&M.

6.1.2.3 Noise

Airborne noise produced by the Projects could result in a change to the integrity of the historic setting of aboveground historic properties by introducing modern sounds into historic contexts both on and offshore. Aboveground historic properties set in urban contexts may not be affected by an increase in airborne noise, while in other contexts it may lead to the disruption of the historic setting by which an aboveground historic property derives its significance. This IPF section focuses on the potential impacts of noise created by the Projects on aboveground historic properties.

6.1.2.3.1 Offshore Facilities

Based on an assessment of operational noise of the Projects (see Appendix II-U), noise generated by the WTGs are not expected to be audible at the nearest shorelines. Therefore, operational noise associated with the Projects is not anticipated to have an impact on aboveground historic properties.

6.1.2.3.2 Onshore and O&M Facilities

The design of onshore facilities will depend on whether high voltage alternating current (HVAC), high voltage direct current (HVDC), or a combination of both HVAC and HVDC onshore interconnection cables are constructed. It is anticipated that the HVDC design would have generally lesser sound impacts on the surrounding community than HVAC technology. Therefore, only the HVAC onshore substation design was evaluated to provide the most conservative assessment of potential noise impacts. The onshore interconnection cables will not generate noise during operations since the cable will be buried beneath existing roads or within other public and utility rights-of-way (ROWs). The onshore substations and/or converter stations will be designed to comply with the NJDEP sound level limits. Screening will be implemented at the onshore substation and/or converter station sites to the maximum extent practicable, to reduce potential noise impacts from onshore facilities during O&M. The anticipated levels of noise generated by onshore facilities are described in greater detail in an Onshore Noise Report, (see Appendix II-U). In addition, anticipated noise associated with the proposed O&M facility will not be out of character with the surrounding environment, i.e., automobile and marine traffic arriving and departing. Operational noise associated with the onshore facilities is not anticipated to have an impact on aboveground historic properties.

6.1.2.4 Traffic

An increase in traffic associated with the Projects could result in a change to the integrity of the historic setting of aboveground historic properties by creating an increase in the flow of aircraft, vessels, or land-based vehicles that could disrupt onshore or offshore historic contexts. This IPF section focuses on the potential impacts of increased traffic created by the Projects on aboveground historic properties.

6.1.2.4.1 Offshore Facilities

Given the relative frequency of seagoing vessels on the horizon within the Offshore Facilities Visual PAPE, it is not likely that traffic related to the Projects will be a noticeable change. Traffic during construction and operation of the Projects is not anticipated to affect the integrity of the historic setting of aboveground historic properties for the duration of the Projects' activity.

6.1.2.4.2 Onshore Facilities

O&M of the onshore substations and/or converter stations and the O&M facility will be unmanned during routine operations and will be inspected regularly based on manufacturer-recommended schedules. Personnel will be on site as necessary for any maintenance or repairs. It is likely that no noticeable increase in existing traffic patterns will occur. The onshore interconnection cable route will have no regular maintenance unless there is a failure or malfunction requiring exposure and repair of the cable. If any unforeseen maintenance is required, impacts to traffic from potential traffic detours might occur. Traffic during the operation of the Projects is not anticipated to affect the integrity of the historic setting of aboveground historic properties for the duration of the

Projects' activity. The O&M facility may result in a slight increase in traffic as automobiles and marine vessels arrive and depart during working hours. However, it is not anticipated that this slight increase will result in adverse effects to aboveground historic properties due to the existing conditions near the O&M facility, as it is located immediately adjacent to a state marina and a major highway onramp.

6.1.2.5 Summary of Proposed Environmental Protection Measures

Atlantic Shores has taken proactive steps to avoid, minimize, and mitigate to the maximum extent practicable the potential effects to aboveground historic properties. Atlantic Shores will implement the following environmental protection measures to reduce potential impacts on aboveground historic properties. These measures are based on protocols and procedures successfully implemented for similar offshore wind projects and involve the mitigation of visual effects, in most cases:

- Atlantic Shores engaged with relevant stakeholders to identify additional avoidance, minimization, or mitigation measures regarding potential effects on aboveground historic properties as required by 30 CFR Part 585.626(b)(15).
- The Projects is located in a designated offshore wind development area that has been identified by BOEM as suitable for development.
- The OSSs will been set back sufficient to minimize their visibility from the shore.
- The WTGs will be painted no lighter than Pure White (RAL 9010) and no darker than Light Grey (RAL 7035) as recommended by BOEM and the FAA. Turbines of this color eliminate the need for daytime warning lights or red paint marking of the blade tips.
- ADLS or related means (e.g., dimming or shielding) will be used to limit visual impact, pursuant to approval by the FAA and BOEM, commercial and technical feasibility at the time of FDR/FIR approval, and dialogue with stakeholders.
- The onshore interconnection cables will be installed underground, thus avoiding potential effects on the visual setting of historic properties.
- The onshore substations and/or converter stations are sited near existing substations, or on parcels zoned for commercial and industrial/utility use.
- Screening will be implemented at the onshore substation and/or converter stations sites to the maximum extent practicable to reduce potential visibility and noise.
- Electrical equipment will be installed within certified enclosures to reduce potential noise impacts.
- Research and investigative studies related to preserving existing shoreline and coastal features that contribute to historic settings of the affected properties may be completed.
- Historic Properties Treatment Plans (HPTPs) have been developed for specific aboveground properties determined by BOEM to be adversely affected by the Projects

and a mitigation fund will be implemented to address the remainder of the adversely affected aboveground historic properties (Appendix II-N3).

Options to mitigate identified adverse effects on aboveground historic properties are limited, given the nature of the Projects (i.e., very tall, vertical structures) and their siting criteria (i.e., the open ocean). Therefore, for most wind energy projects, mitigation of impacts to historic properties typically consists of supporting initiatives that benefit historic sites or buildings and/or the public's appreciation of historic resources to offset potential impacts to historic properties resulting from the introduction of WTGs into their visual setting. The specifics of these initiatives were identified in consultation with appropriate stakeholders subsequent to determination of whether a given historic property would be adversely affected by a project. Atlantic Shores made good-faith efforts to discuss potential visual impacts to historic properties with stakeholders and potential measures to mitigate adverse impacts, as appropriate. The results of these discussions informed the development of historic property-specific mitigation measures developed by Atlantic Shores in the Avoidance, Minimization, and Mitigation Plan (Appendix II-N3), which include the HPTPs.

Atlantic Shores initiated outreach with interested consulting parties who have or may participate in the determination of adverse effects and/or consultations to identify appropriate mitigation projects. Atlantic Shores hmet with Tribal Nation representatives and other stakeholders to discuss the Projects. These include the Absentee-Shawnee Tribe of Indians of Oklahoma, the Shinnecock Indian Nation, the Delaware Nation, the Narragansett Indian Tribe, the Wampanoag Tribe of Gay Head (Aquinnah), the Eastern Shawnee Tribe of Oklahoma, the Delaware Tribe of Indians, the Stockbridge-Munsee Community Band of Mohican Indians, the Shawnee Tribe, Mashantucket (Western) Pequot Tribal Nation, and the Mashpee Wampanoag Tribe. In addition, Atlantic Shores consulted with the NJHPO and NJDEP, as well as municipalities, regional and local historical societies, municipal historians, owners/operators of historic properties, and other stakeholders to explore and discuss appropriate potential mitigation opportunities.

6.2 Terrestrial Archaeological Resources

This section describes terrestrial archaeological resources in the Atlantic Shores Onshore Project Area, associated impact producing factors (IPF), and environmental protection measures to avoid, minimize, or mitigate potential impacts to these resources.

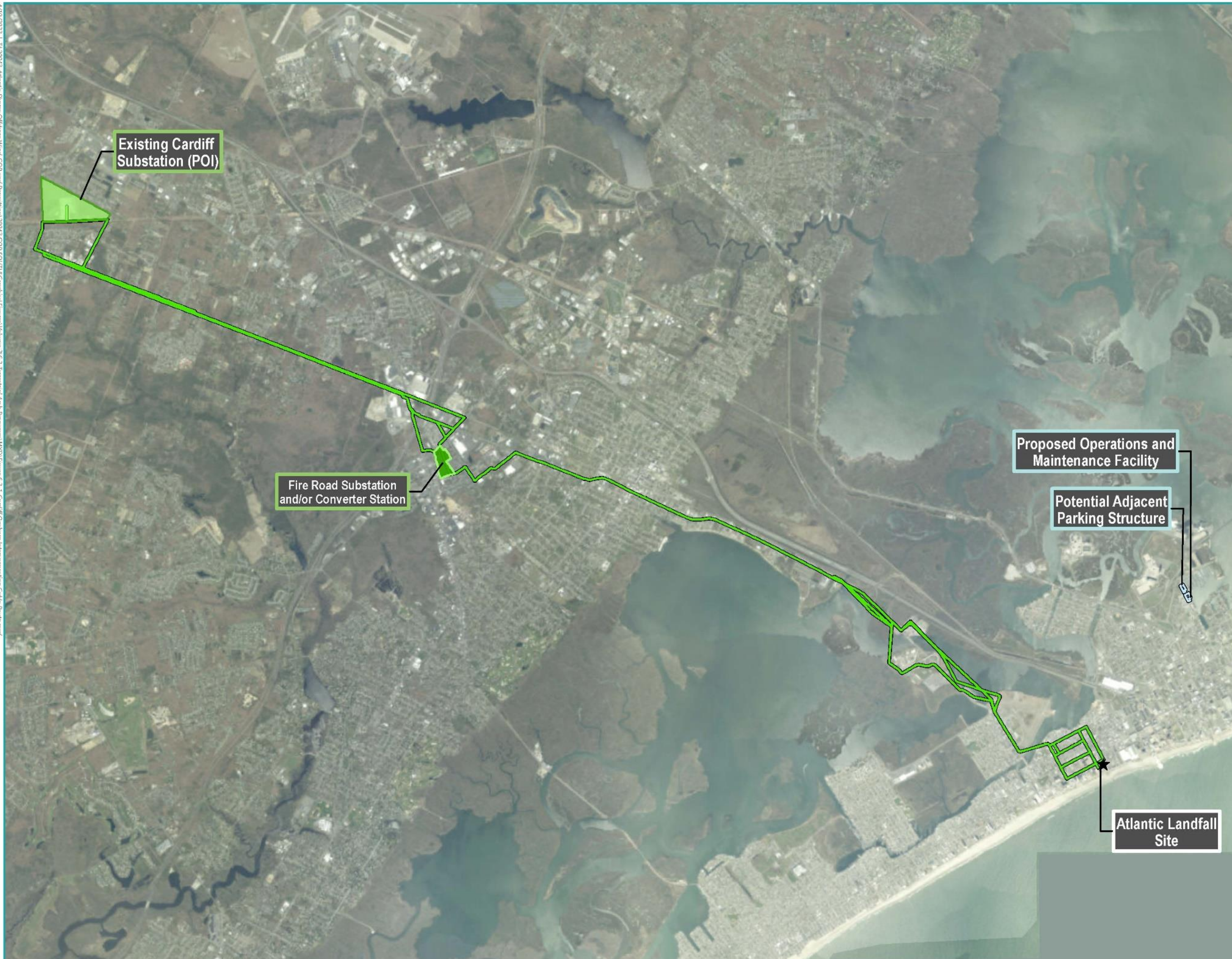
Terrestrial archaeological resources are defined as any prehistoric or historic sites, objects, buildings, structures, or districts that are listed in or eligible for listing in the National Register of Historic Places (NRHP) maintained by the Secretary of the Interior or have been designated as National Historic Landmarks (NHL) by the Secretary of the Interior (54 USC § 300308). Archaeological sites are valuable cultural resources that contain a wealth of tangible information about the past. Identifying, understanding, and to the extent appropriate, preserving terrestrial archaeological resources increases our opportunities for cultural enrichment, education, and knowledge of the past.

Specific requirements for submittal of an analysis of potential impacts to terrestrial archaeological resources within this COP are provided in *Guidelines for Providing Archaeological and Historic Property Information* pursuant to 30 CFR Part 585, Section 106 and Section 110 of the National Historic Preservation Act (NHPA), and the National Environmental Policy Act (NEPA) (BOEM, 2020. In addition, the onshore substations are subject to review under Section 7:4 of the New Jersey Administrative Code, the State of New Jersey Executive Order #215 (NJHPO, 2008). All archaeological work was conducted under the guidance of the NJHPO *Guidelines for Phase I Archaeological Investigations: Identification of Archaeological Resources* (2000) and *Guidelines for Preparing Cultural Resources Management Archaeological Reports Submitted to the Historic Preservation Office* (2008).

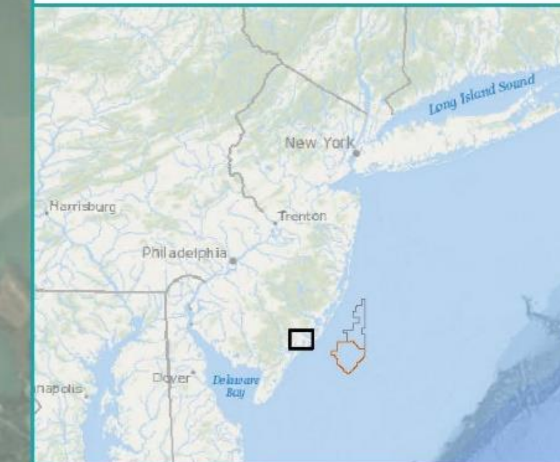
To support the assessment of terrestrial archaeological resources within the Onshore Project Area, in accordance with the above regulations and guidance, Atlantic Shores conducted both desktop research and pedestrian reconnaissance surveys in the form of terrestrial archaeological resources assessments (TARAs) of the Cardiff and Larrabee onshore interconnection facilities and the operations and maintenance facility (O&M facility).

The facilities associated with the Cardiff and Larrabee onshore interconnection cable routes are depicted on Figures 6.2-1 and 6.2-2. The findings from background research, archaeological reconnaissance, and desktop assessment related to the onshore interconnection facilities are presented in the *Terrestrial Archaeological Resources Assessment - Onshore Interconnection Facilities* report (EDR 2022; Appendix II-P1).

Once operational, the Project will be supported by a new operations and maintenance facility O&M facility that will be located in Atlantic City, New Jersey. A description of the O&M facility can be found in Section 5.5 of Volume I. The findings from the background research, archaeological reconnaissance, and desktop assessment related to the O&M facility are presented in the *Phase IA Terrestrial Archaeological Resources Assessment - O&M facility* report (EDR 2021; see Appendix II-P2). The results of the TARAs are summarized in the following sections.



ATLANTIC SHORES offshore wind



0 1,500 3,000 6,000 Feet

0 500 1,000 Meters

N W E S

Map Projection: NAD 1983 UTM Zone 18N
Basemap: NJ Office of Information Technology - 2020 Natural Color Imagery Service

LEGEND

- ★ Atlantic Landfall Site
- Cardiff Onshore Interconnection Cable Route Options
- Existing Cardiff Substation (POI)
- Substation and/or Converter Station
- Proposed Operations and Maintenace Facility

Figure 6.2-1

Cardiff Onshore Interconnection Cable Route

4/19/2023 | T:\20043 Atlantic Shores Offshore Wind COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\6.2 Terrestrial Arch Resources\MXD\Figure 6.2-1 Cardiff Onshore Interconnection Cable Route.mxd

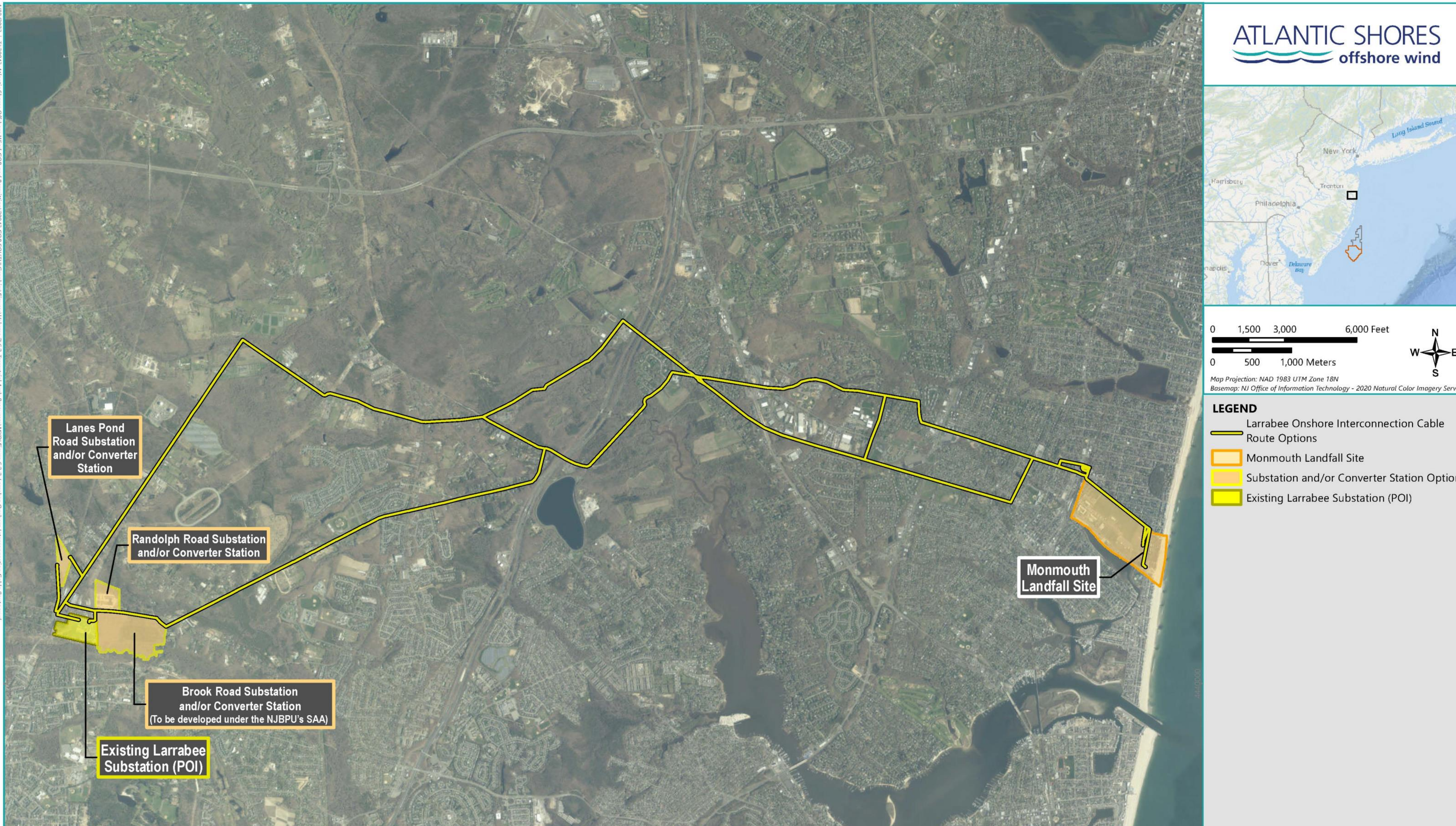


Figure 6.2-2

Larrabee Onshore Interconnection Cable Route

4/19/2023 | T:\20043_Atlantic Shores Offshore Wind_COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\6.2_Terrestrial Arch Resources\MXD\Figure 6.2-2_Larrabee Onshore Interconnection Cable Route.mxd

6.2.1 Affected Environment

The affected environment for terrestrial archaeological resources will consist of the Projects preliminary area of potential effects (PAPE) for physical effects. The *Pape Memorandum* (Appendix I-A) defines a PAPE for physical effects to above ground historic properties and terrestrial archaeological resources that includes all locations under consideration where construction or operation of the proposed Projects has the potential to affect historic properties.

Within the Projects overall PAPE for physical effects, the affected environment for terrestrial archeological resources consists of three distinct PAPEs associated with the Projects two proposed onshore interconnection cable routes and the O&M facility. The PAPEs for physical effects for the Cardiff and Larrabee onshore interconnection facilities include the Atlantic and Monmouth Landfall Sites, the onshore interconnection cable routes, the proposed onshore substation and/or converter station locations[40], and the existing points of interconnection (POI)[41]. Information about the PAPEs is tabulated in Table 6.2-1 and summarized as follows:

- The Cardiff Physical Effects PAPE (Cardiff PAPE) includes the offshore export cable Atlantic Landfall Site, the Cardiff Onshore Interconnection Cable Route, and the Fire Road Site.
    - The Atlantic Landfall Site is collectively 2.90 acres (1.17 ha) and is located on a paved public parking lot at the southeastern terminus of S. California Avenue adjacent to the Atlantic City Boardwalk, and along the block of S Iowa Avenue between Pacific Avenue and the Atlantic city Boardwalk.[42]
    - The Cardiff Onshore Interconnection Cable Route is an approximately 12-14 mi. (19-23 km) underground transmission route that largely uses existing linear infrastructure corridors to connect the Atlantic Landfall Site to a proposed onshore substation and/or converter station at the Fire Road Site and the existing Cardiff Substation POI. It consists of an approximately 20 ft wide (6 m) corridor within which the underground, onshore cables will be installed within concrete duct banks. Installation of the onshore interconnection cable routes will typically be accomplished via open trenching to a depth of up to 11.5 ft (3.5 m), which is the maximum vertical effect along most of the onshore interconnection cable route.

---

40 The Preliminary Area of Potential Effects (PAPE) Memorandum includes a description of "Preferred" and "Alternative" substation locations for both the Larrabee and Cardiff Onshore Facilities within the PAPE, while the December 2021 version of the onshore interconnection facilities TARA narrowed the onshore substation/converter station locations under consideration to the Randolph Road Mulching Site and Vacant Commercial Center Site. Design decisions since these initial filings have eliminated those substation locations from consideration and identified the Fire Road Site as the proposed onshore substation/converter station location in the Cardiff Physical Effects PAPE.

41 The existing substation POIs are by definition included in the PAPEs as described in the *Preliminary Area of Potential Effects (PAPE) Memorandum*; however, they are owned by Jersey Central Power and Light (JCP&L) and Atlantic City Electric (ACE), who will be responsible for the design and construction of the required upgrades at these locations. The TARA for the onshore interconnection facilities does not include an assessment of either POI as no specific actions or effects are proposed by Atlantic Shores at these existing facilities at this time (Appendix II-P1).

42 While the previous December 2021 version of the COP included multiple options for the Atlantic Landfall Site within the PDE, the S. California Avenue location has since been selected.

Some specialty trenchless techniques (i.e., HDD, pipe jacking, and/or jack-and-bore) that avoid surface disturbance will be used to avoid impacts to busy roadways, wetlands, waterbodies, or existing developments or features and could result in disturbance up to 30 ft (9m) below ground surface.

  - The Fire Road Site at approximately 3038 Fire Road, is a proposed substation and/or converter station location situated on approximately 19.71 acres (7.98 ha) of currently wooded and overgrown lots in Egg Harbor Township. Construction activities resulting in ground disturbance at this location may include land and tree clearing, grading, fencing, trenching and excavation, landscaping/planting, and installation of equipment foundations. The maximum vertical effect of these activities is anticipated to be approximately 60 ft (18.3 m) in depth.

- The Larrabee Physical Effects PAPE (Larrabee PAPE) includes the offshore export cable Monmouth Landfall Site, the Larrabee Onshore Interconnection Cable Route, and potential locations under consideration for the proposed Larrabee Onshore Substation and/or Converter Station[43].

  - The Monmouth Landfall Site is made up of two landfall options on the of the grounds of the New Jersey Army National Guard Training Center, immediately west of the Atlantic Ocean shoreline. Collectively, both landfall options are hereafter included when referencing the proposed Monmouth Landfall Site.

    - The first landfall option is an approximately 1.21 acre (0.49-ha) previously disturbed area in the southeast corner of the National Guard Training Center.

    - The second landfall option is an approximately 1.85 acre (0.75-ha) partially disturbed area on the eastern side of the National Guard Training Center, north of the first landfall option.

  - Maximum vertical depth of disturbance is anticipated to be 16.8 ft (5.12 m) at the landfall location from the installation of onshore transition vaults, within which the offshore export cable will be split into onshore cables.
  - The Larrabee Onshore Interconnection Cable Route is an approximately 12 mi. (19.5 km) underground transmission route that largely uses existing linear corridors to connect the Monmouth Landfall Site to a planned onshore substation and/or converter station and the existing Larrabee Substation POI. It consists of an approximately 20 ft wide (6 m) corridor within which the underground, onshore

43 Atlantic Shores previously submitted a memorandum to BOEM in August 2022 with information on eight potential locations (Parcel Areas) for the proposed Larrabee Onshore Substation and/or Converter Station. Design decisions since the transmittal of that memorandum have resulted in the removal of six of the previously identified locations (Parcel Areas 1-6), and the addition of one location (Randolph Road Site). The designations of the two retained locations (Parcel Areas 7 and 8) have been updated to the Lanes Pond Road Site and the Brook Road Site (to be developed under NJBPU's SAA).

cables will be installed within concrete duct banks. Installation of the onshore interconnection cable routes will typically be accomplished via open trenching to a depth of up to 11.5 ft (3.5 m), which is the maximum vertical effect along most of the onshore interconnection cable route. Some specialty trenchless techniques (i.e., HDD, pipe jacking, and/or jack-and-bore) that avoid surface disturbance will be used to avoid impacts to busy roadways, wetlands, waterbodies, or existing developments or features and could result in disturbance up to 30 ft (9m) below ground surface.

  - Atlantic Shores has identified two potential locations for the proposed Larrabee Onshore Substation and/or Converter Station in the vicinity of the Larrabee Onshore Route.[44]

    - The Lanes Pond Road Site is an approximately 16.3-acre (6.6-ha) parcel consisting of agricultural fields and wooded areas south of the intersection of Miller Road and Lanes Pond Road in Howell Township.

    - The Randolph Road Site is an approximately 24.6-acre (9.97-ha) combination of three parcels consisting of a steel fabrication facility with associated laydown yard, offices, and parking, as well as forested wetlands surrounding Dicks Brook. The location is north of Randolph Road to the northeast of the existing Larrabee POI in Howell Township.

- The O&M facility Physical Effects PAPE (O&M PAPE) includes a 1.38-acre (0.56 ha) shoreside parcel which will contain all planned construction and upgrades associated with the O&M facility and an approximately 2.00-acre (0.81 ha) portion of the adjacent State Marina parking lot parcel to the northwest which will potentially contain an adjacent parking structure. Vertically the O&M PAPE may extend up to 60 feet (18.3 m) in depth if pilings or comparable features are required to construct the O&M facility. Alternatively, the O&M facility may utilize the parking lot located on California Avenue at the Atlantic Landfall site or other existing surface lots in Atlantic City supported by shuttles to and from the O&M facility.

[44] A third potential location, the Brook Road Site, will be developed under the NJBPU's SAA.

Table 6.2-1 Summary of PAPEs for Physical Effects

Project Component	Maximum Horizontal Effect	Maximum Vertical Effect
Larrabee Facilities		
Monmouth Landfall Site	3.06 acres (1.24 ha)	16.8 ft (5.12m)
Larrabee Onshore Interconnection Cable Route (Total Length 12-mi. [19-km])	Trenching: 20 ft (6 m) 435.7 acres (176.3 ha)	Open Trenching 11.5 ft (3.5 m) Specialty Installation 30 ft (9 m)
Lanes Pond Road Site	16.27 acres (6.84 ha)	60 ft (18.3 m)
Cardiff Facilities		
Atlantic Landfall Site	2.03 acres (0.82 ha)	16.8 ft (5.12m)
Cardiff Onshore Interconnection Cable Route (Total Length 12-14-mi. [19-23-km])	Trenching: 20 ft (6 m) 238.1 acres (96.4 ha)	Open Trenching 11.5 ft (3.5 m) Specialty Installation 30 ft (9 m)
Fire Road Site	19.71 acres (7.98 ha)	60 ft (18.3 m)
O&M Facility	3.22 acres (1.30 ha)[45]	Up to 60 ft (18.3m) of vertical disturbance if pilings or similar construction methods are required.
Randolph Road Site	24.64 acres (9.97 ha)	60 ft (18.3 m)

As mentioned above, the final Area of Potential Effects (APE) will be formally determined by BOEM in consultation with the NJHPO as part of the Section 106 consultation process. The process for identifying and evaluating effects on historic properties resulting from the construction and operation of the Project will involve consultation with BOEM and the NJHPO, Native American Tribes/Nations, and other consulting parties with a demonstrated interest in the historic properties (e.g., historic preservation organizations).

Pedestrian reconnaissance survey to document and photograph existing conditions within and adjacent to the Projects PAPE were conducted during field visits between September 2020 and August 2022.

To inventory and characterize previously identified archaeological resources and evaluate the potential for unidentified terrestrial archaeological resources to be present within the PAPE, the following research was conducted:

- Archaeological reconnaissance of the Facility Sites to assess and document existing conditions
- Local and regional histories review

45 The *Preliminary Area of Potential Effects (PAPE) Memorandum* quotes 1.22 acres as the maximum horizontal effect for the proposed O&M facility based on conceptual information; however, the acreage has been refined to 1.38 acres based on detailed design.

- A review of the NJHPO's Look Up Cultural Resources Yourself (LUCY) website
- Review of archaeological site forms within a 0.5-mi (0.8-km) buffer of the PAPE
- Review of digitally available previous cultural resources surveys encompassing or intersecting portions of the PAPE[46]
- Historical map review
- Topographic survey
- Lidar and hillshade analysis
- Mapping of buried utilities
- Review of as-built road drawings
- Present and past aerial photography review
- Soils assessment, including soil boring data.

The following primary and secondary sources were reviewed to assess the potential for previously unidentified cultural resources within the PAPEs. Additional information regarding these sources is provided in Appendices II-P1 and II-P2:

- NJHPO online cultural resources database (LUCY)
- New Jersey State Museum archaeological site files
- Library of Congress digital collections
- Great Egg Harbor Township Historical Society (2020)
- Historic American Building Survey / Historic American Engineering Record
- Howell Heritage and Historical Society (2020)
- New Jersey Historical Society digital collections
- Monmouth County Historical Association online resources
- Atlantic County Historical Society website

[46] Due to the Covid-19 pandemic, NJHPO suspended in-person research visits, and review of previous cultural resource survey reports was limited to those that were available digitally or through correspondence with report authors.

- David Rumsey Map Collection database
- NRHP nominations as provided by the NPS
- New Jersey State Library Genealogy and Local History collection
- New Jersey State Archives online catalog
- JSTOR online journal database.

In addition, local and regional histories, historical mapping, community management documents, and archaeological resources were consulted, including the following:

- Early Forges & Furnaces in New Jersey by Boyer (1931)
- Early History of Atlantic County New Jersey by Willis, ed. (1915)
- Geography and History of New Jersey by Meredith and Hood (1921)
- History of Atlantic City and County, New Jersey by Hall (1900)
- History of Monmouth County, New Jersey by Ellis (1885)
- History of Monmouth and Ocean Counties by Salter (1890)
- New Jersey Life, Industries and Resources of a Great State by Parsons (1928)
- Outline history of New Jersey by Morrison (1950)
- Railroad in New Jersey by Cunningham (1997)
- Monmouth County Master Plan (2016)
- Borough of Sea Girt Master Plan Reexamination Report (2018)
- Wall Township Master Plan (1999)
- Howell Township Master Plan (1994)
- Atlantic County Master Plan (2000)
- Egg Harbor Township Master Plan (2002)
- City of Pleasantville Master Plan (2008)

- Multiple sources of historic cartography and aerial imagery (Bache 1864, Beers 1872, Beers 1873, Cook et al. 1888, Gordon 1828, Historic Aerials 2021, Hopkins 1860, Howell 1878, NJDEP 2021, Sanborn Fire Insurance Maps 1886–1943, USGS 1890-1954, Wolverton 1889)

- Multiple archaeological publications related to central and southern New Jersey (Braun 1974, Chelser 1982, 1984, Chelser and Richardson 1980, Custer 2001, Grossman-Bailey 2001, Mounier et al. 1993, NPS 2018, Pagoulatos 2003, 2004, Schrabisch 1915, 1917, Spier 1915, Stanford and Bradley 2012, Stanzeski 1996, 1998, 2005, Stewart et al. 2015, Tuck 1978, Veit et al. 2004).

Both TARAs were prepared by and/or under the supervision of archaeologists with professional qualifications that meet the Secretary of Interior's Guidelines for Professional Qualifications in Archaeology (36 CFR Part 61). The following sections summarize the findings from the background research, archaeological reconnaissance, and desktop assessment for the Cardiff and Larrabee onshore interconnection facilities and the O&M facility. The detailed results are presented in Appendix II-P1 and Appendix II-P2.

6.2.1.1 Cardiff PAPE Assessment Results

With respect to the archaeological potential of the Cardiff Physical Effects PAPE, the results of the assessment in Appendix II-P1 can be summarized as follows:

- Prior ground disturbance was identified within the proposed Atlantic Landfall Site, Cardiff Onshore Interconnection Cable Route, and portions of the Fire Road Parcel. Depth to subsoil is approximately 1.0 to 2.0 ft (0.3 to 0.6-m) for most of the Cardiff Onshore Interconnection Cable Route. As noted previously, Atlantic Shores has elected to site the buried onshore cables within existing, previously disturbed road, bike path, and railroad ROWs, where disturbance during construction and installation of the existing infrastructure likely exceeded the depth of potential archaeological deposits. This siting strategy avoids or significantly reduces potential impacts to adjacent undisturbed soils and avoids or minimizes the risk of potentially encountering undisturbed archaeological deposits throughout most of the Larrabee Onshore Interconnection Cable Route.

- Substantial areas of artificial/historic fill were identified along the eastern half of the Cardiff Onshore Interconnection Cable Route according to NJDEP online mapping (NJDEP, 2018). This historic fill is mapped as extending from Atlantic City all the way to the mainland in Pleasantville, encompassing all portions of the Cardiff Onshore Interconnection Cable Route on Bader Airfield, Great Island and the Atlantic City High School, U.S. Route 40, and the existing 69 kV Atlantic City Electric (ACE) transmission line and railroad ROW.

- No previously recorded archaeological sites are located within the Cardiff PAPE. The proposed Atlantic Landfall Site does encompass previously identified historic properties, all of which were previously determined ineligible for the S/NRHP and subsequently demolished. Lacking spatial specificity, the mapped locations of the earliest recorded

Native American sites (28-At-003, 28-At-004, and 28-At-006) were considered areas of elevated archaeological sensitivity and not be considered equivalent to formally tested and delineated archaeological sites.

- All previously recorded archaeological sites with Native American components within 0.5-mi. (0.8-km) of the Cardiff Onshore Route are mapped near the Pleasantville area. The earliest recorded sites lack spatial specificity as they were not formally delineated. As such, their mapped locations should be considered areas of elevated archaeological sensitivity and not be considered equivalent to formally tested and delineated archaeological sites. Due to extensive documented previous ground disturbance, no "Potential Phase IB Survey Areas" were identified in the Pleasantville area. However, out of an abundance of caution, archaeological monitoring of the construction and installation of the Cardiff Onshore Route in this area is recommended. It is anticipated that the exact locations and scope of this monitoring will be determined in consultation with BOEM, NJHPO, and consulting Native American Tribes during Section 106 consultation regarding the Projects.

- Historic-period sites in the vicinity of the Cardiff Onshore Route include the Greenhouse site in urban Atlantic City and three mid-twentieth century Pinelands Commission sites which did not meet the criteria for the S/NRHP.

- Historical map review demonstrates that the proposed Atlantic Landfall Site was undeveloped before the construction of Atlantic City and its associated block and street grid, which has remained largely unchanged from their original establishment to today.

- MDS are mapped in the immediate vicinity of the PAPE, mostly along existing roadways and at intersections that were largely established by the mid-nineteenth century. Most of the MDS are concentrated in the central and eastern portion of the Cardiff Onshore Interconnection Cable Route in Smith's Landing, Pleasantville, and Risleyville, as well in the developed urban environment of Atlantic City.

- A portion of the proposed Cardiff Onshore Interconnection Cable Route is collocated within a segment of the West Jersey and Atlantic Railroad Historic District. West of the Garden State Parkway and U.S. Route 40 the railroad corridor has been converted into the asphalt paved Atlantic County Bikeway. Only a series of at-grade street crossings were identified between English Creek Avenue and Franklin Boulevard, an area encompassing the entire portion of the PAPE within the former railroad ROW/Bikeway (Gannett Fleming, 2002: Appendix C). In this area, contributing resources to the linear historic property have been removed, and only the rail prism and associated cuts and embankments remain. The actual fills of the rail prism are not contributing features to the eligibility of the resource. Avoidance of the prism may not be feasible but impacts to the fills of the prism are not anticipated to constitute an adverse effect, especially if restored to present condition (as proposed by Atlantic Shores) following installation of the onshore cable.

- The previously demolished McKee City Station, a contributing resource of the West Jersey and Atlantic Railroad Historic District, is mapped within the Cardiff Onshore Interconnection Cable Route near the intersection of English Creek Avenue and the Atlantic County Bikeway (NJHPO, 2021). This documented resource is a demolished historic structure which may exist in the archaeological record. The "Potentially Undisturbed" areas in the vicinity have been characterized as Medium sensitivity "Potential Phase IB Survey Areas". If subsurface Phase IB shovel testing encounters artifacts or features potentially associated with the demolished McKee City Station, additional short interval shovel testing is recommended in an effort to precisely delineate the resource. If possible following precise delineation of a potential resource's extent, micro-siting the buried onshore cables within the former railroad ROW to avoid any impacts is preferred.

- Construction and installation activities associated with the Projects will avoid all cemeteries and burials regardless of S/NRHP status or previous disturbance. Since the boundaries of the Greenwood Cemetery were well established prior to construction of U.S. Route 40, and use of the area adjacent to the U.S. Route 40 does not appear to happen until after the construction of the highway corridor, it is not anticipated that there is any potential for burials associated with the Greenwood Cemetery to be located within the PAPE along the U.S. Route 40 ROW. As such, construction and installation of the Cardiff Onshore Route will avoid all burials, and no remote sensing survey is anticipated to be necessary. However, out of an abundance of caution, archaeological monitoring of construction and installation in the area is recommended. In addition, the Project's Monitoring Plan and Post Review Discoveries Plan: Terrestrial Archaeological Resources (MPRDP) will be in effect for all construction and installation activities, providing guidance and instructions to all contractors on how to proceed in the event (however unlikely) of encountering unanticipated cultural resources during work in this area. The MPRDP will include appropriate "Stop Work" procedures if potential grave shafts or burials are observed.

- Pedestrian survey (with judgmental shovel testing if deemed appropriate based on observed field conditions) is recommended in any Low sensitivity, "Potentially Undisturbed" areas adjacent to paved roadways (within which the onshore cables are actually sited) where depth to culturally sterile subsoil is less than approximately 2.0 feet as well as in any wetlands or areas of steep slope.

- No additional archaeological investigation is anticipated to be necessary for the proposed Atlantic Landfall Site within the Cardiff Physical Effects PAPE.

- Targeted archaeological shovel testing is recommended within portions of the Cardiff Onshore Route and Fire Road Site identified as Medium and Medium-High sensitivity "Potential Phase IB Survey Areas" (Appendix II-P1: Attachment D).

- Phase IB STP survey has been completed for the majority of the proposed Fire Road Site Onshore Substation and/or Converter Station. No archaeological sites were identified, and no archaeological artifacts were encountered during the Phase IB survey. As such, no mitigation or avoidance measures are proposed, and no further archaeological work is recommended for the areas that were surveyed.

- In addition, the Project's MPRDP will be in effect for all construction and installation activities, providing guidance and instructions to all contractors on how to proceed in the event (however unlikely) of encountering unanticipated cultural resources during work in the Cardiff PAPE.

6.2.1.2 Larrabee PAPE Assessment Results

With respect to the archaeological potential of the Larrabee Physical Effects PAPE, the results of the assessment in Appendix II-P1 can be summarized as follows:

- Prior ground disturbance was identified within the proposed Monmouth Landfall Site and Larrabee Onshore Interconnection Cable Route. Depth to subsoil is approximately 1.0 to 2.0 ft (0.30 to 0.61-m) for most of the Larrabee Onshore Interconnection Cable Route. As noted previously, Atlantic Shores has elected to site the buried onshore cables within existing, previously disturbed road, bike path, and railroad ROWs, where disturbance during construction and installation of the existing infrastructure likely exceeded the depth of potential archaeological deposits. This siting strategy avoids or significantly reduces potential impacts to adjacent undisturbed soils and avoids or minimizes the risk of potentially encountering undisturbed archaeological deposits throughout most of the Larrabee Onshore Interconnection Cable Route.

- One previously recorded archaeological resource (28-Mo-283) is mapped within the Larrabee Physical Effects PAPE. Information from the New Jersey State Museum (NJSM) site form is scarce but lists the site as prehistoric and a place where "implements have been found in the borough of Point Pleasant". However, due to the extent of prior ground disturbance indicated by soil data and illustrated in historical mapping and aerial photography of the area, there is a very low likelihood for intact Native American archaeological resources to be located at the mapped location.

- There are ten previously identified archaeological sites within 0.5-mi. (0.8-km) of the Larrabee PAPE. These sites consist of six Native American sites, three historic-period sites, and one multicomponent site. The Native American sites are generally clustered along tributaries to the Manasquan River north of the Larrabee Onshore Interconnection Cable Route.

- Historical map and photography review demonstrates that MDS are mapped in the immediate vicinity of the proposed Larrabee Onshore Interconnection Cable Route, with most MDS mapped along existing roadways and at intersections that were largely established by the mid-nineteenth century.

- A portion of the proposed Larrabee Onshore Interconnection Cable Route is collocated with the Edgar Felix Memorial Bikeway, within the former railroad corridor of the Farmingdale and Squan Railroad. A previous intensive-level architectural survey identified a segment of the Edgar Felix Memorial Bikeway as part of the former Farmingdale and Squan Railroad (RBA, 2012). The research and fieldwork for that survey concluded that the Farmingdale and Squan Railroad was ineligible for listing on the NRHP. A NJHPO opinion letter dated to August 16, 2021 concurred with the results of the survey, stating "No Historic Properties Affected" within the APE for the bridge replacement (NJHPO, 2012).

- Pedestrian survey (with judgmental shovel testing if deemed appropriate based on observed field conditions) is recommended in any Low sensitivity, "Potentially Undisturbed" areas adjacent to paved roadways (within which the onshore cables are actually sited) where depth to culturally sterile subsoil is less than approximately 2.0 ft as well as in any wetlands or areas of steep slope.

- Targeted archaeological shovel testing is recommended within those portions of the Monmouth Landfall Site, Larrabee Onshore Route, and potential Larrabee Onshore Substation and/or Converter Station options categorized as Medium and Medium-High sensitivity "Potential Phase IB Survey Areas" (Appendix II-P1: Attachment C).

- In addition, the Project's MPRDP for terrestrial archaeological resources will be in effect for all construction and installation activities, providing guidance and instructions to all contractors on how to proceed in the event (however unlikely) of encountering unanticipated cultural resources during work in the Larrabee PAPE.

6.2.1.3 O&M PAPE Assessment Results

With respect to the archaeological potential of the O&M facility Physical Effects PAPE, the results of the assessment in Appendix II-P2 can be summarized as follows:

- Based on the results of the background research, the PAPE possesses relatively low sensitivity for the presence of intact Native American and historic-period archaeological resources. This sensitivity is largely dependent on the lack of stable soil units, extent of made land, and existing disturbance.

- The Facility Site has been significantly disturbed by anthropogenic activities since the early-twentieth century. The entire Facility Site is located on made-made reclaimed land that was formerly undeveloped tidal marshland. The Facility Site is mapped within unstable tidal mudflat (PstAt) soil, while geotechnical evidence near the PAPE indicates man-made fill and/or dredged material between six and 18 feet deep.

- Historical maps and aerial photography document the history of the Facility Site from the late nineteenth century to present day. Former structures (removed/demolished between 1984 and 2002) within the Facility Site date to the mid-twentieth century; it is unlikely that potentially significant archaeological resources are associated with these former structures.

- One previously recorded Native American archaeological site is located within one mile of the PAPE. However, this site was located within secondary deposits which likely originated from somewhere on the mainland, and as such is not necessarily indicative of increased Native American archaeological sensitivity in the area. No previously recorded historic-period archaeological sites were located within one mile of the PAPE.

- Previous surveys conducted for submerged cultural resources in the vicinity of the PAPE did not note any submerged resources within or adjacent to the PAPE. Dredging of a navigational channel and turn around basin in Clam Creek has potentially disturbed the underwater sediments within the PAPE.

- Archaeological monitoring of any future geotechnical borings onsite is recommended. If geotechnical borings uncover the presence of potentially intact soil deposits below the fill material (and within the 60 ft (18.3 m) vertical PAPE of potential pilings or other construction methods), then out of an abundance of caution EDR would recommend archaeological monitoring of the construction and installation of those pilings.

- For all construction activities confined to a depth that does not exceed that of the disturbed fill, EDR recommends no further archaeological investigation.

6.2.2 Potential Impacts and Proposed Environmental Protection Measures

The potential impact producing factors (IPF) which may affect terrestrial archaeological resources during the construction/installation of the onshore interconnection facilities, the construction of the O&M facility, or decommissioning are presented in Table 6.2-2.

Table 6.2-2 Impact Producing Factors for Terrestrial Archaeological Resources

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Land disturbance	•		

The PAPE for physical effects to terrestrial archaeological resources includes all facilities within the PDE (including the Cardiff and Larrabee onshore interconnection facilities and the O&M facility) and is the depth and breadth of terrestrial areas potentially impacted by any ground-disturbing activities (as defined in the PAPE *Memorandum*, Appendix I-A). The only significant IPF on terrestrial archaeological resources from construction and operation of the onshore interconnection facilities within the Cardiff and Larrabee PAPEs, is land disturbance associated with site clearing, grading, excavation, and filling during the construction phase of the landfall sites, interconnection cable routes, and substations and/or converter stations. Routine O&M or decommissioning activities for the onshore interconnection cables or onshore substations and/or converter stations are not expected to result in land disturbances or other IPFs to terrestrial archaeological resources. Similarly, the only significant IPF on terrestrial archaeological resources from construction and operation of the O&M facility and a potential adjacent parking structure within the O&M facility PAPE is land disturbance associated with site clearing, grading, excavation, and filling during the construction.

6.2.2.1 Land Disturbance

Ground disturbing activities associated with construction activities (e.g., site clearing, grading, excavation, and filling) have the potential to affect archeological resources. However, as detailed in Section 6.2.1, Atlantic Shores has proposed Onshore Facilities be primarily located within previously disturbed lots, paved roadways, railroads ROWs, and bike paths where disturbance during construction and installation of the existing infrastructure likely exceeded the depth of potential archaeological deposits. This siting strategy avoids or significantly reduces potential impacts to adjacent undisturbed soils and avoids or minimizes the risk of potentially encountering undisturbed archaeological deposits. Therefore, there is very little likelihood for intact or potentially significant archaeological resources to be located within those portions of the PAPE categorized as "Disturbed" in the Appendix II-P1 Archaeological Reconnaissance and Desktop Assessment Results, and no further investigation is anticipated to be necessary in those areas (Appendix II-P1: Attachments C and D).

Although every effort has been made to site Project facilities in areas that have been previously disturbed and away from known archaeological resources, unanticipated discoveries during construction could occur. Atlantic Shores has prepared the MPRDP in accordance with State and Federal laws for agency review and approval prior to construction. The plan will provide specific contacts and a reporting protocol in the unlikely event that archaeological materials or human remains are discovered during construction.

6.2.2.2 Summary of Proposed Environmental Protection Measures

As detailed in Appendix II-P1 and Appendix II-P2, the results of the TARAs identified one previously recorded archaeological resource (28-Mo-283) mapped within the Larrabee Physical Effects PAPE. However, due to the extent of prior ground disturbance indicated by soil data and illustrated in historical mapping and aerial photography of the area, there is a very low likelihood for intact Native American archaeological resources to be located at the mapped location. Out of an abundance of caution, targeted archaeological testing is recommended in "Potentially Undisturbed" portions of the PAPE in the vicinity of the mapped site location.

Additional archaeological testing is recommended within "Potential Phase IB Survey Areas" where the proposed Onshore Facilities are sited within those portions of the PAPE categorized as "Potentially Undisturbed" (Appendix II-P1: Attachments C and D). A summary of potential additional measures which may be necessary to identify archaeological resources within the onshore interconnection facility sites and the O&M facility is presented in Table 6.2-3.

Table 6.2-3 Identified "Potential Phase IB Survey Areas" for Proposed Onshore Facilities

Onshore Facility Site	Archaeological Sensitivity	Recommended Additional Measures to Identify Archaeological Resources
Larrabee Physical Effects PAPE 237.17 ac		**Combined Phase IB STP Survey 49.14 ac (20.17%)**
Monmouth Landfall Site 8.32 ac	Disturbed, Medium-High	No further investigation
Larrabee Onshore Route 187.94 ac	Disturbed, Low to Medium-High	Targeted Phase IB STP Survey 26.35 ac (14%)
Lanes Pond Road Site 16.27 ac	Low to Medium	Targeted Phase IB STP Survey 10.87 ac (66.81%)
Randolph Road Site 24.64 ac	Disturbed, Medium-High	Targeted Phase IB STP Survey 11.90 ac (48.30%)
Cardiff Physical Effects PAPE 342.15 ac		**Combined Phase IB STP Survey 20.07 ac (5.86%)**
Atlantic Landfall Site 2.90 ac	Disturbed	No further investigation
Cardiff Onshore Route 319.56 ac	Disturbed, Low to Medium-High	Targeted Phase IB STP Survey 3.07 ac (0.96%)
Fire Road Site 19.71 ac	Disturbed, Medium	Partial Phase IB STP Survey 17.0 ac (86.2%)
O&M Facility PAPE 3.22 acres	Disturbed	**Archaeological Monitoring**

The Phase IB archaeological field survey effort is ongoing. BOEM has determined, in accordance with Section 106 regulations (36 CFR § 800.4 (b)(2), that a Phased Identification approach is appropriate for the survey, reporting, and consultation related to this outstanding archaeological investigation while property access permissions are acquired to conduct the remaining Phase IB archaeological investigations. The anticipated Phased Identification schedule is included in the Projects' Phased Identification Plan: Terrestrial Archaeological Resources (EDR 2023). The results of the ongoing Phase IB field survey have been and will continue to be incorporated into subsequent revisions to the TARA reports, which will be submitted to BOEM and the Consulting Parties prior to the Projects' Record of Decision (ROD). This approach would be in accordance with BOEM's existing *Guidelines for Providing Archaeological and Historic Property Information Pursuant to Title 30 Code of Federal Regulations Part 585*, and ensure potential historic properties are identified, effects assessed, and adverse effects resolved prior to construction (BOEM 2020).

Any alternate routing options or substation and/or converter locations removed from Project consideration prior to conducting any potential Phase IB archaeological field survey for the Project will result in the omission of any corresponding Potential Phase IB Survey Areas from the field effort. Additional Potential Phase IB Survey Areas may be added within portions of the PAPE categorized as "Potentially Undisturbed" if Project updates or alterations call for the use of roadside ROW or additional areas outside of the current siting within paved lanes and bikes paths.

To further mitigate the potential (however unlikely) for encountering archaeological resources during installation of the Onshore Facilities, Atlantic Shores has prepared a MPRDP for Terrestrial Archaeological Resources, which includes stop-work and notification procedures to be followed if a cultural resource is encountered during installation (EDR 2023: Attachment C). Atlantic Shores anticipates that the MPRDP will be incorporated in a MOA executed among BOEM, SHPOs, Native American Tribes, and potentially other consulting parties to resolve anticipated adverse effects to identified historic properties and to memorialize specific measures that Atlantic Shores will take to avoid and minimize potential effects to other historic properties in the event of a post-review discovery. The MPRDP outlines the steps for dealing with potential unanticipated discoveries of cultural resources, including human remains, during the construction of the proposed Onshore Facilities. In summary the MPRDP:

- Presents to regulatory and review agencies the plan Atlantic Shores and its contractors and consultants will follow to prepare for and potentially respond to unanticipated cultural resources (i.e., terrestrial archaeological) discoveries;

- Includes provisions and procedures allowing for a Cultural Monitor (Archaeologist) and Tribal Monitors to be present during construction and installation activities conducted in targeted areas of concern as identified in the TARA and through consultation with Native American Tribes; and

- Provides guidance and instruction to Atlantic Shores personnel and its contractors and consultants as to the proper procedures to be followed in the event of an unanticipated cultural resource (i.e., terrestrial archaeological) discovery.

6.3 Marine Archaeological Resources

This section describes marine archeological resources in the Offshore Project Area, which includes the WTA (Project 1, Project 2, and the Overlap Area) and the ECCs, associated IPFs, and measures to avoid, minimize, or mitigate potential impacts to these resources during construction, O&M, and decommissioning of the Projects. Atlantic Shores has demonstrated a commitment to working with Federal, Tribal, and State agencies to determine the effects of greatest concern related to marine archaeological and historic resources. Working with experts in Tribal history, marine archaeology, geology, and maritime history, Atlantic Shores designed surveys to identify potentially sensitive materials and landscapes and took appropriate action (as well as planned future actions) to avoid effects to cultural resources.

Submerged historic properties include pre-contact ("prehistoric") and historic period archaeological sites, objects, districts, or structures (including shipwrecks) that are listed in or eligible for listing in the NRHP maintained by the Secretary of the Interior or have been designated as NHLs by the Secretary of the Interior (30 CFR Part 585, Subpart F). The evaluation of IPFs for submerged historic properties described in this section will support BOEM's review of the Projects as required by Section 106 of the NHPA and NEPA. Specific requirements for submittal of an analysis of potential impacts to marine archaeological resources within this COP are provided in *Guidelines for Providing Archaeological and Historic Property Information* (BOEM 2020a).

6.3.1 Affected Environment

The affected environment for marine archaeological resources will consist of the Projects Marine Physical Effects PAPE. The *PAPE Memorandum* (Appendix I-A) defines this PAPE as the combination of the approximately 102,139-acre (413.3 km^2) WTA and both proposed export cable corridors (ECCs) (including the 5,362-acre [21.7 km^2] Atlantic ECC and the 26,509-acre [95.1 km^2] Monmouth ECC). Construction activities are expected to affect a small percentage of the seabed encompassed by the Marine Physical Effects PAPE, as summarized in Table 6.3-1. Further details on the Marine Physical Effects PAPE are provided in Charts 1 through 5 in Appendix II-Q.

The purpose of Atlantic Shores multi-year marine survey campaign and associated assessments were to support the identification and characterization of potential submerged historic properties within the Marine Physical Effects PAPE (hereafter, PAPE). Atlantic Shores conducted a set of comprehensive desktop, geotechnical, and geophysical assessments of the Offshore Project Area to identify known archaeological sites as well as to characterize the potential for the WTA and ECCs to include marine archaeological sites. These surveys were conducted in accordance with approved Marine High-Resolution Geophysical (HRG) Survey Plans (ASOW 2020, 2021), which were developed in consultation with BOEM, the NJHPO, and appropriate stakeholders such as the Narragansett Indian Tribe, the Shinnecock Indian Nation, and the Lenape Tribe of Delaware.

Atlantic Shores conducted HRG and geotechnical surveys of the WTA and/or ECCs in 2019, 2020, 2021, and 2022. All survey data were evaluated to guide the siting, design, and engineering of offshore project components, including WTG and offshore substations (OSS) foundations and offshore cables (export, inter-array, and inter-link cables). The HRG and geotechnical surveys, described in Appendix II-A1, provided the basis for the identification of potential marine archaeological resources. Building on the HRG and geotechnical surveys and intensive background studies focused on the environmental, geologic, and cultural contexts of the PAPE, Atlantic Shores has completed a Marine Archaeological Resources Assessment (MARA) to identify submerged historic properties that could be affected by the Projects (Appendix II-Q.)

The MARA was conducted by Qualified Marine Archaeologists (QMAs) and in accordance with BOEM's *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585*. The MARA provides data in support of BOEM's NEPA and Section 106 review of potential effects to submerged historic properties. HRG data were collected on survey transects ranging between 1,640 and 3,609 ft (500 and 1,100 m) in width. Data collection lines were spaced at 98 ft (30 m) with tie lines spaced at 1,640 ft (500 m) within areas of potential Project-related seabed disturbance. The HRG surveys supported the characterization of seabed/sub-surface soil conditions within the PAPE. Geotechnical investigations included collection of 10 vibracores and sampling of 43 borehole cores. In total, 96 samples were collected from the vibracores and borehole cores including 80 accelerator mass spectrometer (AMS) dating samples, six species identification samples, ten archival samples for potential future analyses. AMS dating provided a robust chronological framework for the paleolandscape reconstruction and modeled sea level curve (see Section 5 and Appendix K of the MARA– Appendix II-Q). The marine archaeological survey research design and analysis that were coordinated with these HRG and geotechnical investigations enabled targeted and interpretation of areas within the PAPE with the potential to contain significant (NRHP-eligible) submerged cultural resources.

The MARA summarizes site-specific marine surveys and reports completed to date that informed the identification of marine archaeological resources. These site-specific surveys have included the following:

- **Marine Survey Integrated Report** for Lease Area OCS-A 0499 (Appendix II-A1)
- **Geophysical Factual Report** for Lease Area OCS-A 0499 (Appendix II-A2).

Other key data sources for the MARA include BOEM's *Inventory and Analysis of Archaeological Site Occurrence on the Atlantic Outer Continental Shelf* (TRC 2012), shipwreck databases maintained by BOEM (2019) and NOAA (2020), pertinent peer-reviewed scholarly literature, and site-specific surveys performed by Atlantic Shores in the Offshore Project Area.

Evaluation of the potential for marine archaeological resources to be present within the PAPE included both assessment of the likelihood that a pre-contact or historic-period site or shipwreck might have been located in a given area, as well as determining the likelihood that any such sites would be preserved. This evaluation required consideration of regional geomorphology to predict the types of relict terrestrial landforms (or paleo-landforms) that could be present. Geologic constraints, the timing and rate of sea level rise through time, and the specific sub-bottom conditions documented through HRG and geotechnical investigations were then evaluated to assess the potential for ancient indigenous sites to be preserved within the identified paleo-landforms. Inventories and charts depicting known shipwrecks, as well as the regional maritime historical context, informed the sensitivity assessment for shipwrecks or other historic-period archaeological resources. HRG data was then carefully analyzed to identify evidence of historic period archaeological resources. The following sections describe the geology of the Outer Continental Shelf (OCS), potential for pre-contact archaeological resources, and potential for historic-period archaeological resources within the PAPE.

6.3.1.1 Geology of the Continental Shelf and Sea Levels Through Time

The modern NJ OCS is situated between the Hudson canyon to the north and Delaware Shelf Valley to the south and measures approximately 75 to 93 mi (120 to 150 kilometers [km]) wide with an area of roughly 9,652.5 mi^2 (25,000 km^2) (Carey et al. 2005). The northeast continental shelf generally breaks into a steep downward slope toward the Atlantic abyssal plain at depths ranging from 328 to 426 ft (100 to 130 m). However, the eastern extents of the shelf are extended by the Hudson Apron, an additional 10 to 12 mi (15 to 20 km). The shelf is considered a mature, passive continental platform with low subsidence and sediment influx rates (Nordfjord et al. 2006). The shelf is associated with a storm-dominated, mixed energy shoreline, with a tidal range of 3 to 6 ft (1 to 2 m) and mean wave height of roughly 3 ft (1 m) (Carey et al. 2005).

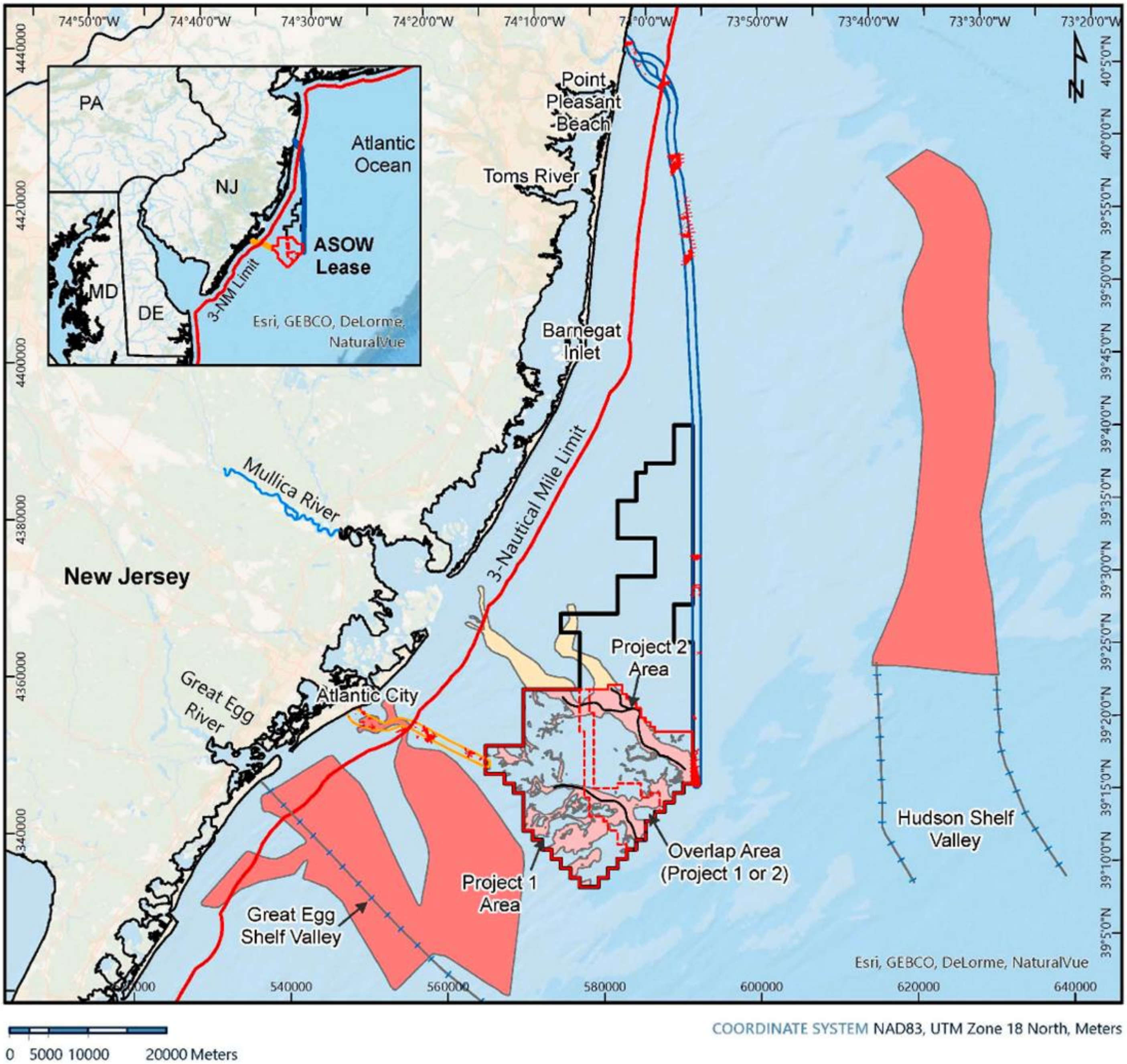
Fluctuating sea levels exerted a strong influence over sedimentation and topography on the OCS. The NJ OCS experienced has three high sea-level stands ("highstands") during the Late Pleistocene to Early Holocene timespan; each highstand is associated with sediment deposition within the PAPE. Highstands occurred during marine isotope stage (MIS) 5e (124,000–119,000 years ago), MIS 3 (55,000-35,000 years ago) and MIS 1 (18,000-present) (Wright et al. 2009). The MIS 5e highstand was approximately 6 m (20 ft) above modern sea levels (Lambeck et al. 2002, Waelbroeck et al. 2002). Deposition during interglacial cycles occurred in two phases. As sea level rose and transgressed across the NJ OCS, sediments were deposited along the mouths of rivers as deltas and submerged (subaqeous) fans and within the incised channels. Once the encroaching sea rose over portions of the shelf, marine sediments were deposited across broad swaths of the ancient landscape. A summary of sea level change since the last glacial maximum (LGM) is presented in Table 6.3-1.

Table 6.3-1 Sea-level Depths and Approximate Shoreline Locations after the Last Glacial Maximum

Age cal BP	Depth Relative to Modern Sea Level	Distance to Modern Shoreline
3,000	-9.8 ft (3 m)	.5 mi (.81 km)
6,000	-23 ft (7 m)	1.95 mi (3 km)
8,000	-59 ft (18 m)	6.7 mi (10.9 km)
11,500	-190 ft (58 m)	60 mi (97 km)
13,000	-213 ft (65 m)	65 mi (105 km)
15,000	-311 ft (95 m)	80 mi (129 km)
21,000	-426 ft (130 m)	84 mi (137 km)

Alternating with the highstands were periods of declining sea level associated with glaciations in the northern hemisphere. Lowered sea levels are generally correlated with periods of erosion and fluvial incision of the exposed OCS landscapes. Incised river channels associated with the LGM (i.e., 29,000 to 22,000 years ago) follow similar courses to channels created during earlier glacial cycles. The effects of cyclical incision and in-filling on the NJ OCS are clearly expressed within the PAPE, which encompasses a complex of buried paleochannels in the southern half and a prominent paleochannel associated with the ancient Mullica River drainage along the northeastern boundary (Figure 6.3-1). Once portions of the ancient shelf were exposed by the receding seas, vegetation adapted to the evolving climate was established and portions of the subaerial landscape stabilized.

The MARA (see Appendix II-Q) presents the interpretation of geotechnical data to describe the sequence of marine sediments within the Lease Area and the potential for submerged pre-contact archaeological resources to be present within the PAPE. The primary horizons and their estimated ages are summarized in Table 6.3-3. Age estimates are informed by extensive Accelerator Mass Spectrometer (AMS) dating of samples from geotechnical cores collected within the PAPE.



COORDINATE SYSTEM NAD83, UTM Zone 18 North, Meters

LEGEND

- 3-Nautical Mile Limit
- Atlantic Shores Lease Area (OCS-A 0499)
- Wind Turbine Area (Project 1 and 2 Areas)
- Wind Turbine Area (Overlap Area - Project 1 or 2)
- Atlantic Export Cable Corridor
- Monmouth Export Cable Corridor
- Regional Paleochannels
- ECC Interpreted Paleochannels (SBP & S-UHRS)
- TCG Generalized Thalweg
- TCG Extent (28 ka - 7.4 ka) / Possible Relict Mullica Paleochannel
- Possible Relict Mullica River Paleochannel (Paleochannels mapped by Fugro for the 2020 Desk Top Study using available seismic data near the lease area.)
- Large Regional Paleochannels (Paleochannels mapped by Fugro for the 2020 Desk Top Study using available seismic data near the lease area.)

Note: 1) The ECC and TCG paleochannel extents were mapped by Fugro based on the G&G data acquired for Atlantic Shores between 2020-2021.

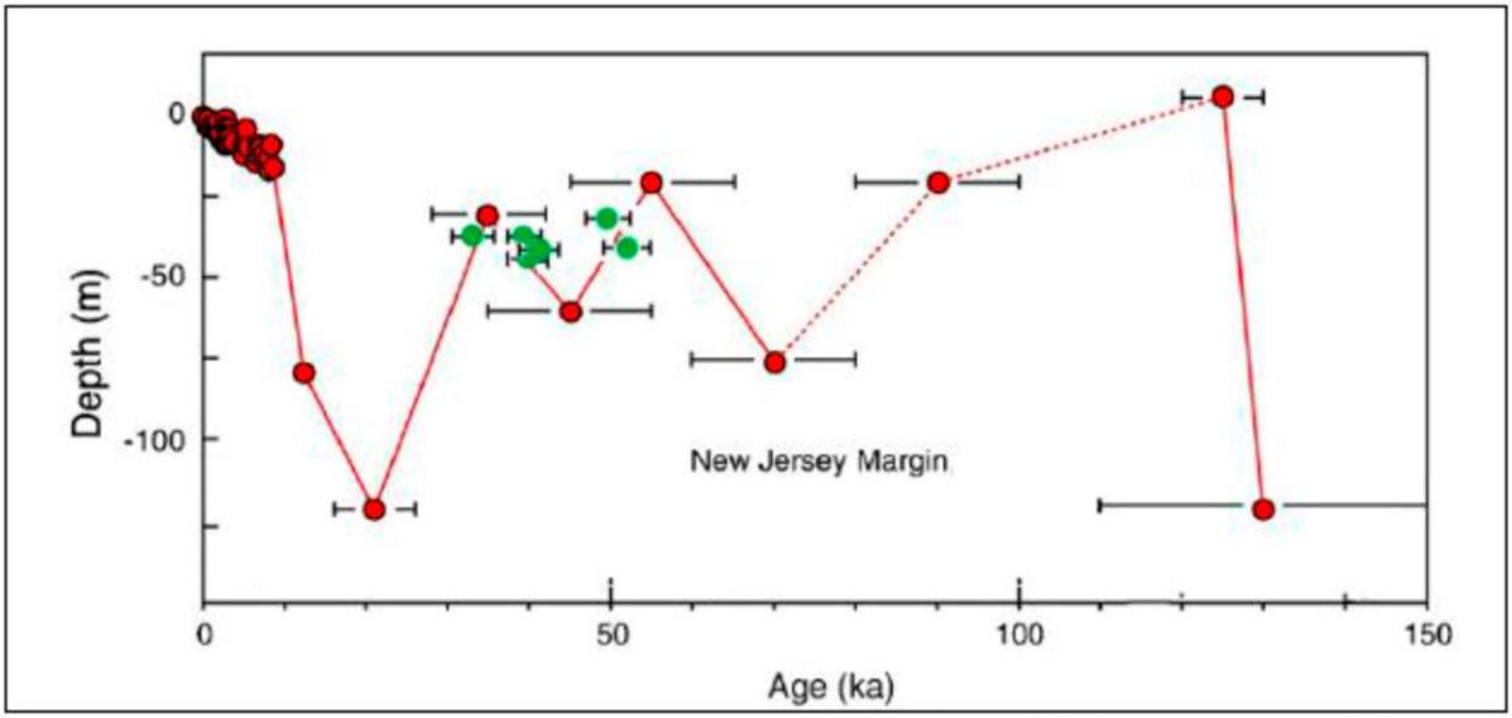
Figure 6.3-1
Mapped Boundaries of Buried Paleochannels within PAPE

Reconstructed sea levels since the LGM based on previous studies and the results of Atlantic Shores analyses offer insight into both rates of marine transgression and dates of submergence of the PAPE and surrounding New Jersey continental shelf (Figure 6.3-2).

Inundation was rapid between approximately 16,000 and 10,000 years ago, increasing the likelihood that sediments containing archaeological materials could have been buried sufficient to preserve archaeological materials in situ. Inundation slowed after that point, thereby increasing the erosive forces within coastal zones that are destructive to archaeological sites.

The geophysical and geotechnical data are presented within Appendix II-A1, as well as within the MARA (Appendix II-Q). Current interpretation has defined seven distinct, identifiable sedimentary sequences in the Offshore Project Area (see Appendix II-Q). The sediments are categorized, with increasing depth below seafloor, as Holocene Marine Deposits (U0), Holocene and Transgressive Channel Group (TCG), Late Pleistocene Deposits and channel fill (U1, Ch20, U2 and U3), and pre-transgressive Coastal Plain Deposits (CP).

Of these sequences only Holocene marine deposits, the transgressive channel sequence, and the transgressive deposits contain sediments of ages consistent with documented human occupations in North America (Table 6.3-2). The age estimates are based on extensive dating of samples collected during geotechnical investigations the PAPE.



Red dots from Wright et al. 2009. Green dots from Atlantic Shores data.

Table 6.3-2 Regional stratigraphic ages and interpreted horizons within the PAPE

Period	Epoch (with *approximate age)	Unit/Key Bounding Horizons
Quaternary	Holocene (7.4kya to Present)	U0 Horizon 000 (Base of U0)
	Early Holocene (~12kya-7.4kya) Upper Late Pleistocene (~28kya-12kya)	TCG (Transgressive Channel Group) Erosional unconformity at base of TCG
	Late Pleistocene (35kya-28kya) Late Pleistocene (39kya-35kya)	U1 H005 - H000 (Upper U1) H020 - H005 (Lower U1) Base of U1 is defined by H020
	Late Pleistocene (52kya-42kya)	U2 Channel 20 Sequence (Upper U2) Base of U2 is defined by combined Horizons 50-80-85
	Late Pleistocene (129kya-52kya)	U3 Base of U3 is defined by H100
Tertiary	Coastal Plains Deposits (Pre-Quaternary age – Miocene to Pliocene)	CP

**Approximate ages inferred from recent radiocarbon dating of geotechnical samples within the PAPE and correlation to regional stratigraphic studies.*

6.3.1.2 Potential for Pre-contact Settlement in the Project Area

There are no confirmed submerged pre-contact archaeology sites in the immediate vicinity of the Atlantic Shores Lease Area; however, the theorized migration of Native Americans suggests the potential for undiscovered sites to exist. Several collections of pre-contact artifacts derived from submerged contexts have been identified along New Jersey's Atlantic coast. These collections clearly demonstrate the ancient indigenous use of the now-submerged lands. Based on paleoecological reconstructions of past environments on the OCS and adjacent portions of the mainland, the PAPE would have supported a diverse range of economically and culturally important plant and animal species comparable to those utilized by ancient indigenous peoples in inland and shoreline settings. Both global and regional settlement patterns for the periods of subaerial exposure of the PAPE suggest ancient occupations and other uses of the NJ OCS would have clustered along the margins of waterways, marshes, and estuaries where a broad and reliable range of food resources were available. Elevated locations providing expansive views of the surrounding landscape were also likely used to monitor the movement of people and game and potentially for ceremony. Potential bedrock or secondary sources of stone for the manufacture of tools is also likely to have influenced ancient indigenous land-use patterns.

Based on sea level reconstructions and seafloor bathymetry, parts of the PAPE excluding rivers, mashes, estuaries, and other surface water bodies, were exposed lands available for occupation by ancient indigenous people prior to marine transgression. Marine transgression progressively inundated the incised valleys and other low elevation sections of the PAPE. Higher elevations along the ECCs may have persisted as dry land for several thousand years longer than the eastern margins of the PAPE. The proposed WTG and OSS elements of the Projects are located in areas that could potentially contain archaeological evidence of Paleoindian (21,000 to 10,000 years ago) and Early Archaic (10,000 to 8,000 years ago) occupations. Nearshore sections of the ECCs, in contrast, could have been available for occupation from the Paleoindian to Late Archaic (6,000 to 4,000 years ago) periods. The potential for archaeological sites associated with pre-contact occupations to be preserved, however, has been substantially reduced by erosion associated with subsequent marine transgression and continuous scour and truncation caused by bottom currents and storm events.

In addition to the assessment of where people may have located themselves within the large expanses of the exposed OCS, identifying potential archaeological sites dating from the Pre-contact Period within the PAPE requires the identification of *preserved* landforms from the periods when humans may have occupied the landscape. The potential for pre-contact archaeological sites to have been preserved in the PAPE relies on specific conditions during geomorphological evolution on the continental shelf. The effect of erosion and other forms of sediment transport on the landscape following occupation largely determines whether associated archaeological sites may be preserved. For example, analyses of the Holocene-age marine sands within the PAPE indicate these deposits primarily present as sand ridges and swales that migrate over time. Bottom currents and coastal storms result in highly mobile sediments and areas of scour between individual ridges. The geologic processes suggest that durable artifacts that may have been present in scoured areas could have been incorporated in the Marine Sands, but their current locations may be quite different from their original contexts. Figure 6.3-3 illustrates the general

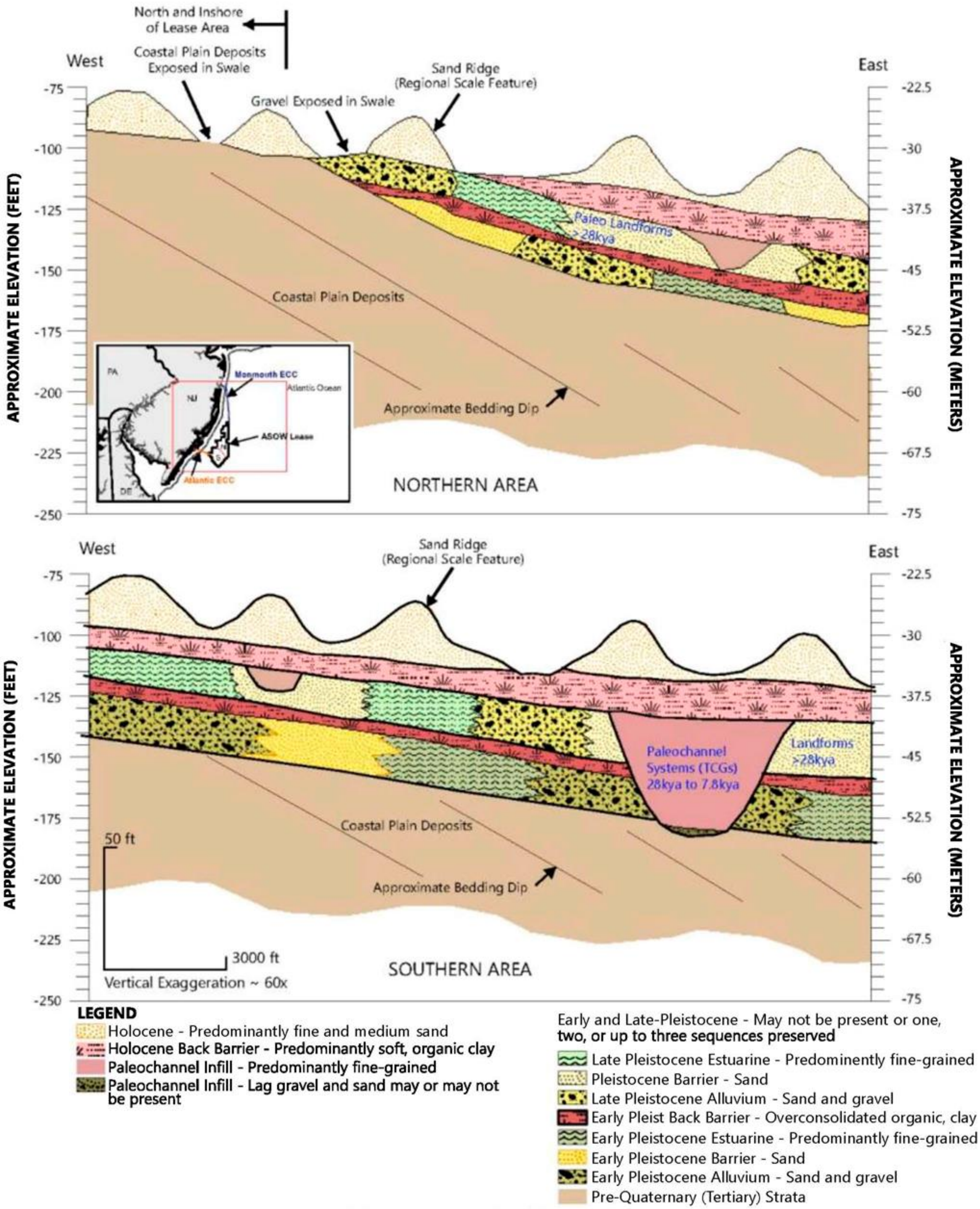


Figure 6.3-3
Schematic Cross Section of PAPE stratigraphy

In contrast, where intact ancient soils (paleosols) are present in the underlying Upper Late Pleistocene to Early Holocene deposits, associated archaeological materials that could be present are more likely to occur in-situ.

Based on extensive dating of sediments recovered from geotechnical investigations within the PAPE, there is a low potential for intact archaeological resources younger than 7,400 years to be present. The potential for archaeological sites older than 7,400 years is generally confined to settings associated with drowned barrier islands along ancient shorelines and buried fluvial terraces or other well-drained landform features along the post-LGM paleochannels.

Table 6.3-3 Sea Level Depths based on Atlantic Shores data and Engelhart et al. (2015), Wright et al. (2009)

Marine Isotope Age/ Archaeological Period or Dated Site	Age cal BP	Depth
Woodland	3,000	-9.8 ft (3 m)
Late Archaic	6,000	-23 ft (7 m)
Middle Archaic	8,000	-59 ft (18 m)
MIS 1	10,000	-105 ft (32 m)
Clovis	13,000	-213 ft (65 m)
Monte Verde	15,000	-311 ft (95 m)
Late Pleistocene	17,000	-393 ft (120 m)
LGM/White Sands	21,000	-426 ft (130 m)
MIS 2	30,000	-213 ft (65 m)
MIS 3a	35,000	-92 ft (28 m)

The historic context for the pre-contact period and chronology for the archaeological periods referenced in Table 6.3-3 including descriptions of the changes in climate, topography, landscape and the associated potential human use of the landscape, are described in the detail in the MARA Report (see Appendix II-Q) and summarized in the following discussion.

The basic pre-contact cultural chronology for the Northeast is outlined in numerous publications, including Lothrop et al. (2011), Funk (1976), and Snow (1995). This cultural chronology includes Paleoindian (Early, Middle, and Late), Archaic (Early, Middle, and Late), Woodland (Early, Middle, and Late), and Contact periods. In drawing upon the documented cultural and chronological patterns of pre-contact settlement and subsistence patterns to estimate the likely patterns of ancient life on the NJ OCS, several specific considerations are appropriate. For example, the contemporary shorelines associated with the earliest periods of settlement along the Atlantic Seaboard are all now inundated. Evidence of coastal adaptations are unlikely to be found in the terrestrial settings where most archaeological investigations are conducted. Second, global settlement patterns suggest people living in coastal settings tend to have low rates of mobility relative to their inland counterparts. Low rates of mobility may be a particularly important consideration for identifying evidence of Paleoindian occupations on the OCS. Existing information about Paleoindian cultures in the Northeast suggest they were highly mobile and carried tool kits specifically suited to lives on the move. If there were contemporary, coastally adapted Paleoindian communities, their stone tools and sites might look quite different from the better-known examples from inland settings. In contrast to the elaborate stone tools know from interior areas, coastal groups may have relied on simple flake tools made from locally available stone (Joy 2020).

New Jersey's Paleoindian period is well represented, with fluted projectile points identified in 19 out of 21 counties (Marshall 1982). Diagnostic artifacts along with other distinctive cultural items such as gravers and scrapers (Funk 1972) were recovered from multiple geographic settings throughout the state. Two Paleoindian sites provide useful analogs for occupation on the contemporary landscape. Site 28-AT-129 is at Somers Point along the northeastern side of Drag Island within Great Egg Harbor Bay where a recreational clam digger recovered a single fluted projectile point in a back-barrier lagoon (Boldurian 2006). At present, the area of Somers Point is coastal; however, during the Paleoindian period the area was a mosaic of boreal forests located as much as 100 km (62 mi) inland along the middle and upper reaches of a much larger, Late Pleistocene Great Egg Harbor River watershed (Boldurian 2006:259). Site 28-OC-100 is approximately 40 km (25 mi) north of Barnegat Bay and provides distinctive evidence of Paleoindian lithic tool manufacture and maintenance activity (Mournier et al. 1993). Multiple excavations at the site have recovered over 1,100 artifacts, including more than 70 channel flakes, multiple bifaces, two fluted point bases, and one tip (Mournier et al 1993). Presently, the site is on a sandy rise near the Kettle Creek drainage. During the Paleoindian Period Kettle Creek was incised deeper than at present as the rapidly melting Laurentide Ice Sheet produced abundant amounts of glacial meltwater.

Early Archaic period sites are relatively rare in New Jersey and appear to have mirrored the preceding Paleoindian settlement patterns to a certain degree. Subsequent Middle and Late

Archaic period sites are far more common, likely attributable to the establishment of stable mast (nut bearing) forests throughout the region after 8,000 years ago. The Archaic period is often characterized by the gradual establishment of modern environmental conditions, as can be seen in its hardwood forests, interior woodlands, ponds, and rivers, as well as the introduction of a broad range of food (i.e., nuts, large and small game, seed-bearing plants, fish, etc.) and manufacturing resources (i.e., stone for making tools and weapons, plants for baskets and textiles, bark for house construction, etc.) (Merwin 2010). New resources and improved conditions supported the widespread human occupation of New Jersey after the Early Archaic period.

Woodland Period assemblages in New Jersey are distinguishable from earlier cultural expressions by the presence of pottery and distinctive mortuary patterns during specific sub-periods. Evidence for an increased reliance on coastal habitats is notable, with a gradual shift from extensive oyster fisheries to an emphasis on quahogs and other clam species over time. Larger settlements in prime ecological settings were established by the Middle Woodland Period (2,000 to 1,000 years ago). Such hamlets or villages may have been supported by early horticulture or rich shellfish and finfish resources in shoreline settings. Heavy groundstone tools such as axes and adzes likely used to clear land for planting became more common in the Late Woodland Period (1,000 to 450 years ago). The ethnographic record of North American hunter-gatherers (summarized in Kelly 1995) suggests that coastal groups, such as the Lenni-Lenape, Shinnecock, Unkechaug, and Montauk, relied heavily on the Atlantic Ocean, Hudson River, and small tributaries for seafood and trade. Aquatic resources utilized by New Jersey natives included shellfish, small fish, and whales. Shell middens attributed to the Lenni-Lenape, part of the Algonquin culture, are frequently recorded along the New Jersey coastline from Sandy Hook to Cape May (Nagiewicz 2016), while oral history from the Shinnecock Tribe depicts the use of one to two whales per year to feed villages through winter, as well as a limited use of whale oil.

The MARA (Appendix II-Q) includes a detailed description of the anthropogenic use of varying landforms and environments that changed through time depending on cultural and ecological conditions. However, in general, the types of landforms that are the most likely locations for archaeological sites and retain the highest preservation potential include: levee terraces, elevated locations with large viewsheds, and drowned spits. When integrated with the site-specific geotechnical and geophysical data collected within the PAPE these contexts and identification of landforms provide the basis for the archaeological sensitivity assessment.

6.3.1.3 Probability for Historic Maritime Cultural Resources in the Project Area

The MARA (Appendix II-Q) includes a detailed historic context summarizing the historical development of maritime trade and associated infrastructure in the region. The historic context informed the assessment of the range of potential historic period submerged historic properties that could be located within the PAPE and how specific shipwrecks may relate to documented patterns in local history. The following section provides a brief overview of the historic context.

In the centuries leading up to European colonization, Absecon Island, one of many barrier islands lining the New Jersey coast, was home to members of the Lenni-Lenape tribe. Commonly, referred to as the Delaware Indians by European emigrants, the Lenape lived in autonomous villages along New Jersey's various tributaries and back bays. These waterways acted as natural highways, traversable by small watercraft such as dug-out canoes. Led by local Sachems and Councils of Elders, these communities typically relied on hunting, fishing, gathering, and small-scale agriculture for survival. During the summer months, for example, the Lenape are known to have frequented the barrier islands including Absecon, in search of waterfowl, fish, clams and oysters (Federico and McHenery 2011:7; Herman 2008:31-40). The name Absecon or "Absegami" was bestowed upon the island by the Lenape and translates into "little water" (Kozek n.d., Rutgers University 2020).

The first known European explorer to visit the Atlantic coast of Absecon Island was Italian explorer Giovanni de Verrazano in 1524. In the years succeeding Verrazano's voyage, other notable European explorers undertook a similar mission, and while the Northwest Passage remained undiscovered, few went home with nothing to show for their efforts (Wroth 1970). In 1609, the English explorer Henry Hudson and his crew of the Dutch pinnace Halve Maen explored the present-day Delaware Bay before following the New Jersey coast to the mouth of the present-day Hudson River. The voyage of the Halve Maen was succeeded roughly six years later by Dutch explorers Cornelius Jacobsen Mey (also spelt May) and Cornelius Hendrickson, respectfully. Mey and his crew of the ship Fortune are known to have explored much of the southern New Jersey coast from the present-day Manasquan River to the Delaware Bay. The expedition is credited with providing lasting names to several present-day geographical features including present-day Great Egg Harbor, Little Egg Harbor, and Cape May (Herman 2008:43-44).

Formal claim to the land led to the establishment of Fort Nassau on the Delaware River in 1623. Named in honor of the Dutch noble family of Orange-Nassau, the fortification served as a trading post for the region's lucrative fur trade. Despite the profitability of the colony as a result of the fur trade, the Dutch would surrender the town of New Amsterdam (present-day New York City) on Manhattan Island to a fleet of English warships under the command of the Duke of York in 1664. As early as 1693, numerous village hamlets and plantations sprang up along New Jersey's coastal waterways including Absecon Creek, Mullica River, Barnegat Bay, Manasquan River, and Great Egg Harbor River and Bay.

It is important to recognize that Native American communities did not disappear when European colonists arrived along the Atlantic coasts of the New World. Long-standing maritime traditions, intimate knowledge of the waters of the Atlantic, and skills developed over generations provided economic opportunities for some. Native fishermen, known for their ability to navigate local waters, were significant members of English whaling operations in the seventeenth century. These men had sought after whaling skills, including blacksmithing, finger weaving, and basket weaving. Particularly, natives of Long Island were heavily involved in numerous shore-whaling stations along New Jersey's southern coast, including Southampton and Easthampton (Shoemaker 2014). Oral history from modern Native American groups memorializes tribal whalers by the phrase "not a ship left the shore of Long Island without a Shinnecock on board to guide it" (Shoemaker 2014). Shinnecock, in this sense, is thought to include all Long Island tribal members participating in whaling. As tribal lands were reduced in size and farming productivity decreased as a result of English settlements, the whaling industry offered natives economic survival (Button 2014). Skilled native whalers were included in long voyages and received a compensation range similar to that of skilled harpooners, boat steerers, and common sailors (Shoemaker 2014). As the value of their skills persisted throughout the eighteenth and nineteenth centuries, Native American whalers advanced in the whaling hierarchy. Shinnecock and Montaukett whalers ascended to officer positions, leading whaling cohorts until the decline of whaling with the Civil War and the discovery of oil (Button 2014).

Maritime trade represented a significant element of historical patterns along the southern New Jersey shorelines throughout the eighteenth and nineteenth centuries. British naval blockades of major ports in Boston and Philadelphia led Americans to rely on smaller ports along the New Jersey coast to maintain the crucial flow of goods to the beleaguered republic. Filling the void left by the larger ports were little known communities, many of which were located along the New Jersey coast including Somers Point, Mays Landing, and Chestnut Neck. The maritime tradition of these ports and landings afforded them the infrastructure to store contraband goods and build and repair vessels as needed. Furthermore, their location along the region's dynamic back bays and barrier islands, supplied ample concealment for the communities and their locally owned and built vessels. The Revolutionary War and War of 1812 saw the development of local privateers who harassed Royal Navy operations and smuggled desperately needed goods to the young nation.

Maritime trade expanded throughout the second half of the nineteenth century. The extensive vessel traffic combined with treacherous conditions led to frequent vessel losses. Public and commercial demands for government action to mitigate the risks of maritime disasters led to the rapid development of lifesaving stations along New Jersey's Atlantic coast. In fact, 1855 alone saw more than 20 stations established along the Jersey shore including Little Egg Harbor Station, Barnegat Station, Toms River Station, Bay Head Station, and Squan Beach Station (USLSS Station #9) (USACE 1996:4-11; USCG 2017). Despite the considerable investment in lifesaving infrastructure, it was soon clear that aids to navigation, particularly lighthouses, were required to assist the overextended Life Saving Service. Thus, Congress appropriated a sum of $35,000 for the construction of a brick lighthouse on Absecon Island's northeastern tip in 1854. Construction began the following year, and the lighthouse was lit for the first time on January 15, 1857.

The Japanese attack on Pearl Harbor plunged the United States back into a state of international war in December 1941. Roughly a month later, the conflict reached the Jersey shore in the form of the of Nazi Germany's Unterseeboot, more commonly known as the U-boat. The Jersey shore experienced the loss of the Norwegian freighter Octavian via torpedoes fired from U-123 off the coast of Cape May on January 17, 1942. The freighter would not be the last victim of the war. In 1942 alone, Octavian would be joined by no less than 13 other vessels, including U.S. Navy destroyer USS Jacob Jones (DD-130), all of which were sunk via German torpedoes along the New Jersey coast from Cape May to Manasquan. Ever-mounting merchant ship losses compelled American war planners to train their focus on U-boat countermeasures. By 1943, the U-boat terror was diminished.

As clearly documented in the historic context, the ocean waters of southern New Jersey have proven hazardous to mariners throughout history. In order to determine whether previously reported historic shipwrecks are located within or near the PAPE, the QMA completed an intensive review of several databases, including the following:

- BOEM's Archaeological Resource Information Database
- Global GIS Data Services, LLC, Global Maritime Wrecks Database (GMWD)
- National Oceanic and Atmospheric Administration (NOAA) Wrecks and Obstructions Database including the Automated Wreck and Obstruction Information System (AWOIS)
- NOAA Electronic Navigation Charts Database (ENC)
- New Jersey Maritime Museum Shipwreck Database (NJMM).

The results of the archival research are presented in Section 2.6 of the MARA (Appendix II-Q). The MARA includes a discussion of historic maritime cultural trends, including significant ports, vessel types, and causes for marine losses, which provide further detail regarding the types of historic-period marine archaeological resources that could be present within the Offshore Project Area. Given the intensity and longevity of maritime activity in this region, navigation charts show numerous vessel wrecks, obstructions, and other navigational hazards within the Offshore Project Area (NOAA-NOS 2000; Appendix II-Q). As a result of the intensive use of these shipping lanes in the region and as evidenced by the density of charted shipwrecks, there is a moderate to high probability of encountering charted maritime cultural resources within the WTA and ECCs.

In addition, offshore waters located in proximity to life-saving stations and lighthouses, typically have a higher likelihood of hazardous nearshore areas and therefore shipwrecks, as do nearshore environments due to the dynamic conditions. Additional shipwrecks are likely to exist on the seabed than have been accounted for in historic and contemporary literature (Pearson et al. 2003). The potential for submerged cultural resources should be considered moderate to high within the ECCs where shallower waters led to more hazardous conditions. However, the dynamic ocean conditions decrease the potential for preservation of shipwrecks.

6.3.2 Potential Impacts and Proposed Environmental Protection Measures

The potential IPFs which may affect marine archaeological resources during construction, O&M, or decommissioning of the Projects are presented in Table 6.3-4.

Table 6.3-4 Impact Producing Factors for Marine Archaeological Resources

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Anchoring and jack-up vessels	●	●	●
Installation and maintenance of new structures and cables	●	●	●

In addition to the IPFs described in Table 6.3-4, marine archaeological resources may also be affected by discharges from vessels and accidental releases (although these are considered unlikely occurrences). The introduction of oil and other chemicals can, among other impacts, hasten the degradation of organic materials lying on, or just below, the seabed. These potential impacts are considered to have a low likelihood of occurrence and are discussed in Section 9.2 Non-Routine and Low-Probability Events.

As described in the introduction to this section, Atlantic Shores conducted desktop, geotechnical, and/or geophysical surveys of the WTA and/or ECCs in 2019, 2020, 2021, and 2022. Marine archaeological survey, in coordination with HRG and geotechnical surveys, was conducted in 2020 and 2021. All survey data are being evaluated to guide the siting, design, and engineering of offshore project components, including WTG and OSS foundations and offshore cables (export, inter-array, and inter-link cables). The goal of these surveys has been to identify potential submerged cultural resources, as well as preserved paleo-landforms where archaeological sites may be present, to inform strategies to appropriately avoid and/or mitigate potential effects to significant cultural resources identified in the Offshore Project Area. The application of these survey data and avoidance strategies relative to IPFs for marine archaeological resources are described in this section.

6.3.2.1 Anchoring and Jack-Up Vessels

Vessel anchoring and use of jack-up vessels have the potential to disturb sediments on the ocean floor and therefore could affect archaeological resources (if present). Jack-up vessels have legs that lower into the seabed and brace the vessel as it elevates above sea level, where it can safely perform operations in a stable, elevated position. Temporary anchoring and use of jack-up vessels within the Offshore Project Area will occur during construction and decommissioning and to a lesser extent during O&M with variations in duration and extent according to the specific work activity. The area of seabed disturbance for anchors and jack-up vessels are described in Table 4.2-1 in Volume I. Vessel anchoring and jack-up vessels are minimally intrusive to the seabed and the depth of disturbance for these activities is anticipated to range from 3.3 to 16.4 ft (1 to 5 m).

All vessel anchoring and jacking associated with Project activities will occur within areas that are included within the marine archaeological survey. Based on this assessment the QMA has identified several shipwrecks or potential shipwrecks within the PAPE. The QMA has recommended seabed disturbance, including vessel jacking and anchoring, be avoided within 164 ft (50 m) of each of the 22 potential historic period marine archaeological resources. Avoidance areas extend 164 ft (50 m) from the discernable boundary of each potential resource, typically delineated through side scan sonar and gradiometer datasets. In addition to the historic period resources, the QMA has identified 65 potential ancient submerged landform features (ASLFs) that could retain evidence of pre-contact period occupations of the PAPE prior to marine transgression. The QMA has recommended seabed disturbance be avoided within 82 ft (25 m) of the identified horizontal boundary of each ASLF. The QMA has further recommended avoiding disturbance that would affect sediments within 3.3 ft (1 m) of any buried elements of ASLFs. Atlantic Shores and the QMA will work proactively with BOEM and the SHPO to devise and implement appropriate mitigation measures within the mapped limits of the ASLFs.

6.3.2.2 Installation and Maintenance of New Structures and Cables

The installation and maintenance of new structures and cables will disturb sediments on the ocean floor and therefore could affect archaeological resources (if present). Seafloor-disturbing activities during construction of the WTG and OSS foundations include seabed preparation for certain foundation types, foundation placement, and scour protection installation. Seafloor-disturbing activities during installation of the offshore cables include pre-installation activities (sand wave clearing, boulder relocation, and a pre-lay grapnel run), offshore cable installation, cable protection where needed, and excavation at the horizontal directional drilling (HDD pit). The sediment disturbance associated with these activities is described in Section 4.0 of Volume I.

All WTG foundations, OSS foundations, and ECCs are included within the area covered by the marine archaeological survey. As noted in Section 6.3.2.1, Atlantic Shores will apply an avoidance buffer of 164 ft (50 m) as recommended by the QMA for historic period marine archaeological resources during installation and maintenance activities. Atlantic Shores and the QMA will also work proactively with BOEM and the SHPO to devise and implement appropriate mitigation measures during installation and maintenance activities when working within mapped limits of the ASLFs and their associated QMA-recommended avoidance areas.

6.3.2.3 Summary of Proposed Environmental Protection Measures

Atlantic Shores has conducted a thorough documentation and inventory of marine archaeological resources so that submerged historic properties located within the PAPE can be avoided or mitigated. Atlantic Shores has conducted a marine archaeological survey of the PAPE under the direction of a QMA in accordance with BOEM guidelines. Based on the results of the MARA investigations, Atlantic Shores is exploring micro-siting and other measures to avoid or minimize impacts to submerged historic properties. The marine survey coverage and the associated MARA provide a sound basis for micro-siting and other protective measures to avoid and/or minimize affects to the identified marine archaeological resources. Using HRG and geotechnical data collected in 2019, 2020, 2021, and 2022, avoidance, minimization, and mitigation strategies to protect marine cultural resources consist of the following measures:

- Identify historic-period marine archaeological resources and ancient submerged landforms that are the most likely locations for pre-contact archaeological sites and that retain preservation potential.
- Establish approximately 164 ft (50 m) protective buffers recommended by the QMA around each identified post-Contact marine archaeological resources or potential marine archaeological resource to minimize the risk of disturbance during construction. Protective buffers extend outward from the maximum discernable limit of each resource. Additional details provided in Appendix D of the MARA report (see Appendix II-Q).
- Consider all survey data, including potential marine archaeological resource locations and characteristics, to guide the siting, design, and engineering of offshore Project components, including WTG and OSS foundations and offshore cables (export, inter-array, and inter-link cables) and planning for associated temporary construction activities (vessel jacking and anchoring).
- Implement the Monitoring Plan and Post Review Discovery Plan: Submerged Cultural Resources.

- If warranted, Atlantic Shores will conduct supplemental surveys or other investigations to support National Register eligibility determinations and/or to mitigate unavoidable adverse effects to submerged historic properties.

Atlantic Shores will continue to proactively consult with BOEM, SHPO(s), Native American Tribes, and other relevant parties to pursue feasible means of avoiding, minimizing, and/or mitigating potential effects to all submerged historic properties. Avoidance of impacts to all identified ASLFs may not be feasible based on current information and planning efforts. If no prudent and feasible means of avoiding one or more ASLFs are available, Atlantic Shores anticipates that the mitigation process for submerged landscapes will proceed in a phased manner with the following procedural and consultation steps:

- All geologic landforms identified within the PAPE have been mapped to encompass the maximum extent of potential impacts from proposed construction operations.

- Efforts are being made to develop the mitigation, avoidance, and treatment plan while also evaluating the preservation potential and probability modeling for these landscapes to be considered for archaeological criteria in informing these plans.

- In consideration of any comments provided by consulting parties during the BOEM-led Section 106 consultations, data collected and a phased mitigation framework developed by Atlantic Shores will be presented to stakeholders/consulting parties for review and comment.

- Atlantic Shores has developed a historic properties treatment plan to address potential submerged historic properties that would be impacted by construction activities. The plan will be revised in consultation with stakeholders/consulting parties, BOEM, and subject matter experts.

- Atlantic Shores would be responsible for implementing all mitigation measures documented in the treatment plan including:

    - **Postconstruction ASLF Investigation.** This mitigation measure will consist of the use of postconstruction export cable burial survey data, supplemental analyses by QMAs, and identification through consultations with Native American Tribes of targeted areas warranting additional inspections and/or documentation. Areas targeted for any supplemental documentation will be confined to specific sections of ASLFs that are physically disturbed by installation of the export cable in Federal waters and are determined to have a high preservation potential for archaeological deposits. For the purposes of this mitigation measure, areas of high preservation potential are defined as those portions of the ASLFs with an elevated likelihood of containing macroscopic cultural materials, including but not limited to chipped stone tools, flakes, modified wooden implements, and bone.

- **Open-Source GIS, Story Maps, and Animations.** This mitigation measure will consist of the compilation and transfer of relevant geophysical, geotechnical, and geoarchaeological datasets pertaining to the ASLF to a non-proprietary GIS system for use by Native American Tribes. The datasets will include subbottom (seismic) data used to characterize the seabed and ASLF features, the location of all geotechnical/geoarchaeological samples collected, and the vertical and horizontal extents of the affected features or sub-features within each ASLF. The GIS will be, to the extent feasible and practicable, compatible with GIS datasets compiled for other OCS projects to assist in the Native American Tribes' on-going research and stewardship efforts. Story Maps or equivalent digital media presentations will be prepared to integrate and present the complex technical data compiled during the MARA and mitigation investigations in a manner best-suited for inter- and intra-tribal audiences. Story Map content would be developed in close consultation and collaboration with the consulting Native American Tribes.

7.0 SOCIOECONOMIC RESOURCES

This section provides a detailed description of the socioeconomics of the area where the Atlantic Shores Project Region (Project Region) occurs including demographics, employment, environmental justice, recreation/tourism, land use/coastal infrastructure, navigation/vessel traffic, aviation, and onshore transportation and traffic.

7.1 Demographics, Employment, and Economics

This section describes demographics, employment, and economics within the Project Region, associated impact-producing factors (IPFs), and measures to avoid, minimize, or mitigate potential effects to these resources during construction, operations, and maintenance (O&M), and decommissioning of the Projects.

For purposes of the assessment of demographics, employment, and economics, the Project Region is the geographic area related to the communities and resources that could be affected by construction, operation, and decommissioning of the Projects, specifically at the county level. The region is well prepared for coastal and maritime construction projects. There is plentiful existing port infrastructure and a robust and available work force that will be drawn upon to fill the employment needs of the Projects. U.S. renewable energy policy has been anticipating that offshore wind development projects in the region would add significant opportunity for substantial additional revenue in this sector. New housing or transportation infrastructure will not be needed to construct and operate the Projects. Construction activities will occur offshore in the export cable corridors (ECC) and the Wind Turbine Area (WTA), which includes Project 1, Project 2, and the Overlap Area. Onshore project components include the Atlantic and Monmouth Landfall Sites, Cardiff and Larrabee Interconnection Cable Routes, Points of Interconnection (POI) and onshore substations and/or converter stations. Ports will serve as mustering points for offshore labor and staging areas for project components both during construction and O&M phases. See Table 4.10-2 of Volume I for a full list of ports that may be used during construction. The representative ports evaluated in this section have been identified by Atlantic Shores and its contractors as facilities that are anticipated to support significant construction and O&M activities associated with the Projects. The Projects will be supported by a new O&M facility in Atlantic City, New Jersey (see Section 5.5 of Volume 1). Other ports in New Jersey may also be used to support project O&M needs.

7.1.1 Affected Environment

The affected environment or Project Region consists of the communities in Atlantic, Monmouth, Salem, Gloucester, Ocean, Essex, and Hudson counties in New Jersey in which construction, O&M, and/or decommissioning activities will take place based on the location of the proposed Project infrastructure and the availability of associated support facilities (e.g., ports, staging areas, etc.). This assessment is based on available U.S. Census Bureau data including population, employment, economic conditions, and housing.

7.1.1.1 Population

Population characteristics and trends of each county within the socioeconomic Project Region describe the substantial size of the workforce available to support the construction and operation of the Projects and provide a basis for evaluating potential changes related to the Projects. Table 7.1-1 summarizes the land-area of each geography in square miles; its population in 2000, 2010, and 2020; the population density in 2010; population change from 2000 to 2020; and the median age of the population.

Of the eleven counties, New Jersey counties closest to New York City (Essex County and Hudson County) have the largest and the densest populations. Salem County, New Jersey, is the least populated and Cape May is the least dense of the counties. Monmouth, Hudson, and Essex counties each had a higher population density than New Jersey State. All counties within the Project Region, except Salem, Camden, and Cape May counties, experienced moderate population growth between 2000 and 2020, according to U.S. Census Bureau data. Ocean, Gloucester, and Hudson counties experienced a higher growth rate than the State of New Jersey. Cape May County, New Jersey has the highest median age of the counties at 50.3 years, while Hudson County, New Jersey has the lowest at 35.3 years.

Table 7.1-1 Population

	Land (Sq. Mi.)	2000 Pop.	2010 Pop	2020 Pop.	2010 Density (Persons Per Sq. Mi.)	Population Change 2000-2020	Median Age (Years)
State of New Jersey	7,354	8,414,350	8,721,577	8,881,418	1,195.5	5.6%	40.0
Atlantic County	556	252,552	273,162	264,650	494.1	4.7%	41.8
Burlington County	820	423,394	447,861	446,301	546.2	5.4%	41.6
Camden County	227	508,932	513,574	506,721	2,262.4	-0.4%	38.8
Cape May County	620	102,326	97,684	92,701	157.6	-9.4%	50.3
Cumberland County	678	146,438	155,456	150,085	229.3	2.5%	37.6
Essex County	130	793,633	780,872	798,698	6,104.2	0.6%	37.7
Gloucester County	322	254,673	285,223	291,745	895.3	14.6%	40.4
Hudson County	52	608,975	622,123	671,923	12,858.3	10.3%	35.3
Monmouth County	469	615,301	628,112	620,821	1,344.7	0.9%	43.4
Ocean County	629	510,916	569,274	602,018	917	11.4%	42.4
Salem County	332	64,285	65,982	62,754	199.1	-2.4%	42.5

Source: U.S. Census Bureau American Community Survey 2018 5-Year Estimates.

7.1.1.2 Employment and Economic Conditions

Labor force and employment rates vary between the counties in the Project Region (Table 7.1-2). Hudson County, New Jersey, had the highest rate of labor force participation at 69.7%. Cumberland County, New Jersey, had the lowest labor force participation rate at 55.7%. The State of New Jersey's labor force participation rate was 65.8%, while the national rate was 63.4%. The highest unemployment rate within the Project Region is Atlantic County at 8.7%, followed by Essex and Cumberland counties, at 8.0%. The lowest unemployment rate is in Monmouth County (5.1%). It is notable that economic data used within this report, and particularly this section, are the most currently available datasets at the time of preparing the report (May 2022) and reflect COVID-19 conditions in 2020. Therefore, data are likely different from today's economic conditions.

Table 7.1-2 Labor Force and Employment

	Total Population 16 Years and Over	Labor Force Participation Rate	Unemployment Rate
State of New Jersey	7,161,184	65.8%	5.8%
Atlantic County	215,732	63.8%	8.7%
Burlington County	364,861	66.5%	5.4%
Camden County	404,482	66.1%	6.7%
Cape May County	78,430	57.7%	6.7%
Cumberland County	117,879	55.7%	8.0%
Essex County	629,085	65.6%	8.0%
Gloucester County	235,654	67.6%	5.3%
Hudson County	547,213	69.7%	5.4%
Monmouth County	506,991	66.5%	5.1%
Ocean County	472,408	58.7%	5.3%
Salem County	51,024	60.7%	7.1%
United States	261,649,873	63.4%	5.4%

Source: U.S. Census Bureau American Community Survey 2020 5-Year Estimates.

As demonstrated on the following table, Atlantic County, New Jersey, experienced the largest change in gross domestic product (GDP) between 2017 and 2020, with an 8.7% decrease in overall GDP likely due to the COVID pandemic and its impact on tourism. Only four counties within the Project Region experienced more growth than the national GDP growth rate in 2020. Essex County, New Jersey, has the highest GDP of the counties at $45.0 billion in 2020 followed by Hudson County, New Jersey, at $41.2 billion (Table 7.1-3). Cape May County, New Jersey, has the lowest GDP at $4.6 billion in 2020.

Table 7.1-3 Gross Domestic Product (GDP)

	Real GDP (In Millions of Chained 2012 Dollars)		2017-2020 Percent Change	Percent of U.S. GDP	
	2017	2020		2017	2020
State of New Jersey	$537,045.1	$535,794.8	-0.2%	2.97%	2.91%
Atlantic County	$12,136.0	$11,074.5	-8.7%	0.06%	0.06%
Burlington County	$25,597.1	$25,636.5	0.2%	0.14%	0.13%
Camden County	$22,264.9	$21,771.6	-2.2%	0.12%	0.11%
Cape May County	$4,912.7	$4,681.3	4.7%	0.02%	0.02%
Cumberland County	$5,722.9	$5,691.7	-0.5%	0.03%	0.03%
Essex County	$48,015.8	$45,044.5	-6.2%	0.26%	0.24%
Gloucester County	$13,231.1	$14,333.8	8.3%	0.07%	0.07%
Hudson County	$40,431.9	$41,215.2	1.9%	0.22%	0.22%
Monmouth County	$32,071.9	$31,956.5	-0.4%	0.17%	0.17%
Ocean County	$19,922.5	$19,049.9	-4.4%	0.11%	0.10%
Salem County	$4,749.1	$5,107.8	7.6%	0.02%	0.02%
United States	$18,079,084.0	$18,384,687.0	1.7%	100%	100%

Source: Bureau of Economic Analysis, GDP, and Personal Income, 2021.

All counties within the Project Region, except Monmouth County had a lower per capita income than their respective statewide per capita incomes (Table 7.1-4). All counties besides Camden County experienced a decline in per capita income national growth in per capita income from 2019 to 2020, as well as the State of New Jersey and the United States.

Table 7.1-4 Per Capita Income

	Per Capita Income 2019	Per Capita Income 2020	2019-2020 Percent Change
State of New Jersey	$44,888	$44,153	-1.6%
Atlantic County	$36,298	$34,175	-5.8%
Burlington County	$44,820	$44,735	-0.2%
Camden County	$35,958	$36,559	1.7%
Cape May County	$43,852	$42,987	-1.9%

Table 7.1-4 Per Capita Income (Continued)

	Per Capita Income 2019	Per Capita Income 2020	2019-2020 Percent Change
Cumberland County	$29,711	$28,311	-4.7%
Essex County	$40,138	$39,685	-1.1%
Gloucester County	$40,617	$40,557	-0.1%
Hudson County	$44,055	$42,822	-2.7%
Monmouth County	$56,171	$53,886	-4.1%
Ocean County	$37,432	$37,041	-1.0%
Salem County	$36,066	$33,575	-6.9%
United States	$66,060	$63,416	-4.0%

Source: U.S. Census Bureau American Community Survey 2019 and 2020 5-Year Estimates.

Table 7.1-5 includes the employment sectors within the overall Project Region. The largest employment sector for all geographies is Educational Services and Health Care and Social Assistance. Retail Trade is also an important industry sector, followed by Professional, Scientific, and Management, and Administrative and Waste Management. Arts, Entertainment, and Recreation, and Accommodation and Food Services is a relatively significant industry sector for Atlantic and Cape May counties, accounting for 21.7% and 16.1% of all employment respectively. Manufacturing is a relatively significant sector in Salem and Cumberland counties, accounting for 11.2% and 11.9% of all employment respectively.

Table 7.1-5 Employment NAICS Industry Sector

Industry Sector	State of New Jersey	Atlantic County	Burlington County	Camden County	Cape May County	Cumberland County	Essex County	Gloucester County	Hudson County	Monmouth County	Ocean County	Salem County	United States
Arts, Entertain., Recreation, Accommodation & Food Services	7.8%	21.7%	6.8%	8.2%	16.1%	5.4%	7.2%	7.2%	8.6%	8.2%	6.2%	9.4%	7.8%
Construction	5.9%	6.3%	5.7%	5.8%	9.4%	6.7%	6.0%	7.0%	5.0%	7.1%	7.9%	7.5%	6.7%
Educational Services, and Health Care and Social Assistance	24.1%	24.3%	26.1%	26.4%	24.6%	26.6%	25.5%	27.6%	19.0%	24.4%	27.4%	27.2%	23.3%
Finance, Insurance, Real Estate, Rental and Leasing	8.5%	8.2%	7.0%	6.8%	2.8%	8.1%	6.9%	12.0%	10.2%	6.6%	3.7%	6.6%	8.5%
Manufact.	8.1%	4.5%	7.5%	7.3%	3.1%	11.9%	6.7%	7.5%	6.7%	5.8%	4.8%	11.2%	10.0%
Other Services, Except Public Admin.	4.2%	4.5%	3.6%	4.5%	4.2%	3.4%	4.5%	3.7%	4.1%	3.6%	4.6%	3.9%	4.8%

Table 7.1-5 Employment NAICS Industry Sector (Continued)

Industry Sector	State of New Jersey	Atlantic County	Burlington County	Camden County	Cape May County	Cumberland County	Essex County	Gloucester County	Hudson County	Monmouth County	Ocean County	Salem County	United States
Professional, Scientific, Mgmt., Admin., and Waste Management Services	13.7%	9.0%	11.9%	12.0%	7.9%	8.5%	13.7%	10.8%	17.1%	14.3%	10.3%	8.1%	11.7%
Public Admin.	4.4%	5.2%	7.1%	4.9%	8.2%	7.5%	4.8%	5.0%	3.1%	4.5%	5.6%	5.5%	4.7%
Retail Trade	10.7%	11.9%	11.7%	12.3%	11.2%	11.7%	9.9%	11.9%	9.7%	10.8%	13.2%	10.0%	11.0%
Transport, Warehouse, and Utilities	6.4%	4.4%	5.8%	6.4%	3.7%	6.6%	7.9%	6.4%	8.0%	4.8%	5.9%	9.9%	5.5%
Wholesale Trade	3.3%	1.9%	3.2%	3.1%	2.8%	4.3%	2.5%	3.9%	3.2%	2.9%	2.7%	3.7%	2.5%
Information	2.6%	1.2%	2.0%	1.9%	1.3%	0.9%	3.0%	1.8%	3.4%	3.1%	2.0%	1.2%	2.0%
Agriculture, Forestry, Fishing, Hunting, and Mining	0.3%	0.3%	0.3%	0.2%	0.9%	3.7%	0.2%	0.4%	0.1%	0.3%	0.3%	1.9%	1.7%

Source: U.S. Census Bureau American Community Survey 2020 5-Year Estimates.

The National Oceanic and Atmospheric Administration's (NOAA's) Office for Coastal Management manages the Economics: National Ocean Watch (ENOW) database, which provides data on the "Ocean Economy." These data describe six economic sectors based on NAICS codes that depend on oceans and the Great Lakes. These sectors include Tourism and Recreation, Ship and Boat Building, Offshore Mineral Extraction, Marine Transportation, Marine Construction, and Living Resources (NOAA Office For Coastal Management, Economics: National Ocean Watch, 2020). Table 7.1-6 depicts data regarding the Ocean Economy in the Project Region, describing the percent of the total GDP, total employment, number of establishments, percent of wages and particular focus on the tourism and recreation sector. Within the Project Region, the Ocean Economy had the largest relative employment in Cape May County, New Jersey, accounting for 27% of all jobs. Tourism and recreation were key contributors to the overall Ocean Economy in all counties besides Burlington County, representing approximately 63% to 95% of Ocean Economy jobs.

Table 7.1-6 Ocean Economy

	Total Ocean Economy GDP (in millions)	Ocean Economy as Percent of Total GDP	Individuals Employed in Ocean Economy (Including Self Employed)	Ocean Economy Employment as a Percent of Total Economy	Ocean Economy Wages as a % of Total Economy	Number of Ocean Economy Establish-ments	Percent of Ocean Economy Employment in Tourism and Recreation
State of New Jersey	$11,900.0	1.9%	169,656	4%	2.4%	9,349	85.8%
Atlantic County	$599.5	4%	11,254	9%	4.9%	666	95%
Burlington County	$1,500.0	5.2%	11,375	6%	6.9%	64	0%
Camden County	$341.9	1.2%	4,168	2%	1.7%	179	68.7%
Cape May County	$627.8	15.8%	11,139	27%	18.6%	1,063	94.2%
Cumberland County	$164.4	2.4%	2,665	5%	3%	150	68.7%
Essex County	$771.2	1.3%	8,476	3%	1.8%	567	81.7%
Gloucester County	$416.8	3.2%	8,293	7%	4.9%	132	62.9%
Hudson County	$1,400.0	2.7%	22,652	8%	3.7%	1,548	91.5%
Monmouth County	$835.2	2.3%	19,042	7%	2.9%	1,415	95.1%
Ocean County	$707.6	3.7%	15,342	9%	4.5%	1,267	91.9%
Salem County	$118.9	4.1%	1,955	10%	6.4%	65	81.5%

Source: National Oceanic and Atmospheric Administration's (NOAA) Office for Coastal Management, Economics: National Ocean Watch (ENOW) 2019.

7.1.1.3 Housing

Data on overall housing characteristics, along with a detailed assessment of vacant housing characteristics, are presented in Tables 7.1-7 and 7.1-8. Cape May County, New Jersey, had the highest vacant housing rate of all counties in the Project Region and more than six times the State level. The lowest total housing vacancy was in Burlington County, at 6.5%. Monmouth County had the highest median home value of $435,300, while Cumberland County had the lowest median home value of $166,400. Median gross rent did not necessarily follow the same trends as home values, with Ocean County having the highest rental rates at $1,459 despite a lower median home value than most of the counties in the Project Region.

Table 7.1-7 Housing Characteristics

County	Total Housing Units	Vacant Housing Units	Total Housing Vacancy Rate	Homeowner Vacancy Rate	Rental Vacancy Rate	Median Value	Median Gross Rent
State of New Jersey	3,628,732	356,678	9.8%	1.4%	4.4%	$343,500	$1,368
Atlantic County	128,472	27,369	21.3%	2.6%	7.5%	$216,600	$1,129
Burlington County	179,955	11,760	6.5%	1.5%	4.7%	$259,600	$1,219
Camden County	206,247	15,587	7.6%	1.4%	4.7%	$200,400	$1,107
Cape May County	99,394	58,724	59.1%	3.4%	36.7%	$306,200	$862
Cumberland County	56,411	5,464	9.7%	1.8%	4.4%	$166,400	$1,082
Essex County	318,385	27,705	8.7%	1.6%	4.8%	$395,900	$1,211
Gloucester County	113,945	7,569	6.6%	1.2%	4.0%	$224,300	$1,258
Hudson County	284,561	23,272	8.2%	2.1%	4.4%	$400,800	$1,450
Monmouth County	262,088	23,853	9.1%	1.1%	3.3%	$435,300	$1,437
Ocean County	284,773	55,319	19.4%	1.6%	3.1%	$286,700	$1,459
Salem County	27,607	3,193	11.6%	1.7%	6.3%	$185,700	$1,024

Source: U.S. Census Bureau American Community Survey 2020 5-Year Estimates.

Table 7.1-8 includes vacancy characteristics in the Project Region by type of rental units that could be available to non-local construction workers. The coastal counties had high percentages of seasonal and recreational units when compared to the rest of the Project Region, likely due to the region’s popularity as a summer vacation destination. Despite the high rate of vacant property being for seasonal or recreational use, all counties had a significant vacant housing stock classified as “For Rent” or “Other Vacant,” indicating potential latent housing supply.

Table 7.1-8 Vacant Housing Characteristics

	Total	For Rent	Rented, Not Occupied	For Sale Only	Sold, Not Occupied	For Seasonal, Recreation or Occasional Use	For Migrant Workers	Other Vacant
State of New Jersey	356,678	54,735	8,923	30,960	15,532	134,412	196	111,920
Atlantic County	27,369	2,714	149	1,828	593	16,459	0	5,626
% Distribution	100%	9.9%	0.5%	6.7%	2.2%	60.1%	0.0%	20.6%
Burlington County	11,760	2,105	719	1,977	585	470	0	5,904
% Distribution	100%	17.9%	6.1%	16.8%	4.9%	3.9%	0.0%	50.2%
Camden County	15,587	3,279	271	1,724	838	364	44	9,067
% Distribution	100%	21%	1.7%	11.1%	5.4%	2.3%	0.3%	58.2%
Cape May County	58,724	5,273	149	1,120	111	50,551	95	1,425
% Distribution	100%	8.9%	0.3%	1.9%	0.2%	86.1%	0.2%	2.4%
Cumberland County	5,464	792	191	612	140	394	0	3,335
% Distribution	100%	14.5%	3.5%	11.2%	2.6%	7.2%	0.0%	61.0%
Essex County	27,705	8,113	965	2,115	1,546	787	46	14,133
% Distribution	100%	29.3%	3.5%	7.6%	5.5%	2.8%	0.2%	51.0%
Gloucester County	7,569	888	285	1,046	328	232	0	4,790
% Distribution	100%	11.7%	3.8%	13.8%	4.3%	3.1%	0.0%	63.3%
Hudson County	23,272	8,162	1,952	1,810	1,567	2,355	0	7,426
% Distribution	100%	35.1%	8.4%	7.8%	6.7%	10.0%	0.0%	31.9%
Monmouth County	23,853	2,081	471	1,980	1,405	12,004	0	5,912
% Distribution	100%	8.7%	1.9%	8.3%	5.9%	50.3%	0.0%	24.8%

Table 7.1-8 Vacant Housing Characteristics (Continued)

	Total	For Rent	Rented, Not Occupied	For Sale Only	Sold, Not Occupied	For Seasonal, Recreation or Occasional Use	For Migrant Workers	Other Vacant
Ocean County	55,319	1,435	242	2,986	1,545	39,598	11	9,502
% Distribution	100%	2.5%	0.4%	5.4%	2.8%	71.6%	0.02%	17.2%
Salem County	3,193	505	15	299	201	98	0	2,075
% Distribution	100%	15.8%	0.5%	9.4%	6.3%	3.1%	0.0%	65.0%

Source: U.S. Census Bureau American Community Survey 2020 5-Year Estimates.

7.1.2 Potential Socioeconomic Effects and Proposed Environmental Protection Measures

This section addresses the potential direct and/or indirect socioeconomic and environmental effects of potential IPFs associated with the construction, operations and maintenance, and decommissioning of the proposed Projects. Overall, the Projects are anticipated to generate economic benefits including, job creation and economic stimulus to the Project Region. Potential IPFs as they relate to specific Project phases are presented in Table 7.1-9.

Table 7.1-9 Impact Producing Factors

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Workforce Recruiting and Training Programs	●	●	●
Workforce Hiring	●	●	●
Procurement of Certain Construction or Maintenance Materials	●	●	●
Vessel charters	●	●	●
Port Utilization	●	●	●
Housing	●	●	●
Temporary Accommodations	●	●	●

Atlantic Shores is working to maximize the positive economic and environmental effects of the Projects, as well as minimize negative effects by consulting with stakeholders to identify potential issues, thoroughly investigating them, and devising strategies to avoid or minimize adverse effects.

Any potential negative socioeconomic effects resulting from the proposed Projects are expected to be limited in time and scope as they will predominantly result from temporary conditions associated with construction activities. Onshore construction will be planned to minimize direct negative effects to the Project Region (i.e., Atlantic, Monmouth, Salem, Gloucester, Salem, Ocean, Essex, and Hudson counties in New Jersey) during the summer tourist season (i.e., Memorial Day through Labor Day). It is anticipated that any housing demand created by workers supporting the Projects would be absorbed by the local market (see Section 7.1.2.6 and 7.1.2.7 for additional information on housing and temporary accommodations). Socioeconomic effects, where they occur, will be concentrated in proximity to the ports hosting Project-related activities. Positive economic effects are expected to outlast any potentially negative economic effects over the life of the Projects.

Anticipated positive socioeconomic effects resulting from the Projects include job creation and economic stimulus to the Project Region. The assumptions regarding what opportunities would occur locally were developed by Atlantic Shores in coordination with over 50 potential suppliers to the Projects (both in and outside of New Jersey) for the major strategic work packages through a formal competitive process designed to optimize local opportunities in the Projects' supply chain. That effort identified a broad range of suppliers from New Jersey who will be providing a large share of the Projects' development, construction, and operation. This will result in a significant amount of positive economic impact in the Project Region. Some examples of the local opportunities in different phases are as follows:

- **Development**: The Projects' development activities include a wide variety of local opportunities including technical and professional services; real estate services, marine operations, charter and crewing of Jones Act compliant vessels including survey vessels; interconnection, and ROW development; O&M base preparations; and local initiatives including forming and maintaining key local partnerships, fostering New Jersey offshore wind research and innovation, and targeted corporate philanthropy.

- **Manufacturing and Assembly Works**: The Projects will attract a broad range of new manufacturing, equipment assembly and marshalling opportunities to the Project Region. These opportunities will require the construction and commissioning of new facilities using materials and manufacturing equipment sourced from within the Project Region, but also requiring multi-modal means of transport within the Project Region for imported goods including local ports, rail, and highways.

- **Installation of Offshore Equipment:** Local opportunities for the WTG and foundation installations will include onshore staff for project management and engineering; component marshalling including stevedoring, waste removal, provisions and security; fabrication and installation of sea-fastening facilities; marine operations; charter and crewing of Jones Act compliant vessels including survey vessels, barges, tugs and crew transfer vessels (CTVs); vessel crews and vessel operations including pilots, shipping agents and port fees; fuel bunkering services; environmental protection and oversight services (e.g., noise mitigation, protected species, emergency containment, etc.); welders and steel fabricators; scour protection (including procurement of locally sourced rock); and food, lodging and transportation of workforce.

- **Electrical Infrastructure**: The design, procurement, and installation of the Projects' electrical grid components for the offshore substations (OSS), onshore substations and/or converter stations and associated onshore interconnection cable routes, and landfall sites will require specialized electrical equipment (e.g., transformers, power quality equipment, switchgear, and control enclosures) from within the Project Region; onshore and offshore staff and support services, component marshalling; offshore supporting vessels and crew; and skilled installation technicians.

- **O&M**: Atlantic Shores will establish an O&M facility in Atlantic City, New Jersey that will provide permanent jobs in technical service, marine operations, vessel crew, data analysis, offshore asset monitoring preventative maintenance, and repair, as well as create economic activity for a wide range of subcontractors including shipyards, spare part producers and vessel and harbor services.

A detailed economic Input-Output (I-O) model was developed for each of the two Projects by Atlantic Shores using the IMPLAN[47] online analysis tool to analyze and estimate the potential labor and economic impacts of the planned spending and local opportunities in the Project Region. Using the projected local spending patterns for the Projects as described above, the I-O model analyzes and estimates anticipated changes to local industry or commodity revenues in the Project Region due to that spending, and the resulting increases in local supply chain and business-to-business transactions. The primary or "direct" effects to the local economy represent the initial impacts felt in the Project Region from the new local spending, such as the number of jobs created, or the total amount of sales or production. The secondary or "indirect" effects are changes in inter-industry transactions in the Project Region when supplying industries respond to increased demands from the directly affected industries. The tertiary or "induced" effects reflect changes in local household spending in the Project Region that result from income changes in the directly and indirectly affected industry sectors.

A planned schedule for the Projects is provided in Table 7.1-10 to provide context for the anticipated duration of the jobs, the timeline of job creation and other associated economic benefits. The total duration of the Projects is assumed to be approximately 40 years followed by a 3-year decommissioning period at the completion of operations. The assumed timeline includes 7 years of development through to financial close (the Final Investment Decision or "FID"), 3 years of construction and installation activities through to the final Commercial Operation Date (COD), and then an operations period assumed to last 30 years.

To estimate the direct, indirect, and induced labor force and other economic effects to the Project Region that result from the new local spending patterns associated with development, construction, operations, and decommissioning of the Projects, Atlantic Shores relied upon the schedule assumptions as outline in Table 7.1-10 and the following project capacity assumption:

- Project 1: Total project capacity of 1,510 MW that reflects the Offshore Renewable Energy Credit (OREC) allowance that the New Jersey Board of Public Utilities (NJBPU) awarded to Atlantic Shores on June 30, 2021.
- Project 2: Indicative project capacity of 1,200 MW was assumed to align with the NJBPU's minimum OREC target for the third offshore wind solicitation scheduled to take place in 2022.[48] It should be noted that the actual capacity of Project 2 could be larger than 1,200 MW and result in additional economic benefits than presented in this section. The final

[47] IMPLAN is an industry-standard regional I-O modelling tool that assembles annual data sets from validated government and industry sources including the U.S. Bureau of Economic Analysis, (BEA) the U.S. Census Bureau, and the Bureau of Labor Statistics (BLS). All annual data sets used in this analysis are current to reporting year 2019. The IMPLAN software applies deflators to the 2019 data to provide results for current year of analysis (2020). The IMPLAN application and supporting documentation may be accessed at: https://www.implan.com/

[48] New Jersey's Clean Energy program. 2020. New Jersey Offshore Wind Solicitations. Available at: https://www.njcleanenergy.com/renewable-energy/programs/nj-offshore-wind/solicitations (accessed December 2021)

size of Project 2 will be dependent not only on the outcome of the pending New Jersey solicitation but also final engineering design.

Table 7.1-10 Anticipated Project Schedule

Phase	Start	End	Duration (Years)
Project 1			
Development	2018	2024	7
Construction	2025	2027	3
Operations	2028	2057	30[a]
Decommissioning	2058	2060	3
Project 2			
Development	2018	2024	7
Construction	2026	20297	3
Operations	2029	2058	30[a]
Decommissioning	2059	2061	3

Notes: A detailed construction schedule is provided in Table 4.1-1 of Volume I Project Information.

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

7.1.2.1 Workforce Recruiting and Training Programs

Atlantic Shores is committed to maximizing the amount of recruiting and hiring from programs targeted at training and providing talent to the offshore wind industry from local New Jersey communities to the extent practicable. This IPF section focuses on the direct effect that workforce training programs will have on local communities during the construction, O&M, and decommissioning. Atlantic Shores is committed to support numerous workforce training initiatives throughout the Projects' lifecycle. These initiatives, which are detailed further in this section, are targeted to provide training and opportunities for students from low-income backgrounds, minority and women-owned business enterprises (MWBEs), and veterans (see Section 7.2 for additional information on how the proposed Project provides opportunities to directly benefit environmental justice and disadvantaged communities).

Atlantic Shores will also support the New Jersey WIND Institute. New Jersey is in the process of establishing the WIND Institute, which will coordinate workforce development and research initiatives, based on the blueprint described in the WIND Council report. The Institute will have a substantial impact on the viability of the offshore wind industry in New Jersey. Atlantic Shores is committed to partnering with the WIND Institute once it is established in the following ways:

- Enable the WIND Institute to provide flexible grants and scholarships in support of industry growth. Atlantic Shores recognizes that the WIND Institute will be established in a way that ensures it has autonomy to award grants and scholarships to partners in its workforce building efforts.

- Serve as a lead sponsor for WIND Institute events. A major role of the WIND Institute will be building education and awareness and sharing important research and development findings through industry events.

- Atlantic Shores will support the WIND Institute's efforts to establish a New Jersey-based Global Wind Organization training program by pledging to hire (directly or through its suppliers) qualified graduates once the program is online, bolstering recruitment efforts and immediately cementing the program as a pathway to meaningful, high-paying jobs.

- Support the development of an offshore wind certificate program at a community college.

- Full participation in the WIND Institute Advisory Board and to help recruit other partners from its network, as desired.

- Collaborate on research projects that support the development of innovative and environmentally sustainable offshore wind development.

Atlantic Shores is committed to partnering with The Rowan College Burlington County Workforce Development Institute to leverage existing workforce programs that will have a direct benefit to the offshore wind industry and supply chain including the following:

- The Energy Industry Fundamentals Program. Students in this program are trained in operations components of the energy industry, safety procedures, and transmission, all of which are critical for a vast array of jobs in offshore wind industry. All Energy Industry Fundamentals students are women and/or people of color. Atlantic Shores will work to recruit from this program as part of our efforts for diversity and inclusion initiatives training programs and hiring practices.

- The Supply Chain, Transportation, Logistics, and Distribution Program. Students in the program learn skills that support transportation, operations management, manufacturing, and international logistics to build a critical talent pool that can support the landside logistics of a robust offshore wind supply chain.

- The Manufacturing Machinist and Industrial Maintenance Program. Students in this program build skills necessary for advanced manufacturing and for the O&M of heavy equipment. As component manufacturers and others establish themselves in the State, Atlantic Shores is actively supporting the development of a robust workforce to provide a pipeline of capable workers.

In addition, Atlantic Shores will provide other initiatives designed to facilitate meeting the long-term O&M requirements of the Projects:

- Contribute to scholarship programs to support and prepare students for careers in the renewable energy field (e.g., Rutgers Future Scholars Program, Egg Harbor Township Police Activities League STEM program).

- Contribute funds to the Science, Technology, Engineering, the Arts, and Mathematics (STEAM) programming with the Atlantic City Boys and Girls Club.

- Partner with local organizations to support education, workforce development, and community initiatives, including OffshoreWind4Kids, Center for Family Services Camden Promise Neighborhood, National Action Network Tech World, Turning Point Community Development Corporation, Atlantic City Community Fund and Community Foundation of South Jersey.

- Partner with Chambers of Commerce within the Project Region and the Rutgers Eco Complex WindIgnite Program to increase opportunities for MWBEs.

- Provide access to Atlantic Shores' parent company (i.e., Shell) training and job programs.

- Coordinate with the Department of Labor.

- Support industry conferences and WTG supplier training programs. For example, Atlantic Shores is partnering with Business Network for Offshore Wind to bring additional offshore wind supply chain training through their trademark Offshore Wind Ready training program. Atlantic Shores will also host smaller supplier events at the ECO Center to target local minority contractors and suppliers.

- Foster university outreach, innovation, and research.

- Fund and support construction industry training programs for veterans, specifically the 'Helmets2Hardhats' which trains veterans for jobs in the construction industry.

7.1.2.2 Workforce Hiring

This IPF section focuses on the direct effect that workforce hiring will have on local New Jersey and New York communities during the development and construction, O&M, and decommissioning phases. The Projects are expected to create a total of approximately 33,000 full time equivalent (FTE) direct jobs, 18,000 FTE indirect jobs, and 22,000 FTE induced jobs over the total duration of the Projects (i.e., approximately 40 years followed by a 3-year decommissioning period).[49] Detailed job creation totals for each of the Projects' various phases, expressed as FTEs, and other types of workforce information including the type of activity, occupation, wages and

[49] Job totals are preliminary estimates only. Totals have been rounded to the nearest thousand and therefore do not match up with the FTE job values presented in the following tables which are calculated based on Project size.

salaries, and required education and training levels for the estimated direct, indirect and induced employment created by Project 1 and Project 2 are provided in Tables 7.1-11 through 7.1-19.

During the construction phase, Atlantic Shores will be directly hiring a diverse range of trades and skills in fabrication, component assembly, and construction/installation. Specific trade unions will include ironworkers, carpenters (e.g., pile drivers, dock builders, millwrights), operating engineers, laborers, and electricians. Estimated direct job creation during the 7-year development and 3-year construction phase of the Projects is summarized in Table 7.1 (see Table 7.1-10 for additional information on the anticipated schedule of the Projects). Over the 10-year development and construction phase, total employment is estimated for Project 1 and Project 2 at approximately 7,445 and 5,915 FTE jobs, respectively, or approximately 745 and 592 FTE jobs annually.

The results in Table 7.1-11 are provided in two sections including tabulation by two-digit North American Industry Classification System (NAICS) industry sector divisions, and further summarized in the second part of the table by 6-digit NAICS codes, the most detailed level of NAICS classification. Almost half (49.1%) of the estimated direct jobs in the development and construction phases will be within the construction sector (NAICS Sector 23), principally in heavy and marine construction, power sector works, and fabrication of manufacturing and industrial buildings. Of the remaining jobs, approximately a third (33.4%) of the jobs will be within the manufacturing sector (NAICS Sectors 31-33), principally associated with the manufacturing of monopiles and nacelle assembly. Other important industries directly impacted by the development and construction phases includes professional services (NAICS Sector 54) for engineering, environmental and other technical studies (9.6%), and transport and warehousing logistics (NAICS Sector 48-49) including marine vessels, harbor services, trucking, and warehousing (7.3%).

The Projects are expected to fill workforce needs where possible through contracting with New Jersey-based companies and employees. Atlantic Shores will use New Jersey trade unions for construction through a six-union Memorandum of Understanding (MOU) executed with its major suppliers. This labor agreement is the first of its kind and monumental moment in developer/labor relations and a positive step forward in workforce development in the clean energy market. Local manufacturing will be used to produce and assemble Project components, including monopile fabrication, transition piece platform fabrication and final assembly, wind turbine nacelle assembly, and wind turbine blade finishing. Local unions that signed the MOU are the UBCJA (carpenters, divers, dock builders and piledrivers), LIUNA (laborers), IBEW (electricians), IUOE (operating engineers), ironworkers and union millwrights. The MOU is modeled after a National Construction Alliance (NCA) Agreement to which the trades mentioned above are already signed at an international level and are key contractors already doing offshore and in shore work associated with offshore wind development. The list of contactors on this agreement continues to grow, which signals the contractors support of this type of agreement.

Table 7.1-11 Total Direct Employment FTEs in New Jersey – Development and Construction Phase

NAICS 2-Digit Industry Sector	Percent	Project 1 FTE (1,510 MW)	Project 2 FTE (1,200 MW)
Sector 23: Construction	49.1%	3,655	2,905
Sector 31-33: Manufacturing	33.4%	2,485	1,975
Sector 54: Professional Services	9.6%	715	570
Sector 48-49: Transport. and Warehousing	7.3%	540	430
Sector 56: Administrative Management	0.6%	45	35
Sector 42: Wholesale Trade	0.1%	5	4
Total:	**100%**	**7,445**	**5,915**
NAICS 6-Digit Industry Classification	**Percent**	**Project 1 FTE (1,510 MW)**	**Project 2 FTE (1,200 MW)**
332312 - Fabricated Structural Steel	27.7%	2,065	1,640
237130 - Power lines and structures	24.5%	1,825	1,450
236210 - Industrial building construction	12.9%	960	765
237990 - Heavy and marine construction	11.7%	870	690
541330 - Engineering services	5.8%	430	340
333611 - Wind turbine services	5.5%	410	325
488310 - Port and harbor operations	4.8%	360	285
541611 - Professional management	3.8%	285	225
483211 - Offshore construction vessels	2.1%	160	125
561599 - Travel and accommodations	0.6%	45	35
484121 - Freight trucking	0.3%	25	20
336611 - Ship building and repairing	0.2%	15	10
423830 - Industrial equipment wholesalers	0.1%	5	4
Total:	**100%**	**7,445**	**5,915**

Source: IMPLAN modelling tool drawing from validated government and industry sources including the U.S. Bureau of Economic Analysis, the U.S. Census Bureau, and the Bureau of Labor Statistics. 2019.
Note: Full Time Equivalent (FTE) employment assuming full-time work of 35 hours a week (1,820 hours per year). The development and construction phase is anticipated to occur over a 10-year period (see Table 7.1-10 for additional information on the anticipated schedule of the Projects).

The Atlantic Shores union labor agreement is important for many reasons. It demonstrates its commitment to using union labor and employers wherever possible. It shows the company's strong commitment to training residents and trades people, and it also shows the unions' willingness to be creative partners in how we meet the growing needs of the industry. New Jersey is poised to be the leader in clean energy job creation, and the Projects demonstrate what good corporate partnership looks like in this new economy.

During the O&M phase Atlantic Shores will be directly hiring a range of trades skilled in offshore wind operations. These include a staff of technicians, engineers, and managers. Estimated direct job creation during the operations phase of the Projects is summarized in Table 7.1-12; estimates are provided in two sections including tabulation by 2-digit NAICS industry sector divisions and 6-digit NAICS codes. The operations phase is anticipated to be a 30-year period including the operations and maintenance of the constructed wind facility.[50] Over the entire 30-year period of the operations total employment is estimated for Project 1 and Project 2 at approximately 10,326 and 8,202 FTE jobs, respectively, or approximately 344 and 273 FTE jobs annually.

Wind turbine servicing (included in the manufacturing sector, NAICS Sectors 31-33) is estimated to create 58.8% of the total estimated direct jobs in the operation and decommissioning phases. Other important industries directly affected by the operations and decommissioning phases includes professional services (NAICS Sector 54) for engineering, environmental and other technical studies (13.1%), construction (NAICS Sector 23) for heavy marine installation and service to the operational turbines and foundations (11.3%), and port and harbor logistics (NAICS Sector 48-49) for the and crew transfer vessels and other harbor services (11.3%).

Table 7.1-12 Total Direct Employment FTEs in New Jersey – Operations Phase

NAICS 2-Digit Industry Sector	Percent	Project 1 FTE (1,510 MW)	Project 2 FTE (1,200 MW)
Sector 31-33: Manufacturing	58.8%	6,072	4,823
Sector 54: Professional Services	15.7%	1,621	1,288
Sector 23: Construction	14.5%	1,497	1,189
Sector 48-49: Transport. and Warehousing	9.2%	950	755
Sector 42: Wholesale Trade	1.8%	186	148
Total:	**100%**	**10,326**	**8,202**
NAICS 6-Digit Industry Classification	**Percent**	**Project 1 FTE (1,510 MW)**	**Project 2 FTE (1,200 MW)**
333611 - Wind turbine services	58.8%	6,072	4,823
541611 - Professional management	13.1%	1,353	1,074
237990 - Heavy and marine construction	11.3%	1,167	927
488310 - Port and harbor operations	9.0%	929	738
541330 - Engineering services	2.5%	258	205
237130 - Power lines and structures	1.7%	176	139
423930 - Recyclable material wholesalers	1.8%	186	148
236210 - Industrial building construction	1.4%	145	115
483211 - Offshore construction vessels	0.3%	31	25
325120 - Industrial Gas Manufacturing	0.1%	10	8
Total:	**100%**	**10,326**	**8,202**

Source: IMPLAN modelling tool drawing from validated government and industry sources including the U.S. Bureau of Economic Analysis, the U.S. Census Bureau, and the Bureau of Labor Statistics. 2019.
Note: Full Time Equivalent (FTE) employment assuming full-time work of 35 hours a week (1,820 hours per year). The operations phase is anticipated to occur over a 30-year period (see Table 7.1-10 for additional information on the anticipated schedule of the Projects).

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

Atlantic Shores will establish an O&M facility in Atlantic City, Atlantic County, New Jersey, that will support both Projects. The number of workers at the O&M facility will fluctuate seasonally and by contract phase and will be dependent on the final engineering design and service strategy.

The O&M facility will be built using the local workforce. Additional economic activity will be created for a wide range of subcontractors including some shipyards, spare part producers, and vessel and harbor services. Additional workforce may be required for planned periodic maintenance within the Offshore Project Area, including the export cables, and periodic maintenance and repairs to in-water and other Project components. Atlantic Shores expects that these jobs will be filled by New Jersey residents, with the existing local maritime and fishing industry supporting some vessel-related needs of the Projects.

During the decommissioning phase Atlantic Shores anticipates directly hiring a workforce similar to the composition of trades, technical, and management professionals as the construction workforce. Specific trade unions will include ironworkers, carpenters (e.g., pile drivers, dock builders, millwrights), operating engineers, laborers, and electricians. Estimated direct job creation during the decommissioning phase of the Projects is summarized in Table 7.1-13; estimates are provided in two sections including tabulation by 2-digit NAICS industry sector divisions and 6-digit NAICS codes. The decommissioning phase is a 3-year period following the completion of operations and includes the removal and proper disposal or recycling of all installed equipment. Over the 3-year decommissioning phase, total employment is estimated for Project 1 and Project 2 at approximately 779 and 618 FTE jobs, respectively, or approximately 260 and 206 FTE jobs annually.

Wind turbine decommissioning (included in the manufacturing sector, NAICS Sectors 31-33) is estimated to create 58.8% of the total estimated direct jobs in the decommissioning phase. Other important industries directly affected by the decommissioning phase include professional services (NAICS Sector 54) for engineering, environmental and other technical studies (13.1%), construction (NAICS Sector 23) for heavy marine installation and service to the operational turbines and foundations (11.3%), and port and harbor logistics (NAICS Sector 48-49) for the and crew transfer vessels and other harbor services (11.3%).

Table 7.1-13 Total Direct Employment FTEs in New Jersey – Decommissioning Phase

NAICS 2-Digit Industry Sector	Percent	Project 1 FTE (1,510 MW)	Project 2 FTE (1,200 MW)
Sector 31-33: Manufacturing	58.8%	458	364
Sector 54: Professional Services	15.7%	122	97
Sector 23: Construction	14.5%	113	90
Sector 48-49: Transport. and Warehousing	9.2%	72	57
Sector 42: Wholesale Trade	1.8%	14	11
Total:	**100%**	**779**	**618**
NAICS 6-Digit Industry Classification	**Percent**	**Project 1 FTE (1,510 MW)**	**Project 2 FTE (1,200 MW)**
333611 - Wind turbine services	58.8%	458	364
541611 - Professional management	13.1%	102	81
237990 - Heavy and marine construction	11.3%	88	70
488310 - Port and harbor operations	9.0%	70	56
541330 - Engineering services	2.5%	19	15
237130 - Power lines and structures	1.7%	13	11
423930 - Recyclable material wholesalers	1.8%	14	11
236210 - Industrial building construction	1.4%	11	9
483211 - Offshore construction vessels	0.3%	2	2
325120 - Industrial Gas Manufacturing	0.1%	1	1
Total:	**100%**	**779**	**618**

Source: IMPLAN modelling tool drawing from validated government and industry sources including the U.S. Bureau of Economic Analysis, the U.S. Census Bureau, and the Bureau of Labor Statistics. 2019.
Note: Full Time Equivalent (FTE) employment assuming full-time work of 35 hours a week (1,820 hours per year). The decommissioning phase is anticipated to occur over a 3-year period (see Table 7.1-10 for additional information on the anticipated schedule of the Projects).

Because of anticipated growth in the offshore wind industry over the 30-year lifecycle of the Projects a larger share of trained workers is likely to be available from the local workforce. Some highly specialized workforce needs during decommissioning may still require some temporary relocation and accommodation to the Project Region. The economic impacts of decommissioning, particularly in proximity to the ports, are expected to be similar and generally consistent with construction. Some local businesses involved in decommissioning may be different than used during construction, such as those specializing in large-scale recycling, sorting, and transportation of offshore wind construction and demolition materials and disposal.

In addition to direct jobs created in construction, manufacturing and professional services, indirect jobs are anticipated in other support services. The indirect jobs are primarily in management services, wholesale trade and transportation, but also include jobs within real estate, finance and insurance and other New Jersey industries that will benefit from increased economic activities.

A summary of estimated indirect job creation during each phase (i.e., development and construction, operations, and decommissioning) of the Projects is presented in Tables 7.1-14 through Table 7.1-16; results are tabulated by two-digit NAICS industry sector divisions. The management of companies and enterprises (NAICS Sector 55), which are activities that are typically provided in-house for the oversight of organizations, is estimated to provide 26.5% of all new indirect jobs. Other important industries indirectly impacted by the Projects include wholesale trade (NAICS Sector 42), transportation (NAICS Sectors 48-49), professional services (NAICS Sector 54), and manufacturing (NAICS Sectors 31-33).

Table 7.1-14 Total Indirect Employment FTEs – Development and Construction Phase

NAICS 2-Digit Industry Sector	Percent	Project 1 FTE (1,510 MW)	Project 2 FTE (1,200 MW)
Sector 55: Management	26.5%	1,045	831
Sector 42: Wholesale Trade	18.1%	714	567
Sector 48-49: Transportation	13.6%	537	426
Sector 54: Professional Services	9.4%	371	295
Sector 31-33: Manufacturing	6.1%	241	191
Sector 53: Real Estate	5.6%	221	176
Sector 52: Finance and Insurance	5.5%	217	172
Sector 92: Public Administration	3.1%	122	97
****Total:**	**100%**	**3,945**	**3,135**

Source: IMPLAN modelling tool drawing from validated government and industry sources including the U.S. Bureau of Economic Analysis, the U.S. Census Bureau, and the Bureau of Labor Statistics. 2019.

Note: Full Time Equivalent (FTE) employment assuming full-time work of 35 hours a week (1,820 hours per year). The development and construction phase is anticipated to occur over a 10-year period (see Table 7.1-10 for additional information on the anticipated schedule of the Projects). **Total of all FTE. For brevity, only top sectors are presented in the table.

Table 7.1-15 Total Indirect Employment FTEs – Operations Phase

NAICS 2-Digit Industry Sector	Percent	Project 1 FTE (1,510 MW)	Project 2 FTE (1,200 MW)
Sector 55: Management	26.5%	1,450	1,152
Sector 42: Wholesale Trade	18.1%	990	787
Sector 48-49: Transportation	13.6%	744	591
Sector 54: Professional Services	9.4%	514	409
Sector 31-33: Manufacturing	6.1%	334	265
Sector 53: Real Estate	5.6%	306	243
Sector 52: Finance and Insurance	5.5%	301	239
Sector 92: Public Administration	3.1%	170	135
****Total:**	**100%**	**5,472**	**4,348**

Source: IMPLAN modelling tool drawing from validated government and industry sources including the U.S. Bureau of Economic Analysis, the U.S. Census Bureau, and the Bureau of Labor Statistics. 2019.

Note: Job numbers are preliminary estimates only. Full Time Equivalent (FTE) employment assumes full-time work of 35 hours a week (1,820 hours per year). The operations phase is anticipated to occur over a 30-year period (see Table 7.1-10 for additional information on the anticipated schedule of the Projects). **Total of all FTE. For brevity, only top sectors are presented in the table.

Table 7.1-16 Total Indirect Employment FTEs – Decommissioning Phase

NAICS 2-Digit Industry Sector	Percent	Project 1 FTE (1,510 MW)	Project 2 FTE (1,200 MW)
Sector 55: Management	26.5%	109	87
Sector 42: Wholesale Trade	18.1%	75	59
Sector 48-49: Transportation	13.6%	56	45
Sector 54: Professional Services	9.4%	39	31
Sector 31-33: Manufacturing	6.1%	25	20
Sector 53: Real Estate	5.6%	23	18
Sector 52: Finance and Insurance	5.5%	23	18
Sector 92: Public Administration	3.1%	13	10
****Total:**	**100%**	**413**	**328**

Source: IMPLAN modelling tool drawing from validated government and industry sources including the U.S. Bureau of Economic Analysis, the U.S. Census Bureau, and the Bureau of Labor Statistics. 2019.
Note: Job numbers are preliminary estimates only. Full Time Equivalent (FTE) employment assumes full-time work of 35 hours a week (1,820 hours per year). The decommissioning phase is anticipated to occur over a 3-year period (see Table 7.1-10 for additional information on the anticipated schedule of the Projects). **Total of all FTE. For brevity, only top sectors are presented in the table.

Induced jobs, created by the expenditure of wages will be in sectors such as health care and social assistance, retail trade and accommodation and food services, which will also benefit from the thousands of jobs created during the Projects. Approximate induced job creation during each phase of the Projects is summarized in Table 7.1-17 through 7.1-19; are tabulated by two-digit NAICS industry sector divisions. The induced jobs are those created through increases of income to households, resulting in a more broad-based job development especially in those industries that serve individuals and families. Health care and social services (NAICS Sector 62), accounts for 21.4% of the new estimated induced jobs. Other important industries impacted by the induced effects of the Projects include retail trade (NAICS Sector 44-45), general services (NAICS Sectors 81), and accommodations and food services (NAICS Sector 72).

Table 7.1-17 Total Induced Employment FTEs – Development and Construction Phase

NAICS 2-Digit Industry Sector	Percent	Project 1 FTE (1,510 MW)	Project 2 FTE (1,200 MW)
Sector 62: Health Care and Social Assist.	21.4%	1,061	843
Sector 44-45: Retail Trade	14.8%	734	583
Sector 81: General Services	10.6%	525	418
Sector 72: Accommodation and Food Svcs.	9.5%	471	374
Sector 55: Management	8.8%	436	347
Sector 52: Finance and Insurance	7.9%	392	311
Sector 53: Real Estate	5.3%	263	209
Sector 48-49: Transportation	4.1%	203	162
Sector 61: Educational Services	3.9%	193	154
Sector 71: Arts and Recreation	3.3%	164	130
****Total:**	**100%**	**4,957**	**3,939**

Source: IMPLAN modelling tool drawing from validated government and industry sources including the U.S. Bureau of Economic Analysis, the U.S. Census Bureau, and the Bureau of Labor Statistics. 2019.
Notes: Full Time Equivalent (FTE) employment assuming full-time work of 35 hours a week (1,820 hours per year). The development and construction phase is anticipated to occur over a 10-year period (see Table 7.1-10 for additional information on the anticipated schedule of the Projects). *Percentages do not add to 100%. **Total of all FTE. For brevity, only top sectors are presented in the table.

Table 7.1-18 Total Induced Employment FTEs – Operations Phase

NAICS 2-Digit Industry Sector	Percent*	Project 1 FTE (1,510 MW)	Project 2 FTE (1,200 MW)
Sector 62: Health Care and Social Assist.	21.4%	1,471	1,169
Sector 44-45: Retail Trade	14.8%	1,017	809
Sector 81: General Services	10.6%	729	579
Sector 72: Accommodation and Food Svcs.	9.5%	653	519
Sector 55: Management	8.8%	605	481
Sector 52: Finance and Insurance	7.9%	543	432
Sector 53: Real Estate	5.3%	364	290
Sector 48-49: Transportation	4.1%	282	224
Sector 61: Educational Services	3.9%	268	213
Sector 71: Arts and Recreation	3.3%	227	180
****Total:**	**100%**	**6,875**	**5,464**

Source: IMPLAN modelling tool drawing from validated government and industry sources including the U.S. Bureau of Economic Analysis, the U.S. Census Bureau, and the Bureau of Labor Statistics. 2019.
Notes: Job numbers are preliminary estimates only. Full Time Equivalent (FTE) employment assuming full-time work of 35 hours a week (1,820 hours per year). The operations phase is anticipated to occur over a 30-year period (see Table 7.1-10 for additional information on the anticipated schedule of the Projects). *Percentages do not add to 100%. **Total of all FTE. For brevity, only top sectors are presented in the table.

Table 7.1-19 Total Induced Employment FTEs – Decommissioning Phase

NAICS 2-Digit Industry Sector	Percent*	Project 1 FTE (1,510 MW)	Project 2 FTE (1,200 MW)
Sector 62: Health Care and Social Assist.	21.4%	111	88
Sector 44-45: Retail Trade	14.8%	1,825	61
Sector 81: General Services	10.6%	1,305	44
Sector 72: Accommodation and Food Svcs.	9.5%	1,180	39
Sector 55: Management	8.8%	1,085	36
Sector 52: Finance and Insurance	7.9%	980	33
Sector 53: Real Estate	5.3%	655	22
Sector 48-49: Transportation	4.1%	510	17
Sector 61: Educational Services	3.9%	485	16
Sector 71: Arts and Recreation	3.3%	405	14
****Total:**	**100%**	**518**	**412**

Source: IMPLAN modelling tool drawing from validated government and industry sources including the U.S. Bureau of Economic Analysis, the U.S. Census Bureau, and the Bureau of Labor Statistics. 2019.
Notes: Job numbers are preliminary estimates only. Full Time Equivalent (FTE) employment assuming full-time work of 35 hours a week (1,820 hours per year). The decommissioning phase is anticipated to occur over a 3-year period (see Table 7.1-10 for additional information on the anticipated schedule of the Projects). *Percentages do not add to 100%. **Total of all FTE. For brevity, only top sectors are presented in the table.

Cross-industry occupation types (identified with its BLS Occupation Code) created through the direct impacts of the Projects are provided in Table 7.1-20. The table presents the average percentage of the total direct jobs created by the Projects for each occupation ("Percent"), the average hourly rate ("Avg. Rate"), the New Jersey wage percentile of the average hourly rate ("NJ PCTL"), and the Location Quotient ("LOC QE"). The average hourly rate is calculated by dividing the FTE-adjusted wages and salaries by the average estimated total hours worked by each occupation. The NJ PCTL is the hourly wage percentile of the average hourly rate for New Jersey by occupation as provided by the U.S. BLS.[51] As seen in Table 7.1-20, the specific occupations created by the Projects tend to provide above average wages and salaries in the 75th and 90th wage percentiles, indicating that the jobs created will generally pay more than expected wages and salaries for the broad occupation class. The LOC QE represents the ratio of an occupation's share of employment in each area to that occupation's share of employment in the United States as a whole. For example, an occupation that makes up 10% of employment in a specific metropolitan area compared with 2% of U.S. employment would have a location quotient of 5 for the area in question. The results presented in Table 7.1-20 indicate that many of the jobs to be created are currently at below national averages in New Jersey; therefore, the Projects have potential to increase opportunities for new employment in these sectors leading to new avenues for economic growth in the State.

51 May 2019 OES Estimates. Occupational Employment Statistics (OES) Survey. Bureau of Labor Statistics, Department of Labor. www.bls.gov/oes

Table 7.1-20 Cross-Industry Occupation Direct Impacts

BLS Occupation Code	Percent*	Avg. Rate	NJ PCTL	LOC QE
51-0000 Production	28.3%	$36.16	90 PCTL	0.68
47-0000 Construction and Extraction	15.9%	$33.03	50 PCTL	0.7
43-0000 Office and Administration	11.5%	$36.12	90 PCTL	1.05
17-0000 Architecture and Engineering	10.2%	$65.47	75 PCTL	0.72
11-0000 Management	7.2%	$91.19	90 PCTL	0.97
13-0000 Business and Financial	6.9%	$57.58	75 PCTL	1.1
53-0000 Transportation	6.6%	$36.33	90 PCTL	1.29
49-0000 Installation, Maintenance and Repair	5.5%	$38.20	75 PCTL	0.87
41-0000 Sales and Related	3.1%	$48.33	90 PCTL	1
15-0000 Computer	2.3%	$68.78	75 PCTL	1.14

Source: IMPLAN modelling tool drawing from validated government and industry sources including the U.S. Bureau of Economic Analysis, the U.S. Census Bureau, and the Bureau of Labor Statistics. 2019.
Notes: *Percentages do not add to 100%. For brevity, only the top results are presented in the table.

Estimated education needs for the occupations required by the Projects are summarized in Table 7.1-21. Over one third (38.93%) of the new jobs require only a high school diploma or equivalent (GED), indicating that the Projects provide new opportunities for people generally left behind in the job market, where a bachelor's degree or associate degree is often required as a minimum level of education.

Table 7.1-21 Cross-Industry Occupation Direct Impacts – Education Requirements

Description	Percent*
High School Diploma or equivalent (GED)	38.93%
Bachelor's Degree	15.69%
Post-Secondary Certificate	12.55%
Less than a High School Diploma	11.32%
Associate degree (or other 2-year degree)	7.48%
Some College Courses	7.25%
Master's Degree	3.60%
Post-Baccalaureate Certificate	1.32%

Source: IMPLAN modelling tool drawing from validated government and industry sources including the U.S. Bureau of Economic Analysis, the U.S. Census Bureau, and the Bureau of Labor Statistics. 2019. *Percentages do not add to 100%. For brevity, only the top results are presented in the table.

Estimated labor income and value-added impacts for each phase of the Projects are summarized in Tables 7.1-22 through 7.1-24. Labor income represents the total value of all forms of employment income paid throughout each phase of the Projects. Labor income reflects the sum of employee compensation (i.e., wages and benefits) and proprietor income (i.e., payments received by self-employed individuals and/or unincorporated business owners). Value added represents the difference between project output and the cost of intermediate project inputs throughout each phase of the Projects. In other words, it is the Projects' contribution to GDP. Overall, the Projects are expected to create significant ripple effects in the New Jersey economy throughout its lifetime, contributing a total of $2.3 billion in labor income and $3.2 billion in value added.

Table 7.1-22 Economic Impact Measures: Direct Value Added & Labor Income

	Project 1 FTE (1,510 MW) ($ Million)		Project 2 FTE (1,200 MW) ($ Million)	
Phase	**Labor Income**	**Value Added**	**Labor Income**	**Value Added**
Development	$98.61	$131.69	$78.36	$104.65
Construction	$267.89	$375.41	$212.89	$298.34
Operations	$263.34	$351.80	$209.28	$279.58
Decommissioning	$3.79	$4.68	$3.01	$3.72
Total	**$633.63**	**$863.57**	**$503.54**	**$686.28**

Notes: Source: IMPLAN modelling tool drawing from validated government and industry sources including the U.S. Bureau of Economic Analysis, the U.S. Census Bureau, and the Bureau of Labor Statistics. 2019.

Table 7.1-23 Economic Impact Measures: Indirect Value Added & Labor Income

	Project 1 FTE (1,510 MW) ($ Million)		Project 2 FTE (1,200 MW) ($ Million)	
Phase	**Labor Income**	**Value Added**	**Labor Income**	**Value Added**
Development	$50.01	$66.78	$39.74	$53.07
Construction	$135.85	$190.37	$107.96	$151.29
Operations	$133.55	$178.40	$106.13	$141.78
Decommissioning	$1.92	$2.37	$1.53	$1.89
Total	**$321.32**	**$437.93**	**$255.35**	**$348.02**

Source: IMPLAN modelling tool drawing from validated government and industry sources including the U.S. Bureau of Economic Analysis, the U.S. Census Bureau, and the Bureau of Labor Statistics. 2019.

Table 7.1-24 Economic Impact Measures: Induced Value Added & Labor Income

	Project 1 FTE (1,510 MW) ($ Million)		Project 2 FTE (1,200 MW) ($ Million)	
Phase	**Labor Income**	**Value Added**	**Labor Income**	**Value Added**
Development	$54.99	$73.43	$43.70	$58.36
Construction	$149.38	$209.34	$118.72	$166.36
Operations	$146.85	$196.17	$116.70	$155.90
Decommissioning	$2.11	$2.61	$1.68	$2.07
Total	**$353.33**	**$481.55**	**$280.79**	**$382.69**

Source: IMPLAN modelling tool drawing from validated government and industry sources including the U.S. Bureau of Economic Analysis, the U.S. Census Bureau, and the Bureau of Labor Statistics. 2019.

7.1.2.3 Procurement of Certain Construction or Maintenance Materials

To the extent practicable, construction materials and other supplies, including vessel provisioning and servicing, and certain fabrication and assembly work, will be sourced from within the Project Region. Suppliers will be selected based on their expertise in the industry, their track record, financial strength, and ability to deliver viable products within the targeted schedule, and their current presence or plans for localizing activities in New Jersey. This IPF section focuses on the direct effect that procurement of certain construction or maintenance materials will have on local communities during the construction, O&M, and decommissioning.

Impacts associated with materials sourcing are anticipated to have a stimulating effect of the Project Region’s economy. Atlantic Shores will procure construction and maintenance materials and services through commitments with local suppliers (e.g., foundation fabrication and assembly, wind turbine nacelle assembly, and building portions of O&M vessels).

The O&M phase of the Projects will require the purchase and use of machinery and equipment that will be necessary for the planned O&M facility such as office and training space, shop space, and warehouse space. Procurement of certain construction services to build the O&M facility and equipment and furniture to staff it will come from local suppliers in proximity to the facility. Over the life of the Projects’ long-term procurement for preventive maintenance of onshore and offshore facilities will also require accessing local suppliers to the maximum extent practicable. It is assumed that some highly specialized equipment or parts may need to be acquired outside of New Jersey during the 30-year lifecycle.

7.1.2.4 Vessel Charters

This IPF section focuses on the direct effect that utilization of vessel charters will have on local communities during the development, construction, O&M, and decommissioning. Offshore construction will utilize vessels from in-State, other U.S.-flagged vessels, and a limited number of foreign vessels where U.S. vessels do not exist or are unavailable. The Projects require the transport of crew transfer vessels (CTVs), from ports and staging areas onshore to the Projects for pre-construction studies and surveys, and during construction. Atlantic Shores will use local charters for transporting some survey, construction, and installation workers as well as for transportation of equipment and materials as available and depending on the transport capacity of local contractors, equipment and material manufacturers, and product suppliers.

During the O&M and decommissioning phases of the Projects it is anticipated that Atlantic Shores will continue using local providers to provide support services, fuel, storage space. Additional opportunities for area marine services including tug and other vessel charters, dockage, fueling, inspection/repairs, and other port and harbor services are also anticipated as part of routine O&M procedures.

7.1.2.5 Port Utilization

Atlantic Shores will maximize use of local New Jersey ports during construction of the Projects. Atlantic Shores will contribute to making the region a hub for offshore wind by using and developing ports across New Jersey, especially the New Jersey Wind Port, Atlantic City Harbor, and Paulsboro, but also other regional ports as summarized in Table 4.10-2 of Volume I. This IPF section focuses on the effects to local communities from port utilization during construction, O&M, and decommissioning. Representative ports that may be utilized during the Projects are described in Table 7.1-25.

Table 7.1-25 Utilization of Representative Ports

Port	Location	Anticipated Utilization
New Jersey Wind Port	Salem County, New Jersey	Will play a key role as the Projects' onshore staging area, marshalling activities, and as a major fabrication center for Project components. Construction activities will provide job opportunities within the marine trades and offshore wind-affiliated industries, particularly those influenced by seasonal hiring. Opportunities for marine trades include tug and other vessel charters, dockage, fuelling, inspection/repairs, provisioning, and crew work. This port will service wind projects across the entire Eastern seaboard once the port is in operation
Repauno Port & Rail Terminal	Gloucester County, New Jersey	Atlantic Shores may use this port temporarily during project construction, only as an alternative site if needed. Repauno Port & Rail Terminal (Repauno) features a new multi-purpose dock with an approximately 40-ft (12-m) draft capable of handling a wide variety of products.

Table 7.1-25 Utilization of Representative Ports (continued)

Port	Location	Anticipated Utilization
Port of Paulsboro	Gloucester County, New Jersey	Paulsboro will serve as the foundation manufacturing center for Atlantic Shores. Atlantic Shores is supporting the expanded growth of the EEW facilities allowing for supply of steel plates and other components, manufacturing of foundation components, staging, and transport from the port to offshore wind sites.
Atlantic City Harbor	Atlantic County, New Jersey	Atlantic Shores will build a brand-new facility using existing docks in the harbor to host its O&M personnel, for storage of equipment, tools, spare parts, and consumables, and dock service vessels.
		Atlantic City is the closest harbor to the Lease Area OCS-A 0499 (Lease Area) and thereby, minimizes costs and environmental impact of vessel activities.

During the O&M phase of the Projects, Atlantic Shores will continue using ports within New Jersey, in particular the New Jersey Wind Port, Atlantic City Harbor, and Paulsboro, but also smaller harbors as needed. Atlantic City Harbor will host the Projects' O&M facility. During decommissioning, it is expected that all Project components will be transported from their installation location to the selected port. Components will be unloaded by crane to onshore transport vehicles and sent to predetermined storage or disposal locations.

7.1.2.6 Housing

This IPF section focuses on the direct effect that availability of housing will have on local communities during the construction, O&M, and decommissioning. Most Project-related activities are anticipated to have location-specific housing effects on local communities during construction, O&M, and decommissioning.

Overall, the Projects will provide benefits to local economies and industries by sourcing certain materials locally from within the Project Region whenever practicable. Because Atlantic Shores places emphasis on local hiring and use of local suppliers it is expected that any increase in housing demand will be limited to neighborhoods and areas close to port locations and housing demand for the Projects will be absorbed by local housing markets. The small number of personnel that may relocate to the Project Region on a permanent basis is not anticipated to affect the availability of housing accommodations at any point of a given year.

7.1.2.7 Temporary Accommodations

This IPF section focuses on the direct effect that availability of temporary (housing) accommodations will have on local communities during the construction, O&M, and decommissioning. Atlantic City is heavily influenced by seasonal tourism within the Project Region, suggesting that short-term Project-related effects on temporary housing or lodging near ports during the peak tourism season, if any, would mostly occur in Atlantic County.

Onshore construction will be planned to minimize effects to the Project Region during the summer tourist season (Memorial Day through Labor Day). In other locations, such as Salem County and Gloucester County, seasonal use is a much lower percentage of all housing and housing units for rent or sale would be more available for short- or long-term use. When lodging demand declines, for example during the off-season for tourism, the Projects may provide additional economic benefits to the local communities by replacing tourism demand with temporary Project demand for accommodations. This may include house, hotel, and motel rentals.

Once the Projects are operational the need for any temporary housing accommodations will be greatly reduced and dependent upon any need for temporary housing skilled technicians or other trades that are not available from local workforce. This is not anticipated to affect local housing demand for temporary accommodations such as hotels and motels.

The need for temporary accommodations during decommissioning is anticipated to be similar to what will be needed during construction.

7.1.2.8 Summary of Proposed Environmental Protection Measures

The majority of potential effects to demographics, employment, and economics are expected to be temporary and localized as described in the previous sections. Potential socioeconomic effects from offshore wind energy projects predominantly result from construction activities. However, these effects are temporary. Atlantic Shores has already taken preliminary steps to maximize the positive economic benefits of the Projects. Positive economic effects are expected to outlast any potentially negative economic effects over the life of the Projects. Negative effects will be minimized by consulting with stakeholders to identify potential issues, thoroughly investigating them, and devising strategies to avoid or minimize adverse effects. Beneficial effects spurred by the construction and O&M of the Projects include job creation and economic stimulus to the Project Region. Onshore construction will be planned to minimize direct effects to the Project Region during the summer tourist season, and it is anticipated that any housing demand created by workers supporting the Projects would be absorbed by the local market. Socioeconomic effects and benefits, where they occur, are expected to be concentrated in proximity to the ports hosting Project-related activities. The following provides a summary of proposed minimization and mitigation measures that Atlantic Shores will implement to maximize the positive economic benefits within the Project Region:

- Atlantic Shores conducted an IMPLAN economic impact analysis model to estimate both Projects' New Jersey workforce numbers.
- An O&M facility will be established in Atlantic City, New Jersey, to be staffed primarily with local workers.
- A diverse and local workforce will be hired (recruited from local training programs).
- Workforce initiatives will be established that will support minority and low-income populations, minority and women-owned business enterprises (MWBE), veterans, and underserved communities and participate in local chambers of commerce.
- Atlantic Shores will participate in multiple local chambers of commerce supporting minority groups.
- Construction materials and other supplies will, to the extent possible and practical, be locally sourced, including vessel provisioning and servicing, and certain fabrication and assembly work.
- Vessels from in-State and other U.S.-flagged vessels will be used to the maximum extent practicable.
- Onshore construction will be scheduled to occur outside of summer tourist season (Memorial Day through Labor Day) and in accordance with local noise ordinances.
- Local ports will be used to the maximum extent practicable.

7.2 Environmental Justice

This section describes the characteristics of environmental justice (EJ) and Disadvantaged communities within the Atlantic Shores Project Region (Project Region) and evaluates impact producing factors (IPFs) and whether EJ Communities and Disadvantaged Communities will bear any disproportionately high or adverse impacts resulting from construction, operations and maintenance (O&M), and decommissioning as well as whether EJ communities and Disadvantaged Communities will receive disproportionately low benefits from the Projects.

For purposes of the assessment of environmental justice, the Project Region is the geographic area that encompasses those EJ Communities and Disadvantaged communities and resources that could be affected by construction, operation, and decommissioning of the Projects. As discussed in Section 7.1 Demographics, Employment, and Economics, the Project Region is well prepared for coastal maritime construction projects with plentiful port infrastructure and robust and available work force that will be drawn upon to fill the employment needs of the Projects. It is not anticipated that new housing or transportation infrastructure will be required to construct and operate the Projects. Construction activities will occur offshore in the export cable corridors (ECC) and the Wind Turbine Area (WTA). Onshore, construction activities will be concentrated at the landfall sites, onshore interconnection cables, and onshore substations and/or converter stations. Ports will serve as mustering points for offshore labor forces and staging areas for project components both during construction and O&M phases. See Table 4.10-2 of Volume I for a full list of ports that may be used during construction. The representative ports evaluated in this section have been identified by Atlantic Shores and its contractors to support significant construction and O&M activities associated with the Projects. The Projects will be supported by a new O&M facility in Atlantic City (see Section 5.5 of Volume I). Other ports in New Jersey may also be used to support project O&M needs. Finally, the analysis in this section also includes counties within the zone of visual influence, or digital surface model viewshed, of the Lease Area. For more information on visual resources, see Section 5.0.

7.2.1 Environmental Justice Community Identification

For the purposes of this analysis, EJ Communities are defined by the New Jersey definitions in accordance with BOEM's recently released Summary Environmental Justice Section of the Annotated EIS Outline Interim Process for Community Identification for Offshore Wind in the Atlantic. These definitions meet the federal definition and exceed it by including more communities based on lower percentage thresholds. The New Jersey thresholds of poverty exceed federal thresholds. A complete analysis of the federal USEPA definition compared to the State of New Jersey definitions is found in Appendix II-V1.

An additional consideration for identifying EJ Communities is the historic presence of Native American nations on the lands within the Project Region, according to BOEM's recently released Summary Environmental Justice Section of the Annotated EIS Outline Interim Process for Community Identification for Offshore Wind in the Atlantic. While individuals belonging to these nations may not be actively residing in the local community, they may still have a vested interest in the area. A summary of correspondence with stakeholders, including representatives of these Native American nations is provided in Appendix I-B Stakeholder Engagement.

7.2.2 Disadvantaged Community Identification

In accordance with BOEM's recently released Summary Environmental Justice Section of the Annotated EIS Outline Interim Process for Community Identification for Offshore Wind in the Atlantic, this analysis also considers Disadvantaged Communities. This analysis pulls from the Federal Definition outlined in the recent Executive Order 14008 Tackling the Climate Crisis at Home and Abroad (2021). A complete analysis of the federal definition of Disadvantaged Communities is provided in Appendix II-V1.

7.2.3 Affected Environment

This assessment of environmental justice encompasses the Project Region and focuses on locations where potential impacts resulting from construction, O&M, and decommissioning activities may occur. Counties within the zone of visual influence, or digital surface model viewshed, of the WTA are also included in this analysis. Population and demographic data used in the EJ assessment was obtained from the Census Bureau and the EPA's Environmental Justice Screening and Mapping Tool (v2017), as well as information provided by State authorities. Data used in the Disadvantaged Communities assessment was obtained from Climate and Economic Justice Screening Tool (released February 18, 2022).

Table 7.2-1 identifies EJ Communities and Disadvantaged Communities in the Project Region based on Federal and State EJ and Disadvantaged Communities indicators and thresholds, specifically the number of EJ Communities census blocks and Disadvantaged Communities census tracts. Figures 7.2-1 (Sheets 1 -16) and Figures 7.2-2 (Sheets 1-16) provide maps of EJ census block groups and Disadvantaged Communities census tracts within each county of the Project Region along with the onshore project components and representatives ports. Figures 7.2-1 (Sheets 1 and 2) show EJ census blocks and Disadvantaged Communities census tracts within Lease Area's the zone of visual influence. Figures 7.2-1 and 7.2-2 are provided in Appendix II-V2.

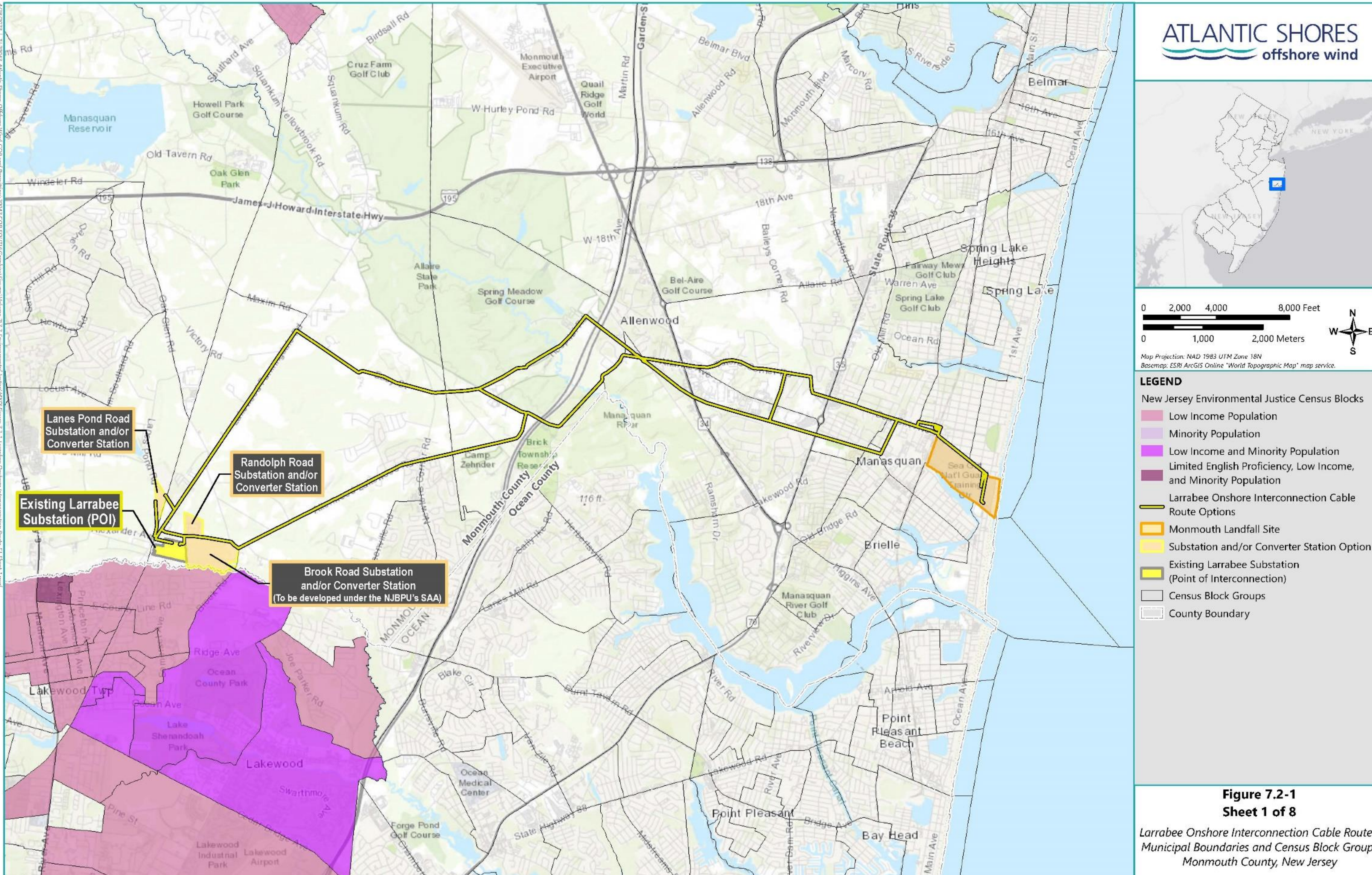


Figure 7.2-1
Sheet 1 of 8

Larrabee Onshore Interconnection Cable Route - Municipal Boundaries and Census Block Groups Monmouth County, New Jersey

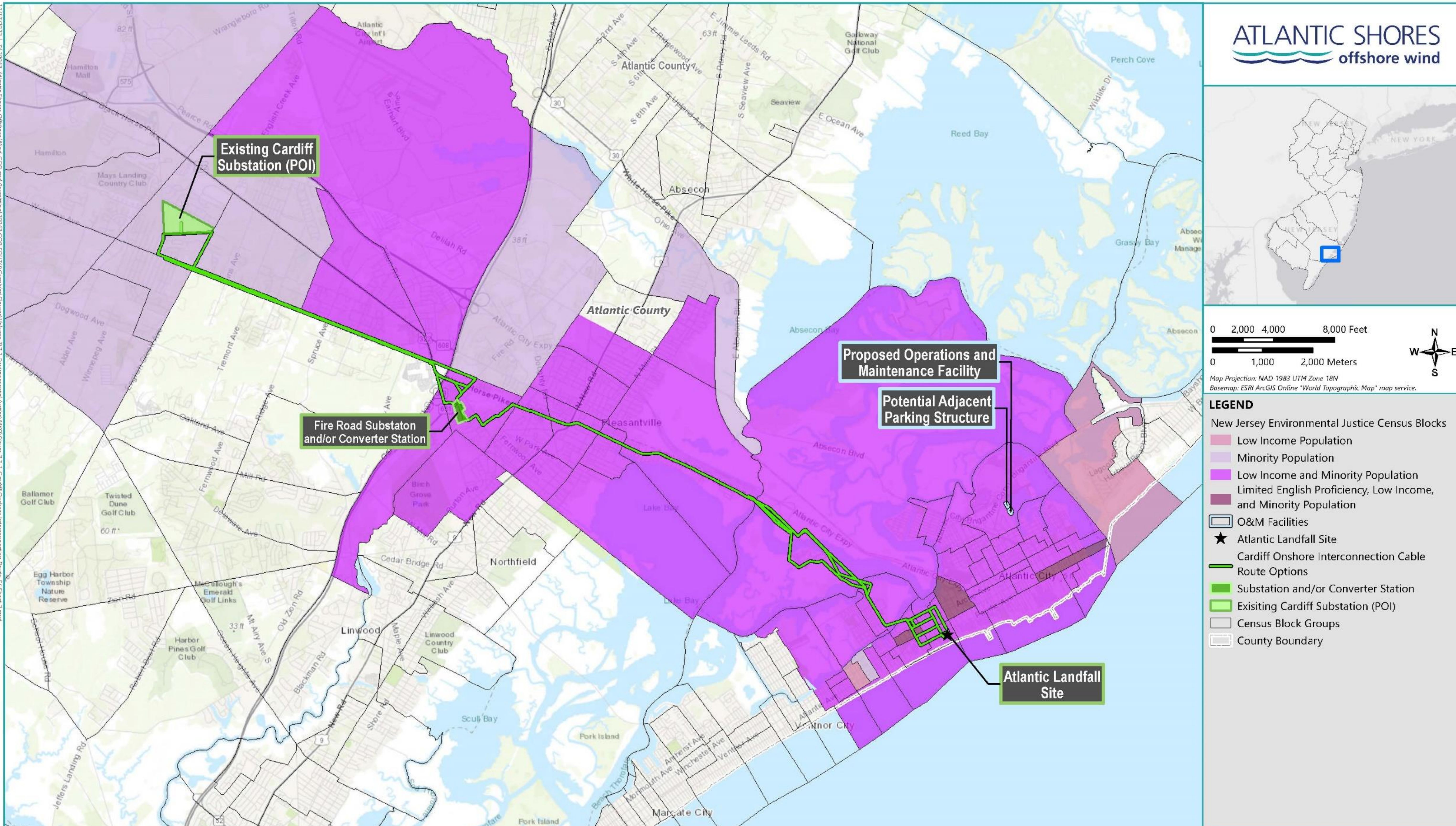
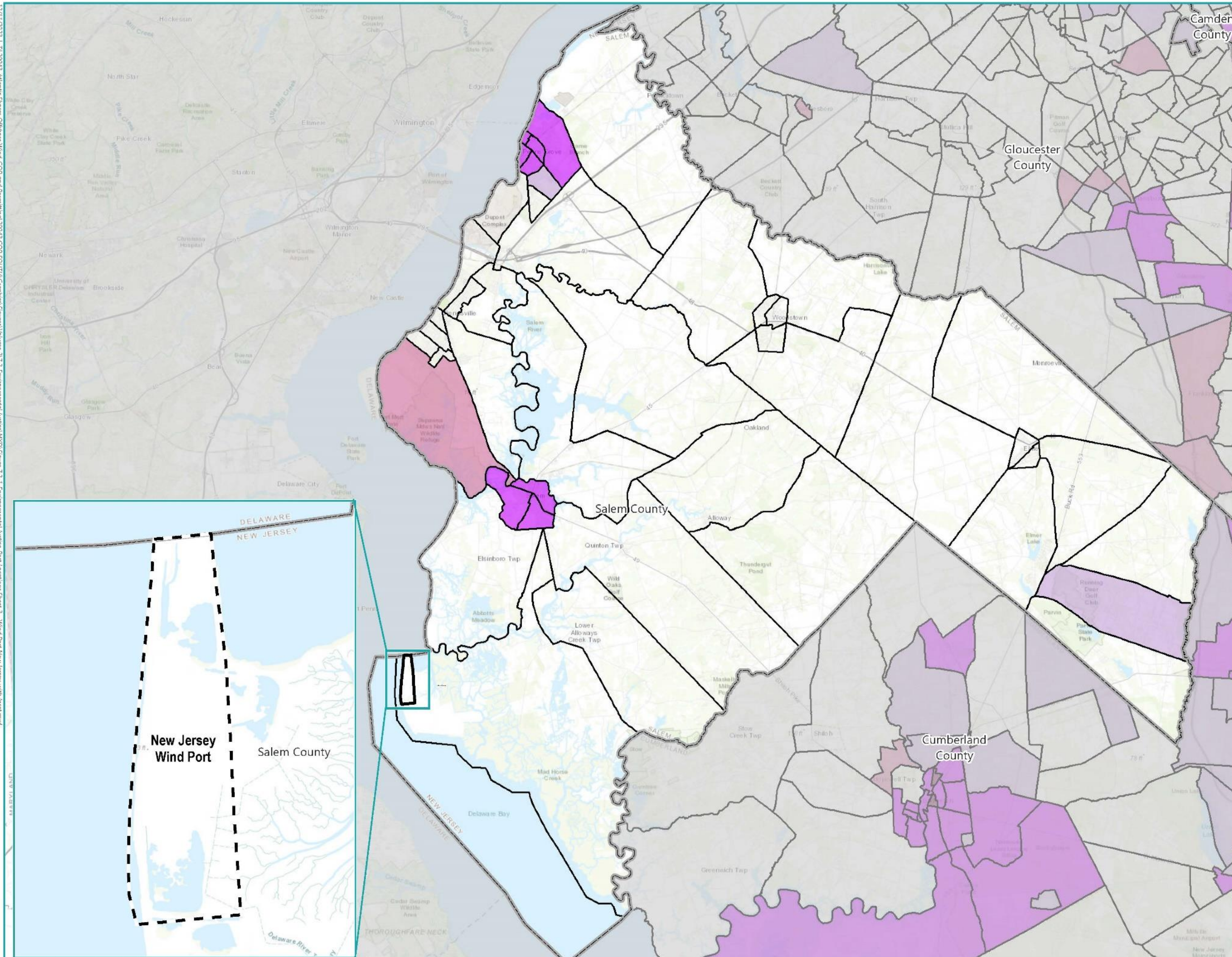


Figure 7.2-1
Sheet 2 of 8

Cardiff Onshore Interconnection Cable Route - Municipal Boundaries and Census Block Groups Atlantic County, New Jersey

12/12/2023 | T:\20043 Atlantic Shores Offshore Wind_COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\7.2_Environmental Justice\MXD\Figure 7.2-1_Cardiff Onshore Interconnection Route_EJ_Sheet 2.mxd



ATLANTIC SHORES offshore wind

0 5,000 10,000 20,000 Feet

0 2,000 4,000 Meters

Map Projection: NAD 1983 UTM Zone 18N
Basemap: ESRI ArcGIS Online "World Topographic Map" map service.

LEGEND

- Port Parcel
- Census Block Group
- New Jersey Environmental Justice Area
  - Low Income Population
  - Minority Population
  - Low Income and Minority Population
  - Limited English Proficiency, Low Income,
- County Boundary

Note: For Environmental Justice demographic for group definitions and thresholds, see Section 2.7.1 Environmental Justice.

Figure 7.2-1
Sheet 3 of 8
Environmental Justice Area
New Jersey Wind Port
Lower Alloways Creek Township, Salem County
New Jersey

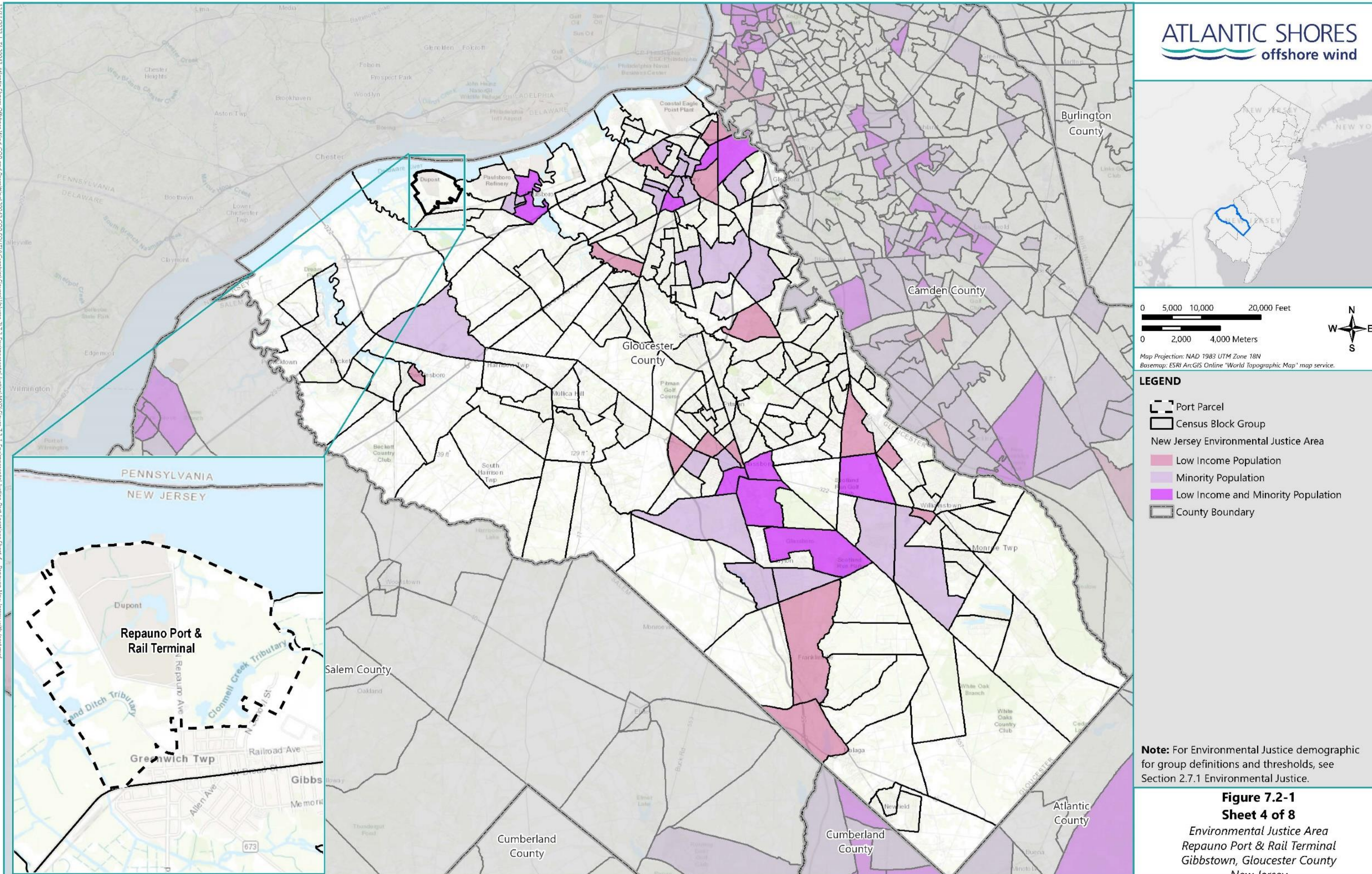
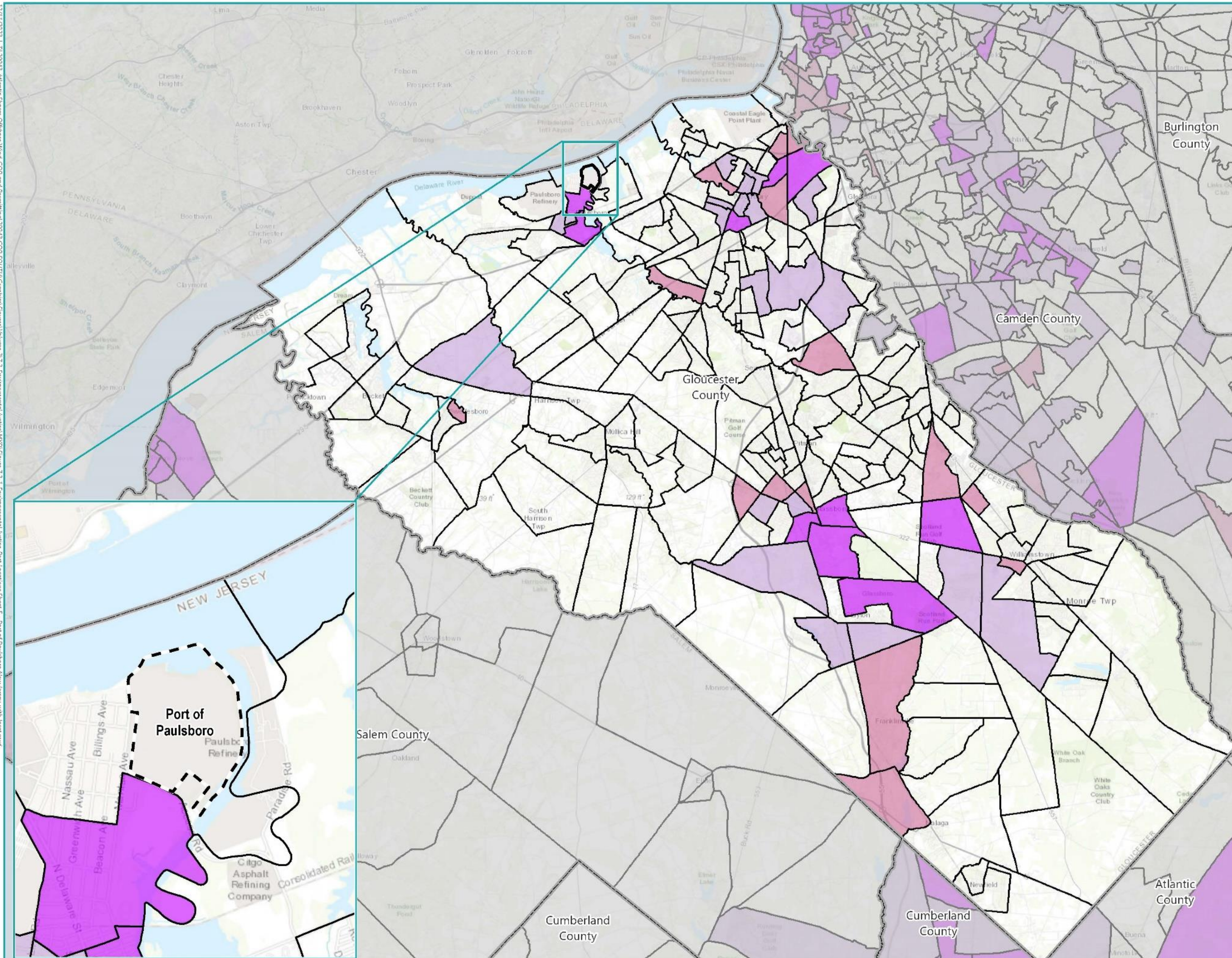


Figure 7.2-1
Sheet 4 of 8
Environmental Justice Area
Repauno Port & Rail Terminal
Gibbstown, Gloucester County
New Jersey



ATLANTIC SHORES offshore wind

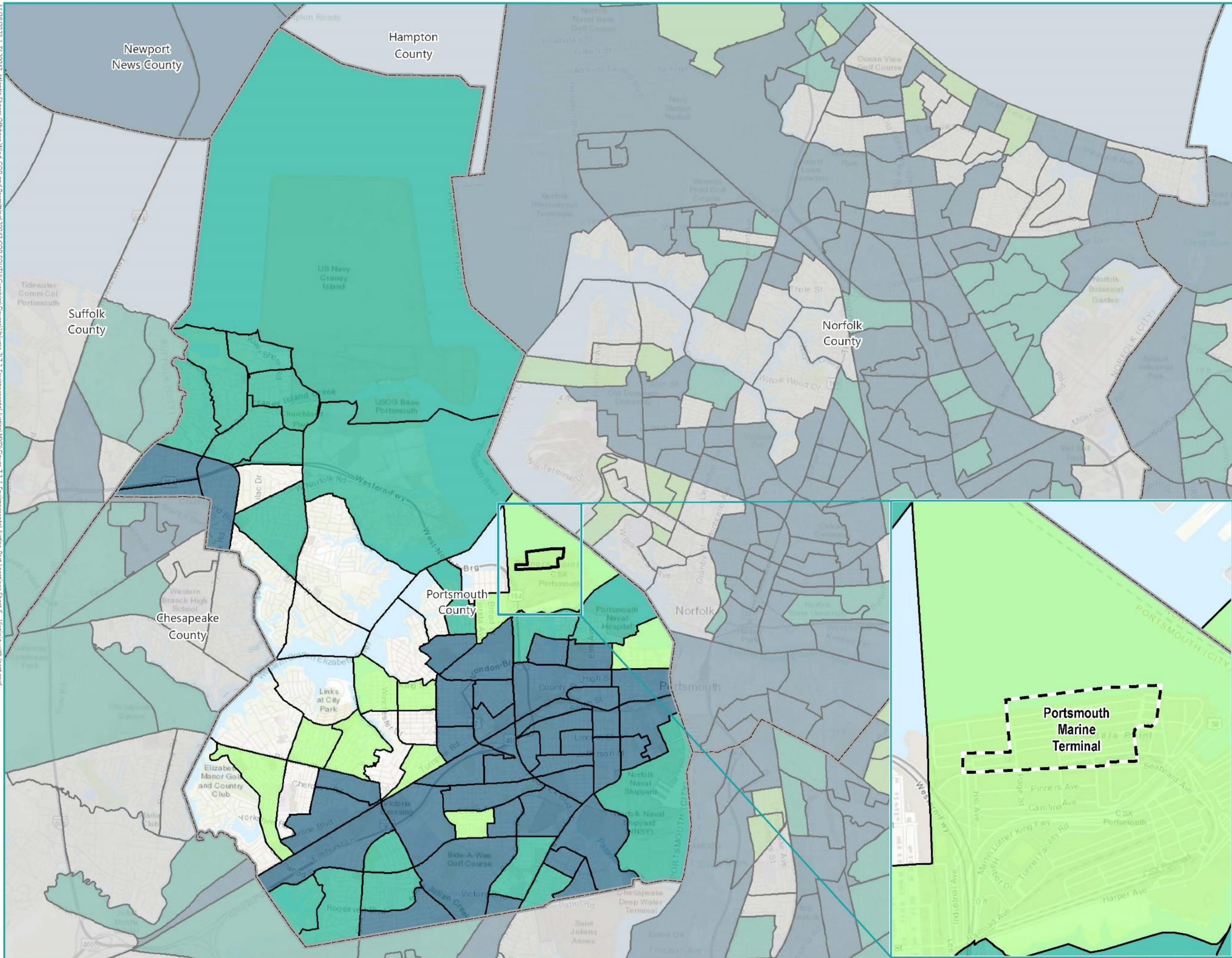
Map Projection: NAD 1983 UTM Zone 18N
Basemap: ESRI ArcGIS Online "World Topographic Map" map service.

LEGEND

- Port Parcel
- Census Block Group
- New Jersey Environmental Justice Area
  - Low Income Population
  - Minority Population
  - Low Income and Minority Population
- County Boundary

Note: For Environmental Justice demographic for group definitions and thresholds, see Section 2.7.1 Environmental Justice.

Figure 7.2-1
Sheet 5 of 8
Environmental Justice Area
Paulsboro Marine Terminal
Paulsboro Township, Gloucester County
New Jersey



ATLANTIC SHORES offshore wind

0 2,500 5,000 10,000 Feet

0 1,000 2,000 Meters

Map Projection: NAD 1983 UTM Zone 18N

Basemap: ESRI ArcGIS Online "World Topographic Map" map service.

LEGEND

- Port Parcel
- Census Block Group

Virginia Environmental Justice Area

- Low Income Population
- Minority Population
- Low Income and Minority Population
- County Boundary

Note: For Environmental Justice demographic for group definitions and thresholds, see Section 2.7.1 Environmental Justice.

Figure 7.2-1

Sheet 6 of 8

Environmental Justice Area
Portsmouth Marine Terminal
City of Portsmouth, Portsmouth County
Virginia

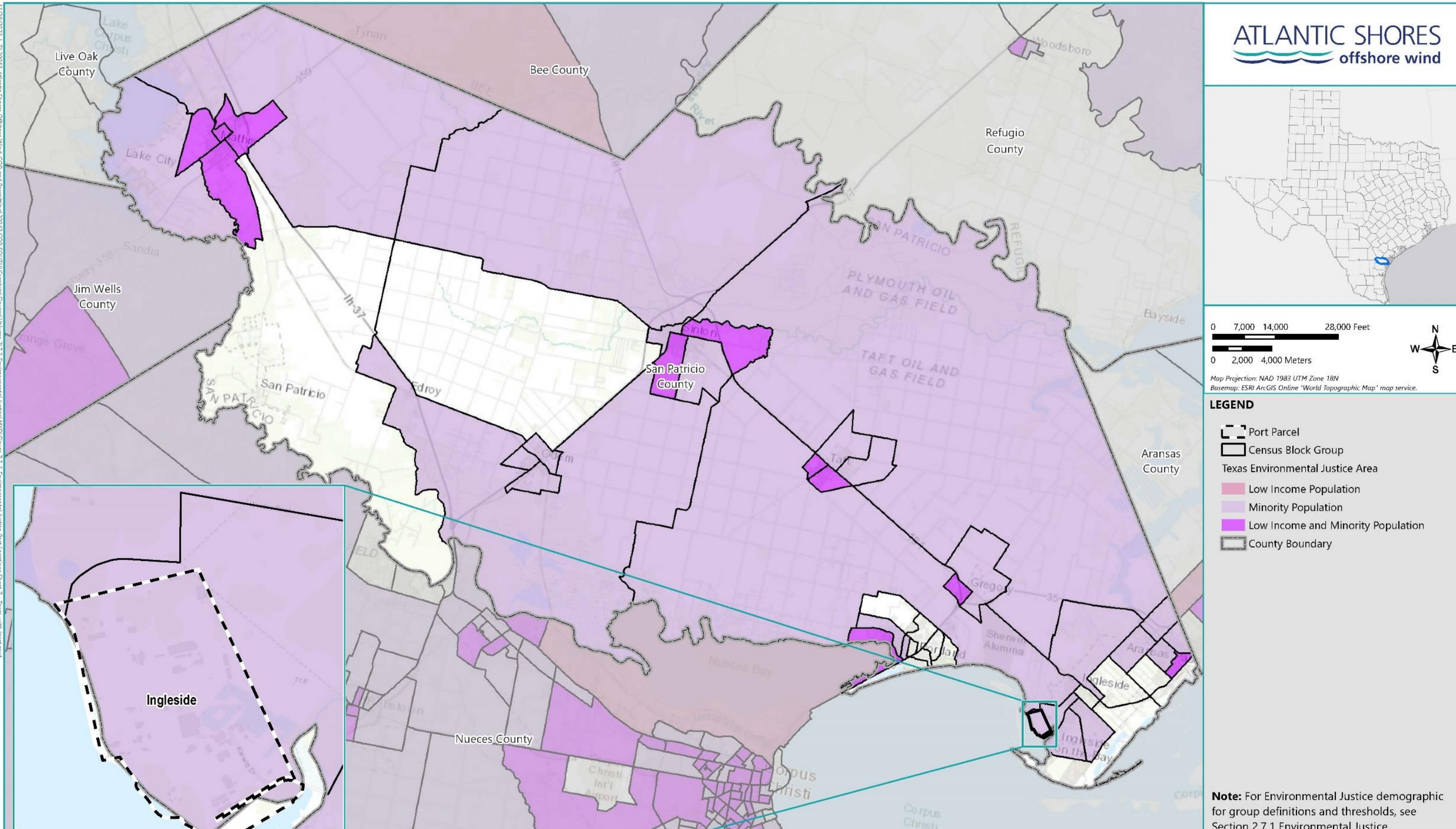


Figure 7.2-1
Sheet 7 of 8
Environmental Justice Area
Kiewitt (Ingleside, TX)
City of Ingleside, San Patricio County
Texas

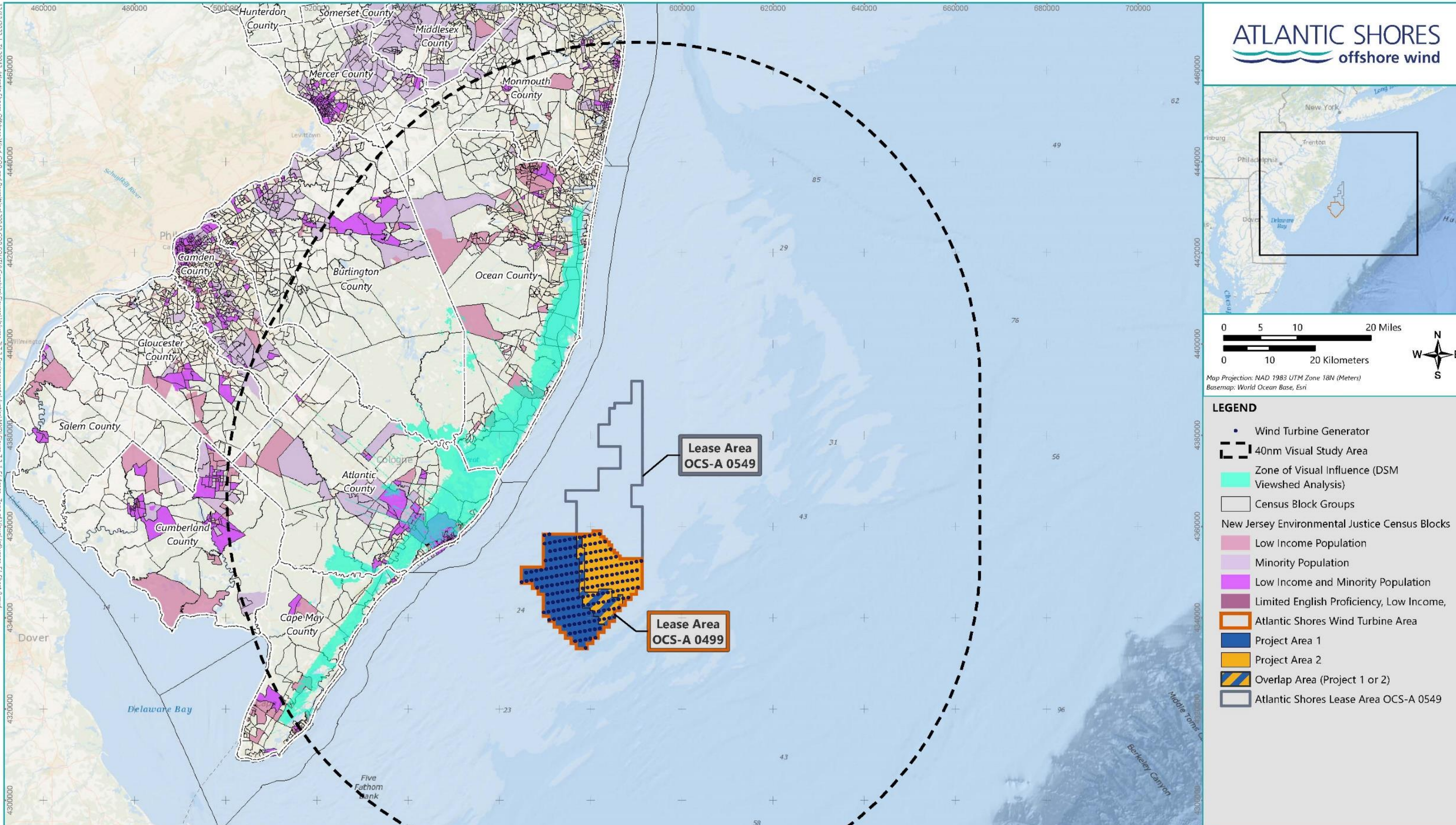


Figure 7.2-1
Sheet 8 of 8

Environmental Justice Census Block Groups Atlantic Shores Offshore Wind Zone of Visual Influence

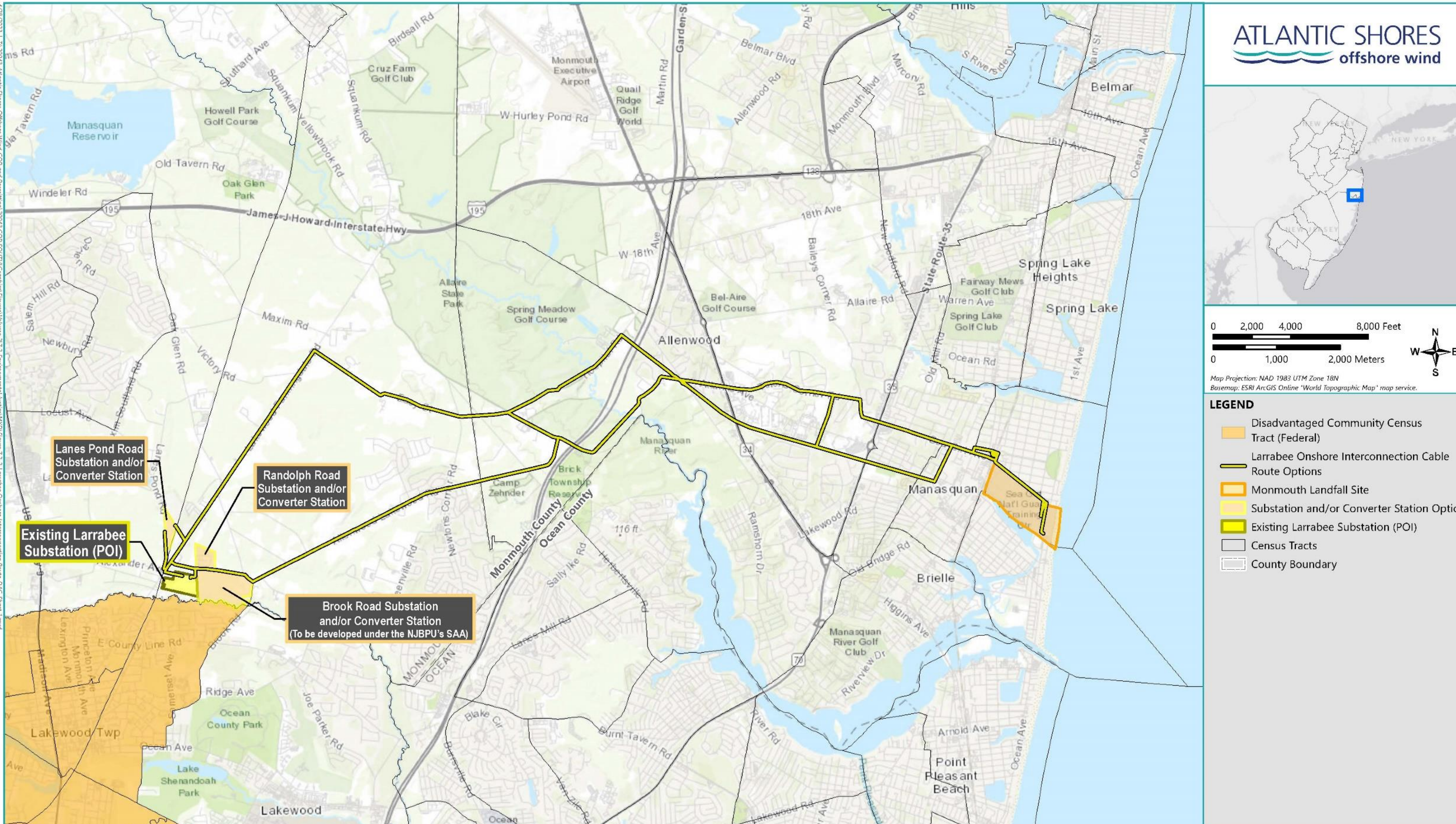


Figure 7.2-2
Sheet 1 of 8

Larrabee Onshore Interconnection Cable Route - Municipal Boundaries and Census Tracts Monmouth County, New Jersey

4/28/2023 | T:\20043 Atlantic Shores Offshore Wind COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\7.2 Environmental Justice\MXD\Figure 7.2-2 Larrabee Onshore Interconnection Route DAC Sheet 1.mxd

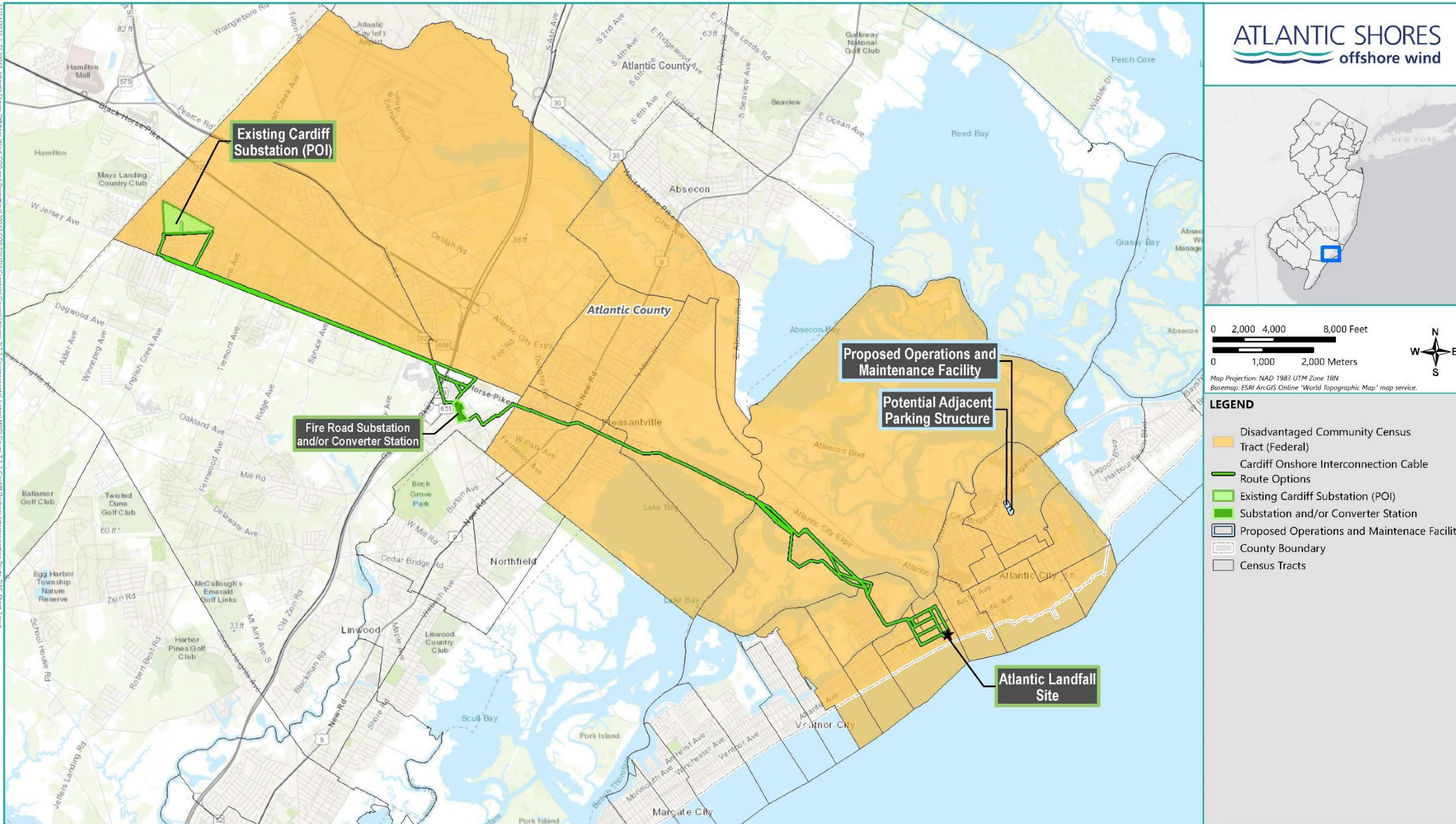


Figure 7.2-2
Sheet 2 of 8

Cardiff Onshore Interconnection Cable Route - Municipal Boundaries and Census Tracts Atlantic County, New Jersey

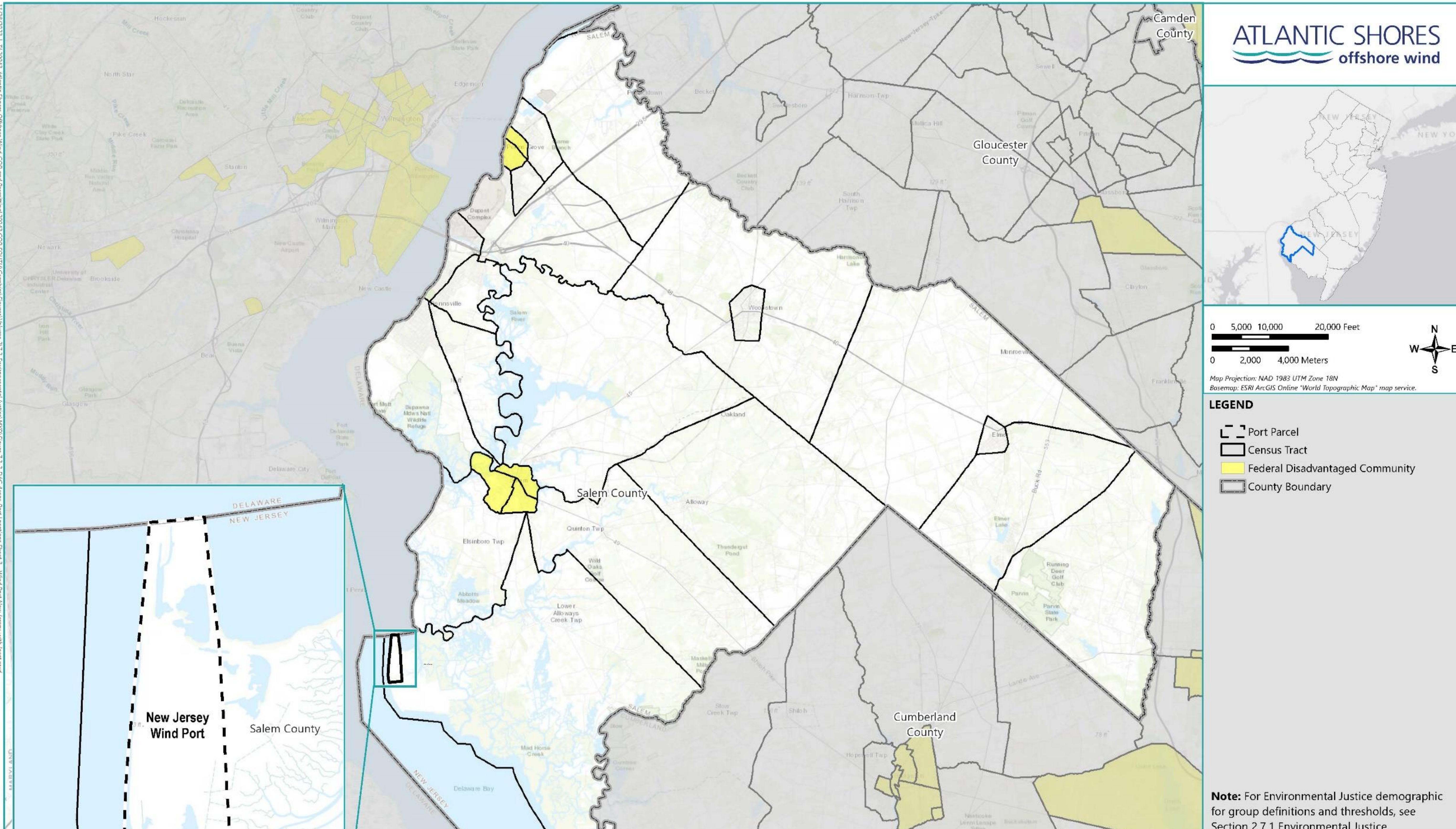
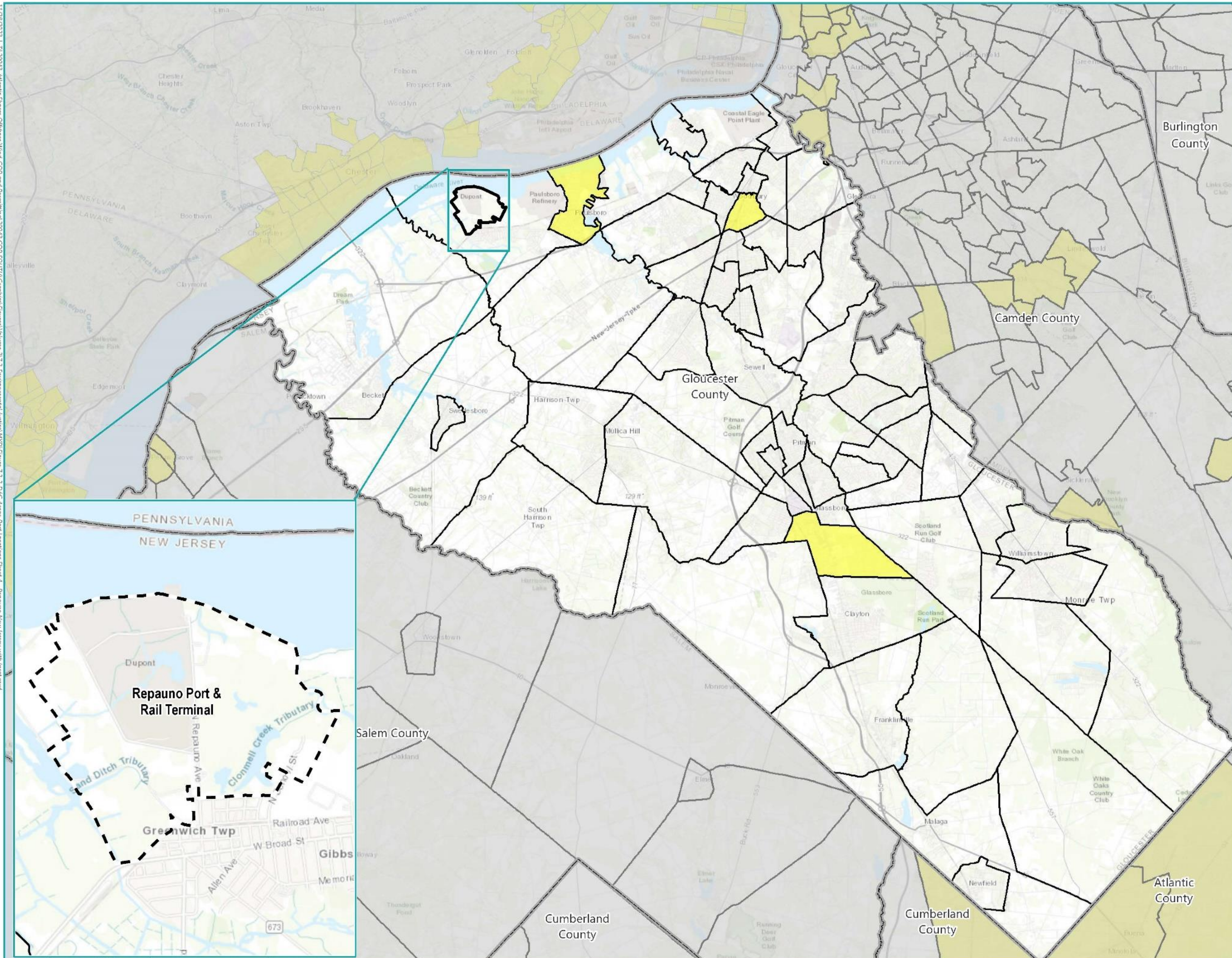


Figure 7.2-2
Sheet 3 of 8
Disadvantaged Communities
New Jersey Wind Port
Lower Alloways Creek Township, Salem County
New Jersey

11/28/2023 | T:\20043 Atlantic Shores Offshore Wind COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\7.2 Environmental Justice\MXD\Figure 7.2-2 DAC Areas Port Locations Sheet 3 - Wind Port New Jersey, with Inset.mxd



ATLANTIC SHORES offshore wind

0 5,000 10,000 20,000 Feet

0 2,000 4,000 Meters

Map Projection: NAD 1983 UTM Zone 18N
Basemap: ESRI ArcGIS Online "World Topographic Map" map service.

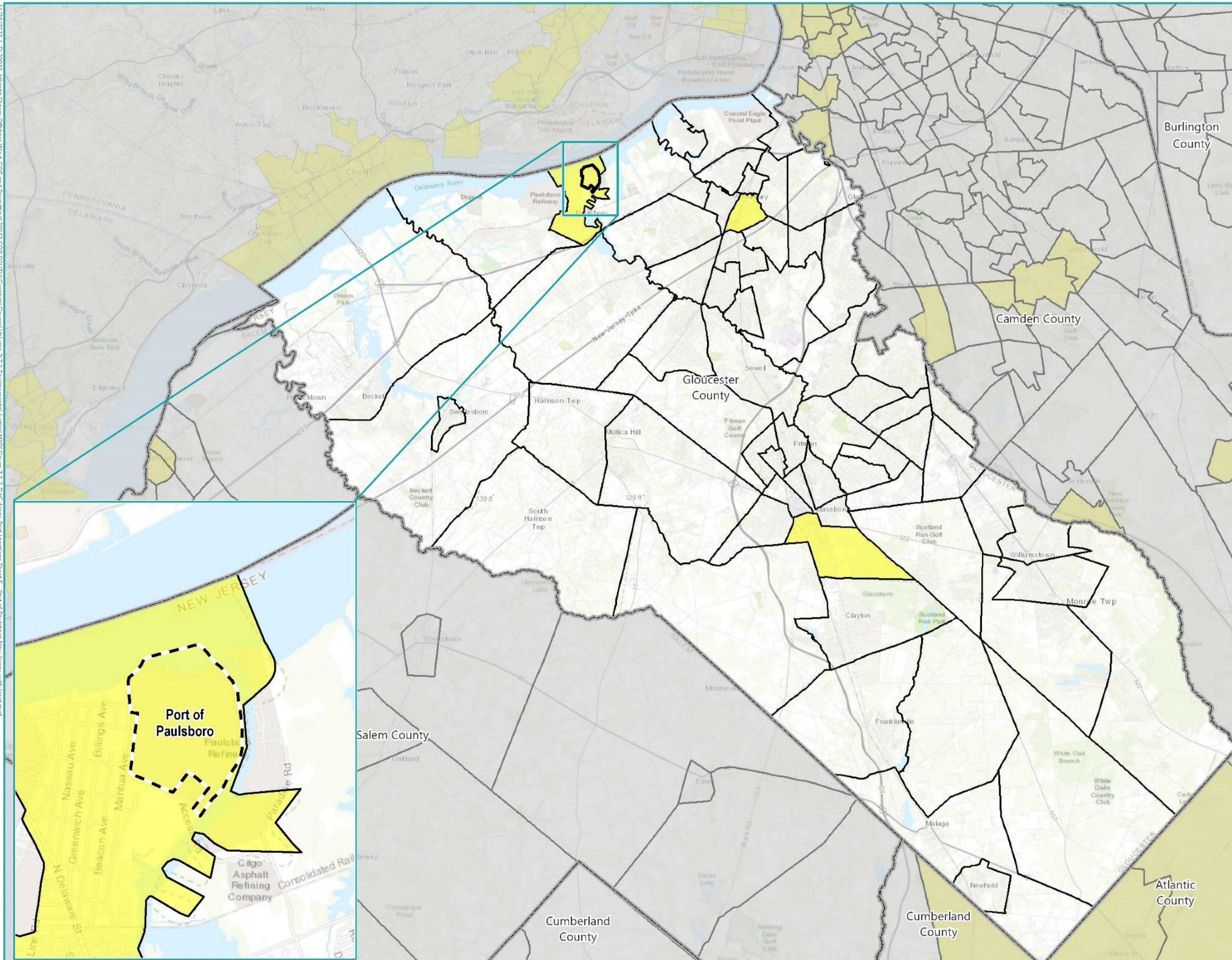
LEGEND

- Port Parcel
- Census Tract
- Federal Disadvantaged Community
- County Boundary

Note: For Environmental Justice demographic for group definitions and thresholds, see Section 2.7.1 Environmental Justice.

Figure 7.2-2
Sheet 4 of 8
Disadvantaged Communities
Repauno Port & Rail Terminal
Gibbstown, Gloucester County
New Jersey

11/28/2023 | T:\20043_Atlantic Shores Offshore Wind_COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\7.2_Environmental Justice\MXD\Figure 7.2-2_DAC Areas_Port Locations Sheet 4 - Repauno New Jersey_with Inset.mxd



ATLANTIC SHORES offshore wind

0 5,000 10,000 20,000 Feet

0 2,000 4,000 Meters

Map Projection: NAD 1983 UTM Zone 18N
Basemap: ESRI ArcGIS Online "World Topographic Map" map service.

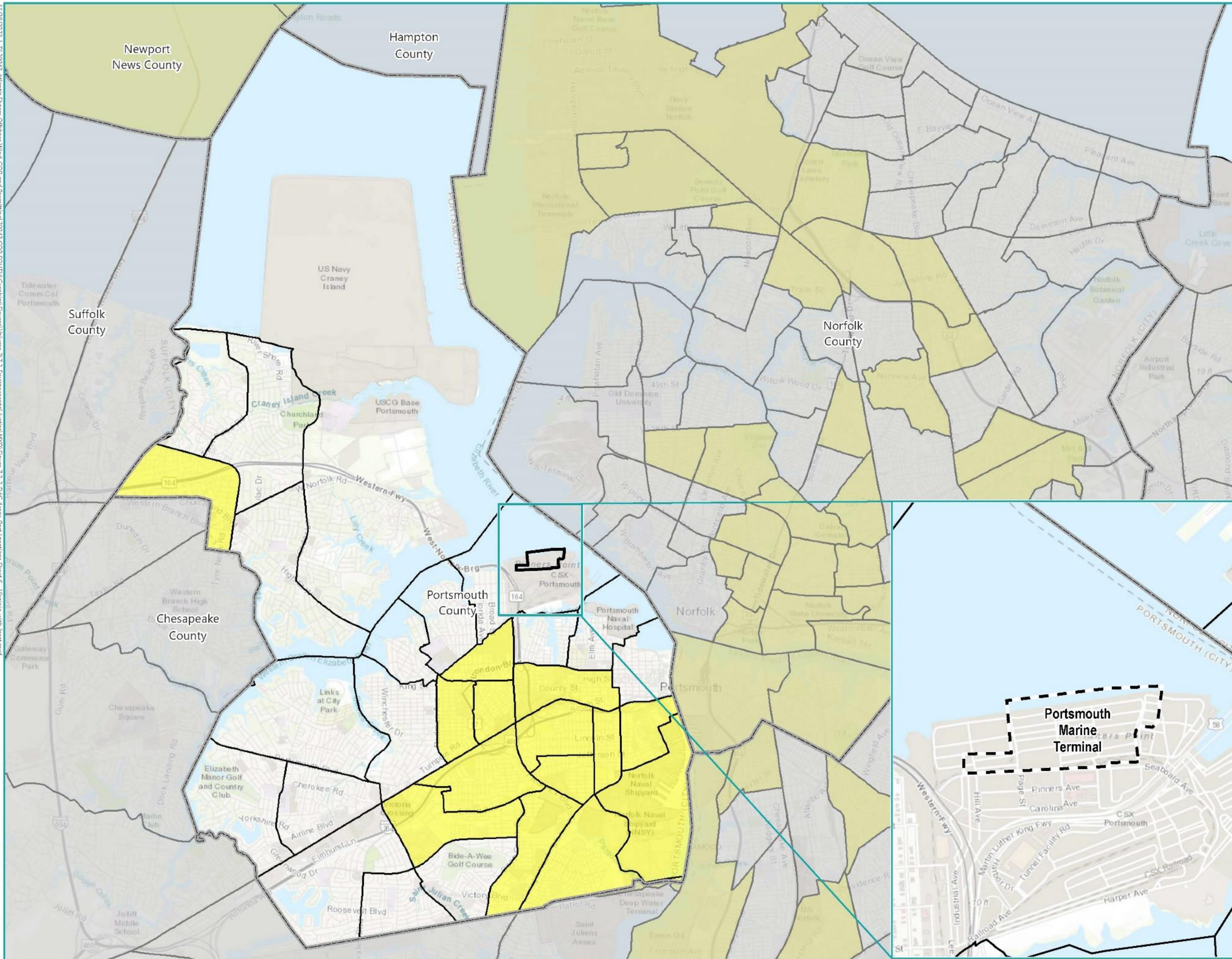
LEGEND

- Port Parcel
- Census Tract
- Federal Disadvantaged Community
- County Boundary

Note: For Environmental Justice demographic for group definitions and thresholds, see Section 2.7.1 Environmental Justice.

Figure 7.2-2
Sheet 5 of 8
Disadvantaged Communities
Paulsboro Marine Terminal
Paulsboro Township, Gloucester County
New Jersey

11/28/2023 | T:\20043 Atlantic Shores Offshore Wind_COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\7.2 Environmental Justice\MXD\Figure 7.2-2_DAC Areas_Port Locations Sheet 5 - Port of Paulsboro New Jersey_with Inset.mxd



ATLANTIC SHORES offshore wind

0 2,500 5,000 10,000 Feet

0 1,000 2,000 Meters

Map Projection: NAD 1983 UTM Zone 18N
Basemap: ESRI ArcGIS Online "World Topographic Map" map service.

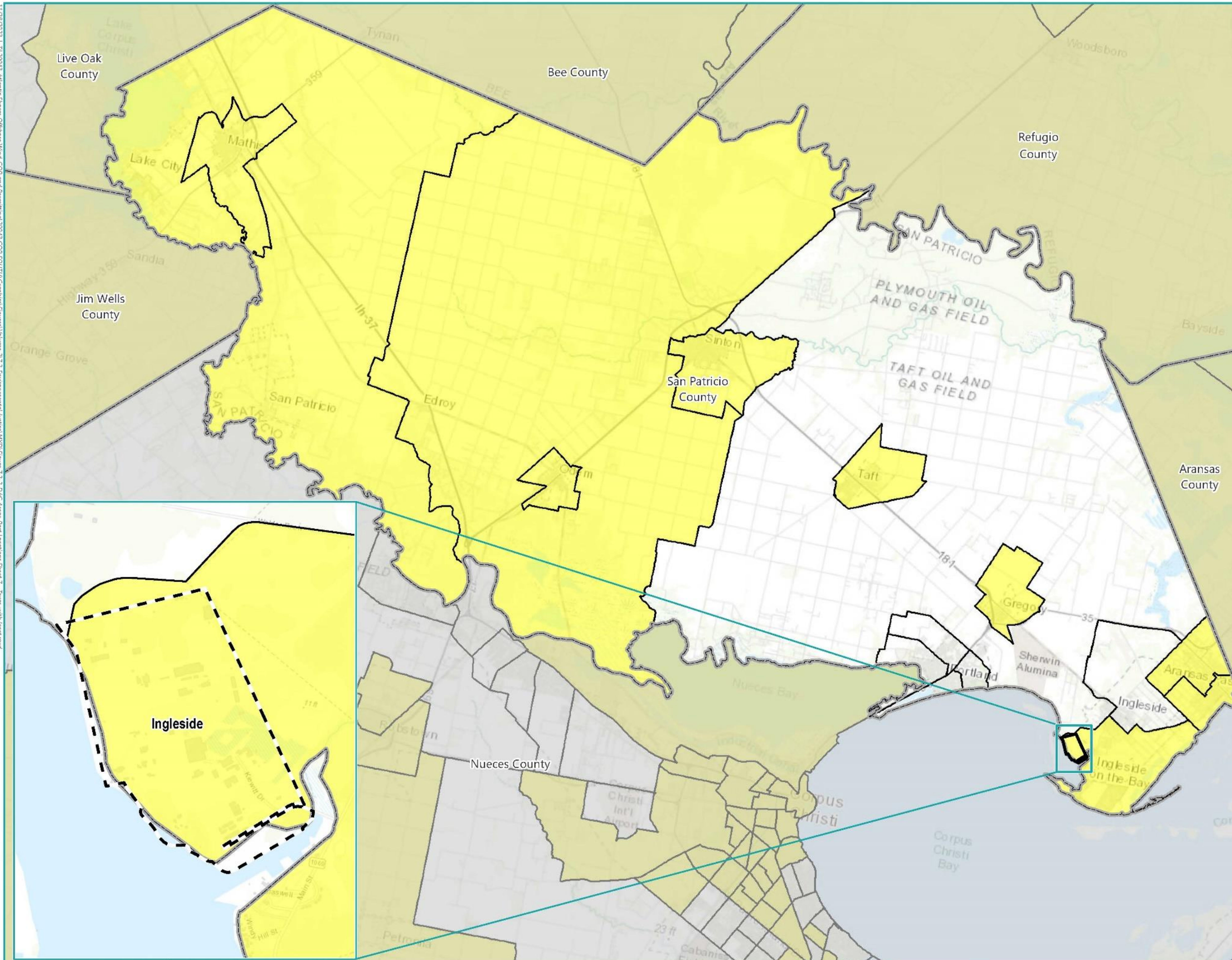
LEGEND

- Port Parcel
- Census Tract
- Federal Disadvantaged Community
- County Boundary

Note: For Environmental Justice demographic for group definitions and thresholds, see Section 2.7.1 Environmental Justice.

Figure 7.2-2
Sheet 6 of 8
Disadvantaged Communities
Portsmouth Marine Terminal
City of Portsmouth, Portsmouth County
Virginia

11/28/2023 | T:\20043_Atlantic Shores Offshore Wind_COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\7.2_Environmental Justice\MXD\Figure 7.2-2_DAC Areas_Port Locations Sheet 7 - Texas_with Inset.mxd



ATLANTIC SHORES offshore wind

0 7,000 14,000 28,000 Feet

0 2,000 4,000 Meters

N W E S

Map Projection: NAD 1983 UTM Zone 18N
Basemap: ESRI ArcGIS Online "World Topographic Map" map service.

LEGEND

- Port Parcel
- Census Tract
- Federal Disadvantaged Community
- County Boundary

Note: For Environmental Justice demographic for group definitions and thresholds, see Section 2.7.1 Environmental Justice.

Figure 7.2-2
Sheet 7 of 8
Disadvantaged Communities
Kiewitt (Ingleside, TX)
City of Ingleside, San Patricio County
Texas

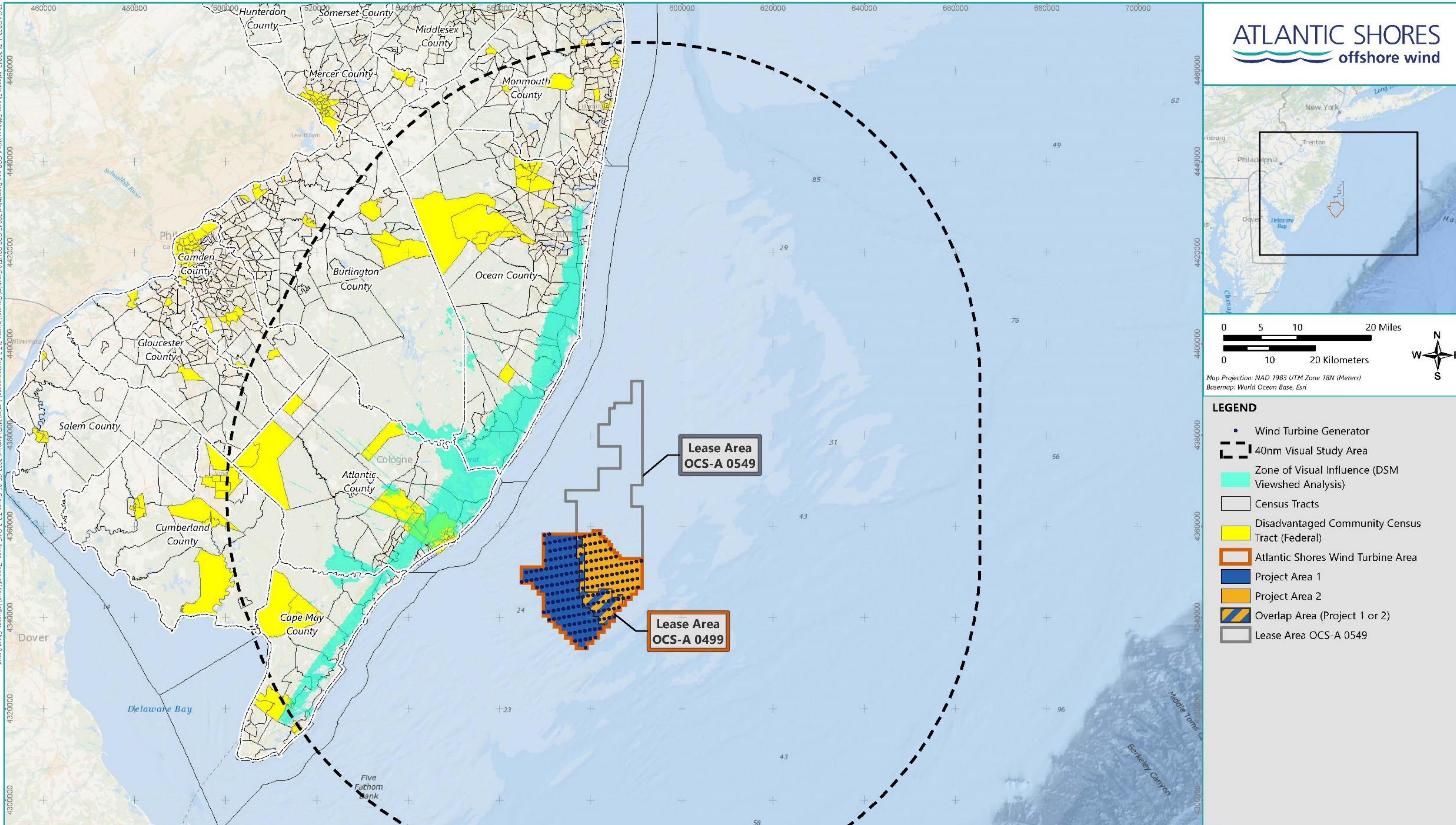


Figure 7.2-2
Sheet 8 of 8

Draft Disadvantaged Communities Atlantic Shores Offshore Wind Zone of Visual Influence

Table 7.2-1 EJ Communities and Disadvantaged Communities Within the Project Region

County	Potential Project Action	Number of EJ Communities (Census Blocks)	Number of Disadvantaged Communities (Census Tracts)
Atlantic County	Cardiff Interconnection Route, Atlantic City Landfall Site, Operations and Maintenance Facility, Zone of Visual Influence	99	26
Burlington County	Zone of Visual Influence	110	9
Cape May County	Zone of Visual Influence	25	6
Cumberland County	Zone of Visual Influence	73	17
Gloucester County	Repauno Port & Rail Terminal, Port of Paulsboro	46	3
Monmouth County	Larrabee Interconnection Route	105	16
Ocean County	Zone of Visual Influence	82	19
Salem County	New Jersey Wind Port	11	5
Portsmouth County, VA	Port of Portsmouth	67	14
San Patricio County, TX	Kiewitt (Ingleside, TX)	34	10

7.2.4 Potential Impacts and Proposed Environmental Protection Measures

Atlantic Shores is committed to managing activities such that EJ and Disadvantaged Communities will not bear disproportionately high or adverse effects resulting from construction or operation. Additionally, Atlantic Shores is committed to managing activities such that EJ and Disadvantaged Communities are not disproportionately excluded from receiving benefits from the Projects. Atlantic Shores recognizes the opportunity to directly benefit EJ and Disadvantaged Communities through thoughtful and targeted development choices and has taken steps to be inclusive in how the Projects are developed, constructed, operated, and maintained. Negative effects will be minimized by consulting with stakeholders to identify potential issues, thoroughly investigating them, and devising strategies to avoid or minimize adverse effects. Potential socioeconomic effects, both positive and negative, from offshore wind energy projects predominantly result from construction activities; however, these effects are localized, temporary, and short-term. Positive economic impacts are expected to outlast any potentially negative economic effects over the 30-year life of the Projects. New housing or transportation infrastructure will not be needed to construct and operate the Projects. Beneficial effects spurred by the construction and O&M of the

Projects include job creation and economic stimulus to the Project Region. A portion these jobs and economic stimulus could occur within EJ and Disadvantaged Communities throughout the Project Region. Specific anticipated benefits from the Projects for these EJ and Disadvantaged Communities are further detailed in this section. For additional information on potential socioeconomic effects of the Projects, please see Section 7.1.

This section addresses the potential IPFs associated with the Projects, which may have direct and/or indirect effects to EJ and Disadvantaged Communities. The potential IPFs as they relate to specific Project elements are presented in Table 7.2-2.

Table 7.2-2 Environmental Justice Impact Producing Factors

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Workforce Training Programs	•	•	•
Workforce Hiring	•	•	•
Port Utilization	•	•	•
Installation and Maintenance of New Structures and Cables	•		•
Vehicle Traffic	•		•
Housing	•	•	

7.2.4.1 Workforce Hiring and Training Program

Atlantic Shores is committed to recruiting, training, and hiring a diverse workforce that will enable the needs of New Jersey's offshore wind workforce to be met by communities local to the Projects. This IPF section focuses on the direct benefits that workforce training programs will have on EJ and Disadvantaged Communities during the construction, O&M, and decommissioning of the Projects. Atlantic Shores will support workforce training initiatives specifically targeted to minority and low-income populations, women, veterans, and underserved communities. Workforce development initiatives Atlantic Shores has committed to supporting include the following:

- Atlantic Shores will fund Science, Technology, Engineering, the Arts, and Mathematics (STEAM) programming with the Boys and Girls Club of Atlantic City. This initiative is committed to ending the cycle of poverty for residents by providing direct exposure and skill building opportunities in technology, construction and green energy innovation, fields that present the community with occupations paying self-sustaining wages. In addition to this funding, Atlantic Shores provides support and engages various programs. Atlantic Shores was the top sponsor for the Boys and Girls Club of Atlantic City's 2nd Annual Community Celebration at Stockton, honoring Senator William Gormley, the opened the

ECO Center doors to attendees that included key community leaders such as Atlantic City Council member Kaleem Shabaaz. Atlantic Shores has also hosted youth at the ECO Center to participate in an OffshoreWind4Kids STEM activity. Additionally, Atlantic Shores donated rowing machines and swim lessons to the Boys and Girls Club. Atlantic Shores has also expanded support to the state-level Boy and Girls Club by being a top sponsor and judge for their Youth of the Year award.

- Atlantic Shores will support the development of offshore wind curricula with Rutgers Future Scholars. Rutgers Future Scholars provides 200 first generation, low-income, academically promising middle school students from New Brunswick, Piscataway, Newark, Camden and Rahway hope, opportunities, a path to college and even a tuition-free Rutgers education. With Atlantic Shores support, students participating in the Rutgers Future Scholars will receive education on the offshore wind and renewable energy fields.
- Atlantic Shores provides annual funding to the Rutgers Eco Complex WindIgnite Program's recruitment of at least five MWBEs interested in offshore wind industry services or the supply chain into its incubator program. Atlantic Shores' funds also supply the Eco Complex with equipment and technology related to offshore wind.
- Atlantic Shores provides multi-year sponsorship of the Egg Harbor Township Police Activities League STEM program. Atlantic Shores participates in their STEM Expos and programs, and invites their summer groups to the ECO Center to participate in offshore wind related STEM Activities.
- Atlantic Shores has partnered with the OffshoreWind4Kids program, which provides hands-on, STEM-focused learning about offshore wind energy and promotes careers in clean energy primarily for students from overburdened communities. As part of the ECO Center programming, Atlantic Shores was the first developer to partner with OffshoreWind4Kids in the US, with an exclusive partnership in New Jersey. Through this program, Atlantic Shores has been able to host and teach youth from the Atlantic City Youth Services Summer Camp, Boys and Girls Club of Atlantic City, Egg Harbor Township P.A.L STEM Camps, and Rutgers Future Scholars Program. Atlantic Shores also held a public demo day open to anyone on the beach in Atlantic City.
- Atlantic Shores will provide scholarship support for Rowan College students. Rowan College at Burlington County's Workforce Development Institute offers a suite of programs that prepare students for careers in renewable energy, many of which are women and people of color. By providing scholarship funds, Atlantic Shores' support will specifically benefit students with a demonstrated financial need.
- Atlantic Shores will provide support to the Ocean County College's Barnegat Bay Partnership which is an environmental organization dedicated to helping restore, protect, and enhance the natural resources of the Barnegat Bay ecosystem. Several programs will be funded including The Communications and Education Grants Program, Paddle for the Edge Program, and Barnegat Bay's wetland restoration program.

- Through engagement with the South Jersey Energy Partnership, Atlantic Shores works with the Center for Family Services Camden Promise Neighborhood to bring Atlantic Shores staff to speak to youth at Camden High School about opportunities in offshore wind.
- Atlantic Shores is working with the National Action Network (NAN) Tech World, founded by Rev. Al Sharpton, aimed at providing technology education in areas with limited opportunities. Atlantic Shores is actively engaged with the Northeastern Regional Director, Pastor Steffie Bartley, and sponsored the NAN Network Newark Tech World Golf Tournament in July 2023. Additionally, Atlantic Shores is donating $40,000 to support the start of their Green Energy Jobs initiative.
- Atlantic Shores is working with Turning Point Community Development Corporation (CDC), an organization dedicated to improving educational attainment, economic prosperity, and recreational opportunities for youth, adults, and families in Atlantic City. Atlantic Shores has developed a collaborative approach to meeting environmental justice needs in the community with Collin Days, President of Turning Point CDC and Pastor of 2nd Baptist Church, and a prominent and trusted voice in Atlantic City. Atlantic Shores Community Liaison Officer, Ryan Tookes, has also appeared on Pastor Day's church podcast to discuss Atlantic Shores projects and visited the Pastor and his congregation.
- Atlantic Shores is a member of the African American Chamber of Commerce of New Jersey, the Statewide Hispanic Chamber of Commerce of New Jersey, the New Jersey Chapter of Professional Women in Construction, and New Jersey Association of Women Business Owners and in partnership with these organizations will work to deepen relationships and increase opportunities for underrepresented groups in the offshore wind supply chain.
- Atlantic Shores will partner with Chambers of Commerce within the Project Region to increase opportunities for minority and women owned business enterprises (MWBEs).
- Atlantic Shores has sponsored the Hispanic Association of Atlantic County (HAAC) annual Latino Festival in Atlatnic City, where Atlantic Shores bilingual staff shares information about our projects in Spanish and English materials. Atlantic Shores CFO, Juan Carlos Puente, has been interviewed about offshore wind and what it means to the community, by the president of HAAC, Bert Lopez, as part of the podcast he hosts for the local Latin community, *Latino Motion*.
- Atlantic Shores supports the Atlantic City Community Fund and Community Foundation of South Jersey, investing into targeted community initiatives through an established entity who organizes and assesses grant applications. Funding grant applicants through the Foundation streamlines the grant request process for potential applicants and provides Atlantic Shores with benefits from the Foundation's local expertise.
- Atlantic Shores also funds and supports construction industry training programs for veterans, specifically the 'Helmets2Hardhats' which trains veterans for jobs in the construction industry.

- Atlantic Shores participates in numerous annual job fairs and career exploration panels including co-hosting the South Jersey Energy Partnership Careers in Energy Expo, African American Chamber of Commerce of New Jersey, Mobile Academy Career Fair; Career Carnival for Kids; and programs with the New Jersey Economic Development Authority (NJEDA) Wind Institute.
- Atlantic Shores was a top sponsor and a participant of the "Environmental Justice" Conference hosted by the Air & Waste Management Association in October 2023, held at the Rutgers University Camden School of Business. Atlantic Shores also sponsored the National Diversity Institute National Clean Energy DEIJ Summit in February 2023. In addition, Atlantic Shores conducts frequent touchpoints and participates in NJEDA WIND Institute for Innovation and Training, including outreach to businesses and community-based organizations in OBCs promoting the Offshore Wind Workforce and Skills Development Grant Challenge.
- Atlantic Shores will launch a series of free information sessions in 2023 and 2024 geared towards guiding potential suppliers. Atlantic Shores is partnering with Business Network for Offshore Wind to bring additional offshore wind supply chain training through their trademark Offshore Wind Ready training program. The first program will be held in December 2023 in Atlantic City. Atlantic Shores will also host smaller supplier events at the ECO Center to target local minority contractors and suppliers, with a focus on sharing opportunities with New Jersey-based businesses to work with prime contractors and larger organizations.

By participating in workforce training programs like the ones listed above, workers will continue to have employment opportunities in the Mid-Atlantic region as additional offshore wind projects proceed through development, and many of the acquired skills may translate to other marine, coastal, or port employment in the area.

7.2.4.2 Workforce Hiring

As further detailed in Section 7.1 Demographics, Employment, and Economics, the Projects are expected to create a total of approximately 33,000 full time equivalent (FTE) direct jobs, 18,000 FTE indirect jobs, and 22,000 FTE induced jobs.[52] During the development and construction phase, direct jobs will primarily be in construction, manufacturing, professional services (e.g., engineering, and general management), transport, and warehousing. During the O&M phase, direct jobs will primarily include technicians, engineers, and managers. During the decommissioning phase, the direct jobs will be similar to the composition of trades, technical, and management professionals as the construction workforce. This IPF section focuses on the direct benefits that the hiring process will have on EJ and Disadvantaged Communities during construction, O&M, and decommissioning of the Projects.

---

[52] Job totals are preliminary estimates only. Totals have been rounded to the nearest thousand.

Atlantic Shores is committed to hiring a diverse and local workforce as well as using local suppliers during Project construction, O&M, and decommissioning. A portion of this workforce could be composed of residents from the EJ and Disadvantaged Communities throughout the Project Region. Additionally, Atlantic Shores is providing disadvantaged groups with opportunities for safe, sustainable, well-paid jobs in the renewable energy industry via multiple investments to support MWBEs development. Atlantic Shores has and will continue pursuing contracts with MWBEs New Jersey suppliers. To engage minority and low-income populations and build awareness of opportunities in offshore wind, Atlantic Shores is an active member of several chambers of commerce supporting minority groups. Atlantic Shores' choice of partnerships is intended to support diversity in workforce hiring among the Projects' EJ goals such as the workforce-related initiatives listed in the Workforce Hiring and Training Program section.

7.2.4.3 Port Utilization

Ports will serve as mustering points for offshore labor forces and staging areas for project components both during construction and O&M phases. Ports evaluated in this section, along with Section 7.1 Demographics, Employment, and Economics, are representative of facilities that may be selected by Atlantic Shores and its contractors to support construction and O&M activities (see Table 7.1-10 for a full list of these representative ports). See Table 4.10-2 of Volume I for a full list of ports that may be used during construction. This IPF section focuses on the effects to EJ and Disadvantaged Communities from port utilization during construction, O&M, and decommissioning.

Atlantic Shores will contribute to making the region a hub for offshore wind by using ports across New Jersey where these activities are currently supported. Most large ports are existing marine facilities that experience significant vessel traffic for industrial, commercial fishing, and recreational purposes. Port facilities were selected, in part, because of their extant workforce and capacity to host Project-related activities. Project-related activities at these ports will be water-dependent marine industrial activities, and the Projects are anticipated to have limited negative impacts to EJ areas of concern and other communities surrounding the ports on land. These ports are well-established in coastal communities and adequately served by existing local and regional transportation networks and facilities. As noted previously, it is expected that onshore construction, including any potential construction related to ports, will be seasonally restricted to avoid adverse effects on residents and businesses during the peak tourist season. This will reduce potential impacts on EJ and Disadvantaged Communities that rely on tourism along the coast and elsewhere in the Project Region.

The Projects will create direct and indirect job opportunities at or in the vicinity of many of these ports, including the location of the Atlantic Shores O&M facility in the Atlantic City Harbor, providing potential local benefits for individuals that reside in nearby EJ and Disadvantaged Communities. As further described in Section 7.1 Demographics, Employment, and Economics, the Projects are expected to create a total of approximately 33,000 full time equivalent (FTE) direct jobs, 18,000 FTE indirect jobs, and 22,000 FTE induced jobs[53] throughout its anticipated lifecycle. Specific to the O&M facility in Atlantic City, New Jersey (Atlantic County), Atlantic Shores will provide between 61 and 110 permanent jobs in technical services, project planning, data analysis, WTG preventative maintenance and repair, cable and foundation monitoring, and substation maintenance. The O&M facility will be built using local labor. Additional economic activity will be created for a wide range of subcontractors including shipyards, spare part producers, and vessel and harbor services. A portion of this workforce could be composed of residents from the EJ and Disadvantaged Communities throughout the Project Region.

7.2.4.4 Installation Maintenance of New Structures and Cables

Atlantic Shores is committed to managing the installation and maintenance of new structures and cables such that EJ and Disadvantaged Communities do not bear any disproportionately high or adverse impacts. The installation and maintenance of new onshore interconnection cables and onshore substations at the Atlantic Landfall Site may affect EJ and Disadvantaged Communities through direct temporary access restrictions and disruptions to areas when these Projects' activities take place. This IPF section focuses on the temporary direct and indirect disturbances that will primarily occur during the construction, O&M, and decommissioning. To avoid unnecessary additional effects, onshore interconnection cables will travel underground primarily along existing roadway and/or utility rights-of-way (ROWs) and/or along bike paths to proposed onshore substations as described in Section 4.8 of Volume I. Easements and ROWs for private parcels will be acquired where necessary. From the proposed onshore substations, onshore interconnection cables will continue to the proposed points of interconnection (POIs) at the existing Larrabee Substation and existing Cardiff Substation for interconnection to the electrical grid. Both underground interconnection cable routes are approximately 12 mi (19 kilometers [km]) long and largely use existing linear infrastructure corridors to avoid and reduce adverse impacts on neighborhoods.

Before starting any onshore work, Atlantic Shores will coordinate with municipalities and work to inform members of the public (as may be required through the permitting process) regarding onshore construction locations and schedules, including interconnection cable routes. Onshore construction hours will adhere to local noise ordinances. While Atlantic Shores is not anticipating significant nighttime work, any nighttime work that may become necessary would be coordinated with the local authorities. Based on local permit requirements, Atlantic Shores expects that construction will be seasonally restricted from Memorial Day to Labor Day, the peak summer season. During construction, a job-site safety program will also be implemented to prevent public access to construction sites.

7.2.4.5 Vehicle Traffic

Atlantic Shores is committed to managing vehicle traffic effects such that EJ and Disadvantaged Communities do not bear any disproportionately high or adverse traffic impacts resulting from

[53] Job totals are preliminary estimates only. Totals have been rounded to the nearest thousand.

construction or operation activities. This IPF section focuses on the localized, short-term disturbances from Project-related vehicle traffic that could be expected to occur in or near EJ and Disadvantaged Communities during construction and decommissioning.

Vehicle traffic could result in temporary detours to certain routes or restricted parking which could affect EJ and Disadvantaged Communities due to incremental increases in traffic volume mainly during construction and concentrated along the interconnection cable routes and near the ports (see Section 7.9 Onshore Transportation and Traffic). For the most part, however, traffic impacts from these Project-related activities at these locations will be minimized. To avoid unnecessary additional impacts, onshore interconnection cables will primarily travel underground using trenchless installation techniques (e.g., HDD, jack-n-bore, etc.) along existing roadway and/or utility ROWs and/or along bike paths to proposed onshore substations as described in Section 4.8 of Volume I. Easements and ROWs for private parcels will be acquired where necessary. Activities at ports will be water-dependent marine industrial activities, and the Projects are anticipated to have limited negative traffic impacts to EJ areas of concern and other communities surrounding the ports on land. These ports are well-established in coastal communities and adequately served by existing local and regional transportation networks and facilities.

New transportation infrastructure will not be needed to construct and operate the Projects, further minimizing any potential traffic effects. As noted previously, it is expected that onshore construction will be seasonally restricted to avoid adverse impacts on residents and businesses during the peak tourist season. This will reduce potential impacts on EJ and Disadvantaged Communities that experience high traffic volumes related to tourism. Atlantic Shores is actively researching options to provide electric car infrastructure in Atlantic City, reducing localized air pollutant emissions to the benefit of its citizens.

Atlantic Shores will develop a Traffic Management Plan (TMP) in consultation with the NJDOT and local transportation agencies to avoid and minimize traffic- and transportation-related impacts during construction and decommissioning. This includes EJ populations along the interconnection cable route in Atlantic County as identified on Figure 7.2-1, as well as in the vicinity of ports. The TMP will be reviewed and approved by the NJDOT. As noted previously, installation of the interconnection cable will generally occur within existing roadway, railroad, and utility ROW to the maximum extent practicable to avoid adverse impacts. Best management practices for the TMP are expected to include traffic control measures such as signage, police details, lane closures, and detours, among others.

7.2.4.6 Housing

The Projects are not anticipated to create adverse housing impacts on low-income and minority populations. As discussed in Section 7.1 Demographics, Employment, and Economics, housing needs of the Projects are expected to be met by the local housing market.

7.2.4.7 Summary of Proposed Environmental Protection Measures

The majority of potential effects to EJ and Disadvantaged Communities are expected to be in the form of positive benefits, including jobs and economic stimulus. Atlantic Shores is committed to managing activities such that EJ and Disadvantaged Communities will not bear disproportionately high or adverse impacts resulting from construction, O&M, and decommissioning activities. Additionally, Atlantic Shores is committed to managing activities such that EJ and Disadvantaged Communities are not disproportionately excluded from receiving Project benefits. Atlantic Shores has already taken preliminary steps to maximize the positive economic benefits of the Projects for EJ and Disadvantaged Communities. Additionally, Atlantic Shores recognizes the opportunity to directly benefit EJ and Disadvantaged Communities through thoughtful and targeted development choices and has taken steps to be inclusive in how the Projects are developed, constructed, and maintained. Negative effects will be minimized by consulting with stakeholders to identify potential issues, thoroughly investigating them, and devising strategies to avoid or minimize adverse effects. Potential socioeconomic impacts, both positive and negative, from offshore wind energy projects predominantly result from construction activities, however, these effects are localized, temporary, and short-term. Positive economic impacts are expected to outlast any potentially negative economic effects over the 30-year life of the Projects. New housing or transportation infrastructure will not be needed to construct and operate the Projects. Beneficial effects spurred by the construction and O&M of the Projects include job creation and economic stimulus to the Project Region. A portion of these jobs and economic stimulus could occur within EJ and Disadvantaged Communities throughout the Project Region. The following provides a summary of proposed minimization and mitigation measures that Atlantic Shores will implement to maximize the positive economic benefits for EJ and Disadvantaged Communities within the Project Region:

- A workforce hiring program will be implemented and designed to benefit EJ and Disadvantaged Communities.
- Project infrastructure, such as cables, will be installed to avoid disproportionate impacts to EJ and Disadvantaged Communities.
- Atlantic Shores will support workforce initiatives that will have a strong focus on providing support to minority and low-income populations, women, veterans, and underserved communities and local chambers of commerce that support minority groups.
- A TMP will be developed for construction activities and traffic monitoring will be conducted.
- Onshore construction will be scheduled to occur outside summer tourist season (i.e., Memorial Day through Labor Day) and in accordance with local noise ordinances.
- Atlantic Shores will update their website and coordinate with municipalities to inform members of the public of construction schedules.
- Local ports will be used the maximum extent practicable.

7.3 Recreation and Tourism

This section describes recreation and tourism (including recreational fishing) in the Offshore Project Area, associated impact producing factors (IPFs), and measures to avoid, minimize, or mitigate potential effects to these resources during construction, operations and maintenance (O&M), and decommissioning. Atlantic Shores recognizes that there are often concerns regarding how the presence of an offshore wind farm might influence recreation and tourism. Data from operating wind farms around the world and in the U.S. suggest that negative effects are minor and if they do occur, are temporary, and typically limited to the period of project construction (ICF 2012). Usually, wind farms have resulted in positive benefits to recreation and tourism over the lifetime of a project.

In particular, Atlantic Shores recognizes the importance of recreational fishing and is committed to ensuring coexistence with recreational fishermen within the Project 1 and Project 2 Wind Turbine Areas (WTAs) (collectively, the WTA) and Export Cable Corridors (ECC). Atlantic Shores has dedicated considerable resources to reach recreational fishermen and boaters. Atlantic Shores has developed a detailed Fisheries Communication Plan (see Appendix II-R) and has hired a Fisheries Liaison Officer (FLO) and a Recreational Fishing Industry Representative (FIR), both of whom are local, New Jersey fishermen. To better understand recreational fishing in the area and to inform this assessment of recreational fishing, Atlantic Shores has compiled information from industry conversations, direct data gathering exercises with fishermen, consultations with government agency representatives, and analysis of public data (see Section 1.4.2 of Volume I). This information also guides the siting, design, O&M, and decommissioning of the Projects. In addition to promoting communication with recreational fishermen, Atlantic Shores is dedicated to improving and understanding New Jersey's marine resources and is a founding member of the Responsible Offshore Science Alliance (ROSA), which shares Atlantic Shores' commitment to advance regional research and monitoring of fishery and offshore wind interactions.

Atlantic Shores has hired Community Liaison Officers (CLOs) to help inform the public of Project activities and to support productive and effective dialogue with stakeholders. The CLOs are New Jersey residents and have existing relationships and prior experience within New Jersey coastal communities, allowing Atlantic Shores to better understand the stakeholder groups and their concerns.

Atlantic Shores has also conducted a thorough review of potential visual effects of the Projects to recreational beaches and other locations (see Section 5.0 Visual Resources) and a detailed assessment of the finfish species that are considered commercially and recreationally important (see Section 4.6 Finfish, Invertebrates, and Essential Fish Habitat). For the purpose of this analysis, the affected environment and the potential effects related to recreation and tourism are anticipated to be the same for Project 1 and Project 2.

7.3.1 Affected Environment

The description of the affected environment related to recreation and tourism encompasses a variety of activities that are known or expected to take place in the Onshore and Offshore Project Areas. Consistent with previously published studies on offshore wind energy projects and effects on recreation and tourism, several types of activities are likely to occur in the vicinity of project activities during construction, O&M, and decommissioning (ICF 2012) including the following:

- nature-based (e.g., birdwatching, kayaking, hiking);
- beach (e.g., shell collecting, sunbathing, swimming);
- sporting (e.g., surfing, hunting, fishing);
- history-based (e.g., tours, museums);
- cultural (e.g., festivals, dining, community immersion, wine-tasting); and
- boardwalk (e.g., arcades, shopping, amusements).

Given the regional importance and unique attributes of recreational fishing compared to the other types of recreation and tourism, the following discussion is separated into two categories: recreation and tourism and recreational fishing.

Recreation and Tourism

The affected environment for recreation and tourism includes the Offshore and Onshore Project Areas but mainly the New Jersey shore counties of Atlantic, Cape May, Monmouth, and Ocean Counties. Within these areas, offshore and onshore recreation and tourism opportunities are abundant and may experience some limited interruption by Project activities, mainly during construction. Offshore recreation and tourism include boating, sightseeing, and other water sports (e.g., kayaking, diving, stand-up paddle boarding). Onshore recreation and tourism include activities associated with visits to beaches, parks, conservation areas, boardwalks, and tourist destinations, like Atlantic City, which offers shopping, sightseeing, and entertainment near the shoreline. The description of recreation and tourism within the affected environment is based on available literature, online data portals, and relevant information from Federal and State agencies (ICF 2012; Parsons and Firestone 2018; Tourism Economics 2020).

The New Jersey shoreline is predominantly sandy beach, which is widely accessible to the public from many locations. At least 90 beaches, some with associated boardwalks, are listed in public databases along the shoreline from Monmouth County south to Cape May County. Some of these areas face the Offshore Project Area and may have visibility of the Wind Turbine Generators (WTGs) and Offshore Substations (OSSs) (see Section 5.0 Visual Resources). The ECCs make landfall in southern Monmouth County near Manasquan Beach (Monmouth Landfall Site) and in Atlantic County near Atlantic City (Atlantic Landfall Site).

The coast of New Jersey is a popular tourist destination and is famous for its beaches and boardwalks. The recreation and tourism industry which is centered around New Jersey's shore counties (i.e., Atlantic, Cape May, Monmouth, Ocean) typically lead the State in direct sales from tourism. In the State of New Jersey's annual reporting on the economic impact of tourism on the broader economy, visitor spending in New Jersey grew 3.8% in 2019 to reach $46.4 billion; 12% ($5.6 billion) of that total is attributable to recreational spending. Visitor spending increased by $1.7 billion in 2019 and has grown nearly $6 billion since 2015 (Tourism Economics 2020). Atlantic County, the host-county for Atlantic City, significantly fueled the 2019 growth attributed to the opening of new casinos in 2018 (Tourism Economics 2020). The visitor economy drives economic growth for New Jersey and is responsible for growth in employment and State and local tax revenues (Tourism Economics 2020). Despite significant downturns in tourism and related economic activity because of the COVID-19 pandemic, quick rebounds in activity and spending are anticipated (Tourism Economics 2020).

In addition to the tourism and entertainment center of Atlantic City, the coastal counties of New Jersey offer a diversity of recreation and tourism opportunities. Beaches, parks, recreational/public access areas, bike paths and wildlife areas constitute the primary onshore recreational outlets in the area. Figures 7.3-1 and 7.3-2 indicate the locations of the mapped recreation and tourism opportunities in the general vicinity of the Cardiff and Larrabee Onshore Interconnection Cable Routes, including the Cardiff and Larrabee POIs, respectively (NJDEP 2020).

Within the Offshore Project Area, inclusive of waters along the ECCs, recreational boating and fishing are known to occur with varying intensity. Historically, the recreational boating industry has been credited for 18,000 jobs and an estimated $2.1 billion dollars in annual spending across New Jersey (MTANJ 2008). According to a Marine Trades Association of New Jersey survey, most recreational boating is associated with fishing activity and most recreational boaters target lakes, rivers, and bays, rather than offshore waters, as destinations (MTANJ 2008). There are many marinas along the New Jersey Coast between the Atlantic and Monmouth Landfall Sites but there are no marinas directly affected by these landfall locations.

Figure 7.3-1

Cardiff Onshore Interconnection Cable Route - Recreation and Tourism Opportunities

4/19/2023 | T:\20043 Atlantic Shores Offshore Wind COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\7.3 Recreation and Tourism\MXD\Figure 7.3-1 Cardiff Recreation and Tourism.mxd

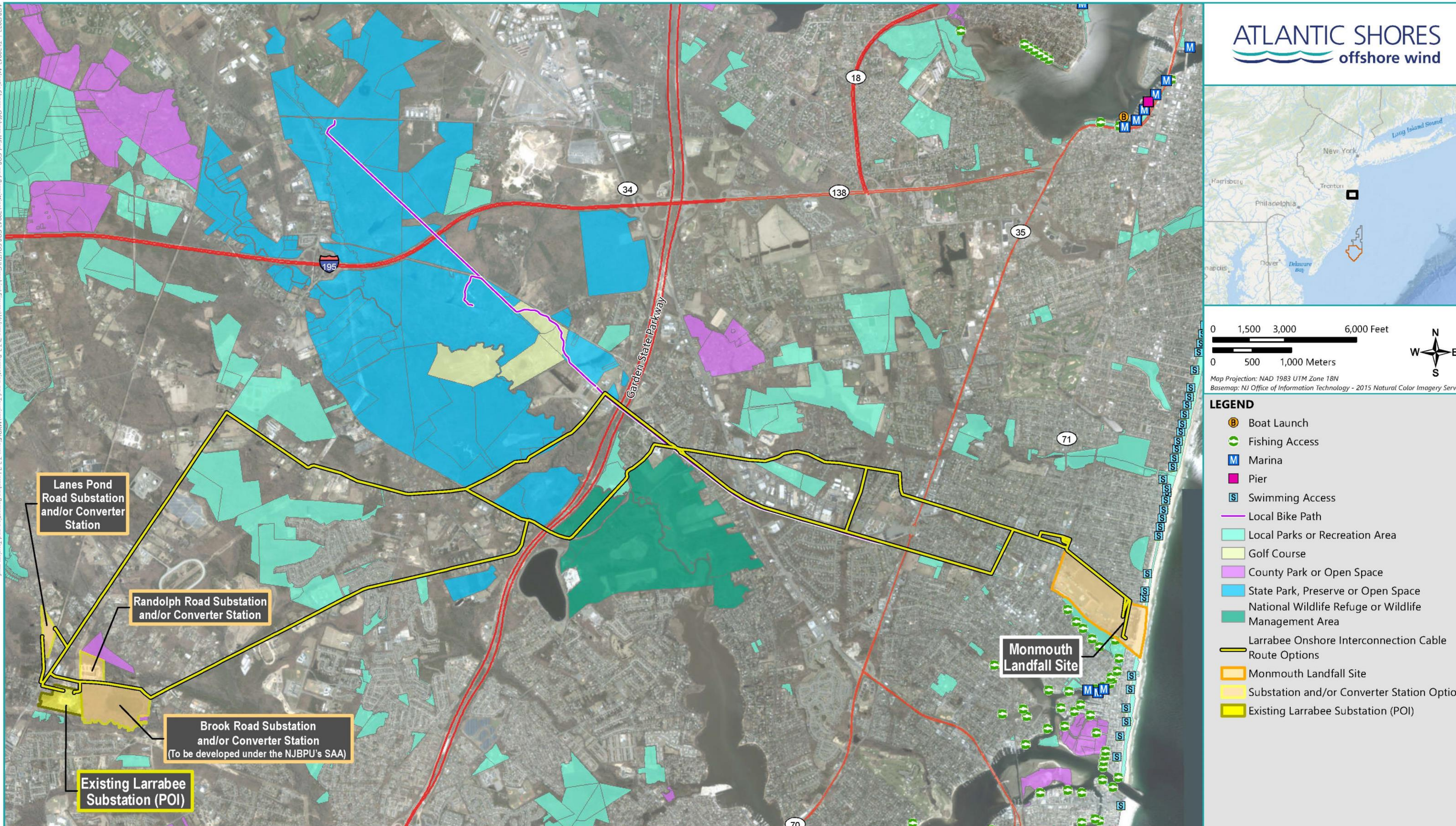


Figure 7.3-2

Larrabee Onshore Interconnection Cable Route - Recreation and Tourism Opportunities

4/28/2023 | T:\20043_Atlantic Shores Offshore Wind_COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\7.3_Recreation and Tourism\MXD\Figure 7.3-2 Larrabee Recreation and Tourism.mxd

7.3.1.1 Recreational Fishing

Recreational fishing is a popular activity in the waters offshore New Jersey. Most statistics on recreational fishing effort are reported on a statewide basis, such that data specific to recreational fishing activity in the WTA and ECCs is more limited. In 2020, Atlantic Shores hired Captain Adam Nowalsky, the New Jersey State Chapter Lead for the Recreational Fishing Alliance, as a FIR. Atlantic Shores is the first and only developer to hire a Recreational FIR. The purpose of a Recreational FIR is to represent the collective voice of the recreational fishing industry and share their views to advise Atlantic Shores. An additional role is to bring recreational expertise to help inform Atlantic Shores' Project planning and to disseminate project information to the recreational community. The Recreational FIR is working with local recreational fishermen to help Atlantic Shores fill data gaps and gather local knowledge of recreational fishing activity within the WTA and ECCs. During the winter of 2021, Atlantic Shores held two open houses with members of the recreational fishing industry to present details of the Project, gather input on key concerns, and to identify potential collaborative research efforts. Atlantic Shores' outreach efforts continue with one-on-one meetings with stakeholders to better understand fishermen's concerns and to familiarize New Jersey fishermen with the Project.

According to statewide data, just over 2.0 million angler trips per year were conducted in the coastal and offshore waters in all of New Jersey from 2015 to 2020. More than 530,000 New Jersey residents participated in statewide, marine recreational fishing in 2016. In addition to local fishermen, about 380,000 out-of-state recreational anglers fished New Jersey waters in 2016 (NOAA MRIP 2020). The *New Jersey Offshore Wind Strategic Plan* highlights the economic contributions of the millions of recreational anglers and angler trips each year in New Jersey: Statewide recreational fishing provides at least 15,000 jobs and adds $1.7 billion in sales, $0.7 billion in income, and $1.1 billion in value added to the State's economy (NJBPU 2020; NOAA Fisheries 2019). Privately owned vessels make up a significant portion of the overall recreational fishing effort.

Although recreational fishing occurs on a year-round basis throughout the waters offshore New Jersey, recreational fishing increases in the warmer weather months. Based on Marine Recreational Information Program (MRIP) data, the number of angler trips in New Jersey are typically greatest during July and August. For example, from 2015 to 2019, angler trips peaked in July and August with an average of approximately 720,000 trips for those two months combined, which is approximately 35% of all annual angler trips. The timing of migratory species' "run" through the waters offshore New Jersey, as well as open seasons, catch limits, and size limits may also dictate the intensity of recreational fishing effort for specific species. Although there are a diverse range of species in the waters offshore New Jersey, from 2015 to 2019, the non-bait species most frequently caught in New Jersey by landed weight were striped bass (*Morone saxatilis*), summer flounder (*Paralichthys dentatus)*, bluefish (*Pomatomus saltatrix*), and black sea bass (*Centropristis striata)* (NOAA 2020). Other common and important demersal species include scup (*Stenotomus chrysops*), tautog (*Tautoga onitis*), clearnose skate (*Raja eglanteria*), little skate (*Leucoraja erinacea*), and monkfish (*Lophius americanus*).

Much of the State's recreational fishing effort is concentrated within 3 miles (mi) (4.8 kilometers [km]) of shore, far inshore from the WTA which is located a minimum of 8.7 mi (14 km) from the New Jersey coast. However, fishing for federally regulated Atlantic Highly Migratory Species (HMS), such as federally regulated sharks, blue and white marlin (*Makaira nigricans* and *Tetrapterus albidus)*, sailfish (*Istiophorus albicans*), roundscale spearfish (*Tetrapturus georgii*), and swordfish (*Xiphias gladius*), occurs farther offshore than most other recreational fishing and may occur within the WTA and portions of the ECCs farther offshore. As a result of their distance offshore, comparatively fewer anglers participate in these fisheries. To fish for federally regulated HMS in the Atlantic Ocean, an Atlantic HMS Angling category permit is required. In 2016, there were 20,020 angling permit holders for Atlantic HMS (this number includes for-hire recreational fishermen) and that same year 13.3% of HMS angling trips originated in New Jersey (NMFS 2019).

Atlantic Shores' FIR is conducting extensive outreach to recreational fishing stakeholders to better understand how recreational fishing is pursued in the Offshore Project Area. During the winter of 2021, Atlantic Shores held two open houses with members of the recreational fishing industry to present details of the Project, gather input on key concerns, and to identify potential collaborative research efforts. Atlantic Shores' outreach efforts continue with one-on-one meetings with stakeholders to better understand fishermen's concerns and to familiarize New Jersey fishermen with the Project.

There are artificial reef sites adjacent to the WTA and ECC that are managed by the New Jersey Artificial Reef Program and are considered prime recreational fishing grounds. The New Jersey Artificial Reef Program is one of the largest on the east coast of the U.S. consisting of 15 ocean sites containing over 1,000 reefs and 100 sunken vessels. Atlantic Shores understands the importance of artificial reefs and has signed a Memorandum of Understanding (MOU) with Stockton University to sponsor research on the "reef effect," or the aggregation or generation of fish biomass, biodiversity, or movement in and around artificial structures. The first project identified under this MOU is mapping the ecological succession on the Little Egg Artificial Reef to determine how submerged structures enhance sport fisheries and increase habitat for structure-oriented finfish and invertebrate communities.

Recreational anglers often take advantage of artificial reefs, which provide refuge for recreational species and their prey. Therefore, these artificial sites have been excluded from the WTA and ECCs, although some sites are present near or at the borders of the WTA and the Monmouth ECC. Some of the fishing hotspots in proximity to the WTA and ECCs are: San Saba Wreck, Great Isaac Wreck, Garden State North Reef, The Fingers, The Wall, Atlantic City Reef Site, and the Lobster Hole. Artificial reefs and areas identified as recreational fisheries hotspots are shown in Figure 7.4-19.

New Jersey also hosts several offshore fishing tournaments each year and participating anglers may transit or fish within the WTA and ECCs, though fishing effort in any geographic area is highly dependent on the productivity of that area. Fishing tournaments are economically important to local cities or towns where shoreside amenities and services (e.g., dockage, fuel, supplies, and lodging) support tournament participants. In 2020, for example, 20 such tournaments were held in New Jersey (Table 7.3-1). These events primarily occur in the summer months and are geared toward anglers targeting HMS.

Table 7.3-1 New Jersey Recreational Fishing Tournaments, 2020

Tournament	Location	Start Date	End Date
Manasquan River Marlin Tuna Club (MRMTC) Blue Fin Tuna (BFT) Tournament	Brielle, New Jersey	5/29/2020	6/30/2020
South Jersey Shark Tournament	Cape May, New Jersey	6/4/2020	6/6/2020
Tuna Mania	Point Pleasant Beach, New Jersey	6/6/2020	6/14/2020
Bluefin Tournament	Brielle, New Jersey	6/11/2020	6/14/2020
Ocean City Marlin and Tuna Club (OCMTC) Shark & Bluefin Tournament	Ocean City, New Jersey	6/13/2020	6/14/2020
Mako Fever	Point Pleasant, New Jersey	6/13/2020	6/21/2020
Tuna Fever	Point Pleasant, New Jersey	6/13/2020	6/21/2020
The Mid-Atlantic Tuna Tournament	Cape May, New Jersey	6/18/2020	6/21/2020
Beach Haven Marlin and Tuna Club (BHMTC) Mako And Tuna Tournament	Beach Haven, New Jersey	6/20/2020	6/20/2020
The Mid-Atlantic Cup	Cape May, New Jersey; Manasquan Inlet, New Jersey; Ocean City, Maryland	7/4/2020	7/4/2020
Offshore Tournament	Ocean City, New Jersey	7/6/2020	7/12/2020
War at The Shore	Manasquan, New Jersey	7/6/2020	7/12/2020
1st Offshore Tournament - War at The Shore	Beach Haven, New Jersey	7/6/2020	7/19/2020
Beach Haven White Marlin Invitational	Beach Haven, New Jersey	7/20/2020	7/24/2020
Yacht Club of Stone Harbor Invitational Marlin	Cape May, New Jersey	7/24/2020	7/25/2020
Inshore Offshore Team Tournament	Ocean City, New Jersey	7/25/2020	7/26/2020
The Mid-Atlantic Tournament	Cape May, New Jersey; Ocean City, Maryland	8/17/2020	8/21/2020

Table 7.3-1 New Jersey Recreational Fishing Tournaments, 2020 (Continued)

Tournament	Location	Start Date	End Date
Offshore Overnight Tournament	Beach Haven, New Jersey	8/29/2020	10/4/2020
MRMTC Offshore Open	Brielle, New Jersey	8/31/2020	9/7/2020
MRMTC Offshore Open (Summer)	Brielle, New Jersey	8/31/2020	9/7/2020

7.3.2 Potential Impacts and Proposed Environmental Protection Measures

Data from economic impact studies in Europe and the U.S. indicate the potential for net positive gains to recreation and tourism activities due to the attractive quality of offshore wind projects (ICF 2012). Proposed Project activities are not expected to have long-term negative effects on recreation and tourism. Only localized, short-term adverse effects could be experienced in certain onshore and offshore areas primarily near and during active construction activities. To further lower the potential for adverse effects to people engaging in recreational and tourism activities near Project activities, Atlantic Shores, its CLOs, FLO, and its Recreational FIR will liaise, throughout all phases of the Projects, the public to raise awareness of Project activities, reconcile issues, and facilitate the exchange of information.

Atlantic Shores is committed to scheduling construction activities near the shoreline outside of peak tourism season (Memorial Day to Labor Day). However, planned construction activities, onshore and offshore, may temporarily disrupt or limit people from accessing work areas for public health and safety reasons where heavy equipment or vessels are maneuvering. For marine construction, most of these work areas will be 8 mi (12.9 km) or more offshore and localized to specific locations within the Offshore Project Area (i.e., foundation installation and WTG locations). Onshore, the presence and movement of Project personnel, equipment, and vehicles during construction could generate short periods of activity resulting in traffic, noise, and light, which may temporarily change the experience in isolated locations near the work activity. Similar effects may be expected during decommissioning only if onshore and offshore Project components are removed or significantly altered.

During O&M, the primary concern related to recreation and tourism is the presence of the WTGs and OSSs and the effects their presence may have on tourism (i.e., attracting or deterring visitors) and recreation (i.e., attracting or deterring recreational boaters and fishermen). Otherwise, Project activities during O&M involve routine movements of Project vessels, vehicles, and personnel, which would not lead to any measurable effect. Only in limited, non-routine situations where a Project component requires substantial repairs or replacement, would disturbances, albeit very localized and short-term, occur.

The specific potential impact producing factors that may affect recreation and tourism during Project construction, O&M, or decommissioning are presented in Table 7.3-2 and detailed further in the following sections. Potential effects on public health are discussed in Section 9.0 Public Health and Safety.

Table 7.3-2 Impact Producing Factors for Recreation and Tourism

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Installation and Maintenance of New Structures and Cables	●	●	●
Presence of Structures	●	●	●
Traffic (Vessel and Vehicle)	●	●	●
Noise	●		●
Light	●		●

The maximum Project Design Envelope (PDE) analyzed for potential effects to recreation and tourism is the maximum onshore and offshore build-out of the Projects (see Section 4.11 of Volume I), assuming the use of all piled foundations for the assessment of pile driving noise. The potential impacts to recreation and tourism are anticipated to be the same for Projects 1 and 2.

Given the unique characteristics of recreational fishing compared to other types of recreation and tourism, the description of potential impacts is separated into two categories: recreation and tourism, and recreational fishing.

7.3.2.1 Installation and Maintenance of New Structures and Cables

Recreation and Tourism

The installation and maintenance of new foundation structures, WTGs, OSSs, offshore cables, onshore cables, and onshore substations may affect recreation and tourism through direct temporary access restrictions and disruptions in distinct onshore and offshore areas when these Project activities take place. Indirect or secondary, temporary effects may be experienced for the duration of Project activities by recreation and tourism businesses that operate in or around construction areas. In any phase when there are installation, maintenance, or removal (decommissioning) activities, there will be established work areas and specific periods of time when work takes place. During these periods of onshore and offshore work activities, recreational and tourism activities will be temporarily interrupted at discrete locations to allow Project activities to be conducted safely.

During all Project phases, Atlantic Shores will post notices on their website and will work with local officials to inform the public of Project activities. The Projects will have a designated Marine Coordinator that will communicate Project schedule information to user groups that may be impacted by certain onshore and offshore activities. The Marine Coordinator, like the Atlantic Shores CLOs, FLO, and Recreational FIR, will serve as another point of contact for Project stakeholders to facilitate the exchange of information, answer questions, and address any Project-related concerns. These actions have been established to minimize impacts to recreation and tourism to the maximum extent practicable

The Presence of Structures section addresses the change in viewshed and user experience resulting from the WTGs and OSSs, although this topic is more thoroughly analyzed in Section 5.0 Visual Resources.

Recreational Fishing

Construction and support vessels will be present within the WTA and ECCs during pre-installation and installation activities for WTGs, OSSs, offshore cables (export, inter-array, and inter-link), and other Project components. It is anticipated that temporary safety zones will be established around Project construction vessels and installation activities, which may cause short-term disruption to recreational fishing activities in proximity to the temporary safety zones in the WTA and/or ECCs. The duration of effects depends, in part, on the installation method selected. Regardless of installation method, only a limited area surrounding the installation activity will be affected at any given time, leaving surrounding areas available for recreational fishing activities. Installation methods and timeframes are described in Section 4.0 of Volume I. For the ECCs, it is anticipated that the duration of construction will be on the order of several months. Additionally, during Project installation, noise from activities such as pile-driving or vessel engines may cause the temporary, short-term displacement of some target species (see Section 4.6 Finfish, Invertebrates, and Essential Fish Habitat).

During all Project phases, Atlantic Shores will adhere to its Fisheries Communication Plan (see Appendix II-R) to avoid and minimize interactions with fishing vessels and fishing gear. Atlantic Shores, its FLO, and its Recreational FIR will continue to liaise with the fishing community to reconcile issues and facilitate the exchange of information. Atlantic Shores will also employ a Marine Coordinator to monitor daily vessel movements, enforce temporary safety zones, and to be the primary point of contact with regulators, authorities, and stakeholders. Additionally, Atlantic Shores will coordinate with the U.S. Coast Guard (USCG) to distribute a local Notice to Mariners at each phase of Project development when vessels and/or equipment are deployed offshore. This notice will show the development area, depicted on local nautical charts, with a description of the assets in the area, the activities taking place, any safety parameters, and timelines of the operation/deployment. The Projects' website will also include a "For Mariners" page containing Project information specifically for commercial and recreational fishermen. These activities and actions have been established to minimize impacts to recreational fishing to the maximum extent practicable.

7.3.2.2 Presence of Structures

Recreation and Tourism

The Offshore Project Area does not have any permanent, visible structures currently located within it. Once installed, the Projects result in a change in the visual and physical character of the ocean environment. People engaged in offshore recreation or tourism activities (e.g., boating, sailing, other watercraft, etc.) may choose to explore the waters in and around the WTGs to experience the structures or to fish near the structures. Some visitors may choose to recreate outside of the WTA. Data from European and U.S. studies of coastal area visitation and the presence of offshore wind farms, suggest that recreational or visitation choices made by individuals vary greatly and are strongly influenced by factors both dependent and independent of the presence of wind turbines (ICF 2012; Parsons and Firestone 2018). For example, changes in people's access to natural resources (e.g., fishing, boating) or their general perception about offshore wind, seem to influence their opinion regarding perceived versus actual effects. European studies also suggest that certain factors, such as age, income, types of tourism/recreation choices, and location, influence the magnitude of perceived effects (ICF 2012).

Decisions by both beachgoers and non-beachgoers to visit shoreline areas with views of an offshore wind farm are influenced by more than just the offshore structures (Parsons and Firestone 2018). How developed a shoreline is greatly influences how its visitors will react to offshore WTGs and was the single most important beach characteristic in the survey for a BOEM 2018 Study. Parsons and Firestone (2018) estimated trip loss for beaches with boardwalks was 6.5% lower than for beaches without boardwalks. Beaches with boardwalks and more non-beach related activities for beachgoers may experience fewer negative effects because visitors are more concerned with non-beach related activities than the presence of an offshore wind facility (Parsons and Firestone 2018).

Recreation and tourism may benefit from the presence of operational WTGs. Parsons et al. (2020) have documented large increases in the number of trips to the shoreline to view offshore wind projects in parts of Europe. New studies of the Block Island Wind Farm corroborate positive effects on tourism. In a study relying on trends in summer vacation property rentals, researchers at the University of Rhode Island observed a 19% increase in summer monthly revenue for Block Island vacation property landlords compared to other regional summer vacation rental hotspots like Narragansett and Westerly, Rhode Island and Nantucket, Massachusetts (Carr-Harris and Lang 2019). The factors that may be driving the increase in rental volume are not defined in the study, but the researchers hypothesized that tourists may be curious to see the wind farm or that the recreational fishing near the wind farm has improved significantly, thereby increasing interest to visit the wind farm itself (Carr-Harris and Lang 2019).

Recreational Fishing

Introduction of new offshore foundations (for WTGs, OSSs, and the meteorological [met] tower), scour protection, offshore cables, and offshore cable protection will introduce habitat complexity and diversity in a largely homogenous, sandy environment, which may result in habitat conversion/creation and species attraction. The presence of structures may also affect navigation by recreational fishermen within the WTA; however, the layout has been developed to accommodate vessel transit to local fishing ports and offshore fishing grounds.

As described more fully in Section 4.6 Finfish, Invertebrates, and Essential Fish Habitat, the presence of structures and cable protection can create a "reef effect," providing ecological benefits and habitat diversity in the Mid-Atlantic Bight. The offshore foundations, scour protection, and cable protection provide habitat for developing new ecosystems and attract species seeking prey or refuge from predators. For example, the creation of structured habitat is expected to benefit species such as striped bass, black sea bass, and Atlantic cod by potentially increasing their habitat. Similarly, the presence of foundations may increase habitat and provide forage and refuge for some migratory finfish targeted by recreational fishermen. Increasing potential habitat for fish and their prey may positively affect recreational fishing within the WTA. Additionally, interest in visiting the WTA may result in an increased number of fishing trips originating from New Jersey ports. These additional vessel trips could support an increase in angler expenditures at shoreside facilities servicing for-hire recreational fishermen (Kirkpatrick et al. 2017).

In September 2019, Atlantic Shores signed a MOU with Stockton University to sponsor research, support faculty and students, and investigate technology innovation related to the development of offshore wind energy. One of the projects identified under this MOU is to investigate potential fisheries benefits resulting from offshore wind structures. One such effect is the "reef effect," or the aggregation or generation of fish biomass, biodiversity, or movement in and around artificial structures. Findings from this research will be used to support the design and implementation of pre-, during, and post-construction fisheries monitoring in and around the WTA and ECCs.

Atlantic Shores is working to site Project infrastructure to avoid areas of concentrated fishing activity to the maximum extent practicable. The WTA and ECCs will be open to marine traffic and no permanent restrictions to recreational fishing are proposed during the O&M phase of the Projects. Limited restrictions may occur during some maintenance activities, where temporary safety zones may be established around maintenance vessels and activities.

Atlantic Shores is also working to minimize effects to recreational fishing from the presence of offshore cables. All offshore cables will have a target minimum burial depth of 5 to 6.6 feet (ft) (1.5 to 2 meters [m]). The cable burial depth is based upon a cable burial risk assessment that considers activities such as fishing practices and anchor use to develop a safe target burial depth for the cables (see Appendix II-A5). Atlantic Shores has determined that the target burial depth is sufficient to protect the cables from expected fishing practices, so the presence of these cables is not anticipated to interfere with any typical recreational fishing practices.

Atlantic Shores has conducted a detailed Navigation Safety Risk Assessment (NSRA), included as Appendix II-S, for the Offshore Project Area. The NSRA indicates that the proposed WTG and OSS layout will safely accommodate the transit of recreational fishing vessels through the WTA. The

1.0 nautical miles (nm) (1.85 km) east-northeast corridors will accommodate all the existing AIS-equipped fishing fleet and 99.6% of the Automatic Identification System (AIS)-equipped recreational vessels. A 0.60 nm (1.1 km) corridor will accommodate 99.9% of the fishing fleet and 92.4% of the recreational vessels. A 0.54 nm (1.0 km) diagonal corridor will accommodate 99% and 89% of the fishing and recreational vessels, respectively. Navigational impacts are not anticipated along the ECCs.

To facilitate safe navigation, all foundations will contain marine navigation lighting and marking in accordance with the USCG and BOEM guidance. To aid mariners navigating within and near the WTA, each WTG position will be maintained with a Private Aid to Navigation (PATON). Atlantic Shores will work with the USCG and BOEM to determine the appropriate marine lighting and marking schemes for the proposed offshore facilities. Based on USCG District 5 Local Notice to Mariner (LNM) 45/20, Atlantic Shores expects that each permanent structure (including WTGs, OSSs, and the met tower) will include unique alphanumeric identification and lights that are visible in all directions. Sound signals will be installed on select foundations in accordance with the Marking and Lighting Plan that will be developed in consultation with the USCG. Atlantic Shores will have the capability to mark each permanent structure including WTG, OSS, and meteorological position (virtually or using physical transponders) with AIS; however, the number, location, and type of AIS transponders will be determined in consultation with USCG. Additional information on marine navigation lighting and marking on the foundations can be found in the NSRA (see Appendix II-S). Additionally, WTG and OSS foundations will be equipped with access ladders to allow distressed mariners access to an open refuge area above the splash zone. The presence of a person on the offshore structure will be detected, for example, by cameras or intrusion detectors.

As explained in Section 8.2 of the NSRA (see Appendix II-S), the presence of structures in the WTA is anticipated to have only a minor impact on recreational fishing vessels transit routes. With input from the FIR, the potential rerouting of recreational fishing vessels through and around the WTA was analyzed. Based on this analysis, there would be very little change in overall distance traveled if vessels elected to navigate through the WTA, routing around turbines where and if necessary, though it is assumed vessels may operate at slower speeds when traveling within the WTA. If vessels elect to transit around the WTA, it is anticipated that rerouting will have a small effect on travel distance and time, at most, increasing travel distance by up to 1.6 nm (3.0 km) and increasing travel time by up to approximately 3.8 minutes. Several routes would not be impacted by the WTA and for most routes, transiting around the WTA would result in less than 0.7 nm (1.3 km) of additional distance traveled.

7.3.2.3 Noise and Vibration

In-air sounds and vibrations generated during activities, primarily the movement of heavy equipment and engine sounds from vessel and vehicle traffic, have the potential to affect recreation and tourism. It is important to note that to the maximum extent practicable, onshore equipment that produce noise will be located to avoid areas where recreational and tourism activities take place, so adverse effects of Project-related noise and vibration are greatly minimized. Except for the ECC landfall points at the shoreline (where the export cables will be installed via horizontal directional drilling [HDD] under the beach), the Project areas do not encompass specific recreation and tourism areas. Most Project-related noise and vibration would be short-term and localized to the immediate work areas.

Sounds from the operation of Project vessels, vehicles, equipment, and facilities can occur at levels that are considered noisy. Noise is controlled and abated by State (i.e., stationary commercial and industrial noise sources) and local (i.e., construction noises) regulations to primarily safeguard public health and safety. Noise and vibration generated during Project construction, O&M, and decommissioning have the potential to result in temporary disruption of few individuals participating in recreational and tourist activities within range of noise and vibration-producing Project activities. Noise and vibration have the potential to disturb people that want to utilize areas where and when the noise and vibration is occurring.

Noise and vibration will be most prevalent during periods of construction (and possibly decommissioning). Very limited direct effects on recreation and tourism activities are expected offshore during construction because temporary safety zones will be established around work areas and boaters will be notified when construction activities are ongoing. The Onshore Project Area is characterized by existing development, vehicle traffic and commercial activity. Noise and vibration from the Projects are expected to be limited in the context of the surrounding land uses, localized and short-term. Onshore construction will be scheduled outside of peak tourist season (Memorial Day through Labor Day) in the affected counties of Atlantic and Monmouth. Additional detail regarding onshore noise is provided in Appendix II-U Onshore Noise Report.

7.3.2.4 Vessel and Vehicle Traffic

Recreation and Tourism

Only localized, short-term effects on recreation and tourism from Project-related vehicle and vessel traffic could be expected during construction (and possibly decommissioning).

Onshore vehicle traffic could result in detours to certain routes or restricted parking, especially near the cable landings, which could affect visitors. However, onshore construction will be scheduled outside of peak tourism periods (Memorial Day through Labor Day) and incremental increases in traffic volume associated with the construction and operation of onshore facilities will be concentrated along the cable routes and at the substations (see Section 7.9 Onshore Transportation and Traffic).

Increased vessel traffic will occur during construction, O&M, and decommissioning, as described in detail in Section 7.6 Navigation and Vessel Traffic. On average, approximately two to six vessel round trips per day between shore and the Offshore Project Area are expected during construction and O&M. Atlantic Shores will manage vessel activities to minimize disruptions to mariners (including recreational fishermen) to the maximum extent practicable. Recreational boaters may experience few and isolated situations when they might modify activity specifically because of

Project vessel traffic. These situations would mostly be concentrated in the WTA or along the ECCs where most of the Project vessels will remain for days or weeks at a time, during construction, and will not be transiting to port facilities on a frequent basis.

Recreational Fishing

As discussed in the previous section, Project vessel traffic is not expected to result in impacts other than limited and isolated instances during construction when vessels are temporarily occupying a work area in the WTA or ECCs. Otherwise, Project vessels used for construction and O&M will operate primarily from ports with little commercial fishing activity. Consequently, competition for dock- and shore-side services within these ports is not expected to affect recreational fishing activities.

Atlantic Shores will utilize a Marine Coordinator to manage vessel movements throughout the Offshore Project Area. The Marine Coordinator will be charged with monitoring daily vessel movements, implementing communication protocols with external vessels both in port and offshore to avoid conflicts, and monitoring safety zones. Communications will begin prior to construction and will continue throughout the construction process. Daily coordination meetings between contractors are expected to be held to avoid conflicting operations at port facilities and transit routes to the Offshore Project Area. To provide construction zone control, the Marine Coordinator will employ radio communications and safety vessels to address any vessels entering the construction zone.

The Marine Coordinator will be responsible for coordinating with the USCG for any required Notices to Mariners, and during construction will be the primary point of contact with the USCG, port authorities, State and local law enforcement, marine patrol, port operators, and commercial operators (e.g., ferry, tourist, and fishing boat operators).

Communication with the recreational fishing community will take place throughout all Project phases. As described in the Fisheries Communication Plan (see Appendix II-R), Atlantic Shores will regularly distribute updated asset and operational awareness bulletins showing the development area, depicted on local nautical charts, with a description of the assets in the area, the activities taking place, timelines, and relevant contact information. Finally, Atlantic Shores also expects to establish specific methods for communicating with fishermen while they are at sea including establishing a 24-hour phone line to address any real-time operational conflicts and/or safety issues.

Further, all construction vessels and equipment will display the required navigation lighting and day shapes and make use of AIS as required by the USCG.

7.3.2.5 Light

Project-generated light from equipment, vehicles, and vessels during construction, and offshore Project components during O&M, may be visible to people participating in recreational or tourism activities. Visual impacts from the Projects are discussed in Section 7.3.2.2 and in Section 5.0 Visual Resources. Direct effects of Project light sources on recreational and tourism are not anticipated.

Within the Onshore Project Area, construction lighting may be necessary to illuminate portions of the onshore Project work areas in order to maintain safety standards for workers and the surrounding communities. It is likely, however, that onshore nighttime work will be limited for a variety of reasons, including adherence to local zoning ordinances, building permit conditions, and community agreements. Many of the areas along the Onshore Project Area are already illuminated by artificial light because they are associated with the existing substations, commercial areas, or roadways. The specific Project-related information regarding Project light sources and anticipated effects are also discussed in Section 5.0 Visual Resources.

During O&M, the onshore substations will require security lighting on buildings. The lighting will be the minimum necessary to comply with security and safety guidelines and will not illuminate adjacent areas. No other portions of the Onshore Project Area will have permanent lighting. Within the Offshore Project Area, the WTGs, OSSs, met tower, and their associated foundations will be equipped with marine navigation lighting in accordance with Federal Aviation Administration (FAA), USCG, and BOEM requirements. As discussed in Section 5.0 Visual Resources, Atlantic Shores is considering use of an Aircraft Detection Lighting System (ADLS), subject to FAA and BOEM approval, which could substantially reduce the amount of time that the aviation obstruction warning lights are illuminated, minimizing visual impacts on recreation and tourism activities.

7.3.2.6 Summary of Proposed Environmental Protection Measures

Atlantic Shores understands the importance of recreation and tourism within New Jersey's coastal communities and has developed the following proposed environmental protection measures:

Recreation and Tourism

Atlantic Shores is working to maximize the positive economic and environmental benefits of the Projects. As discussed in Section 7.3.2.2, the Projects will likely result in beneficial effects spurred by the operation of the Projects including increased visitation to the New Jersey shoreline to view the Projects or to fish around the new structures, which are anticipated to enhance recreational fisheries over time. Atlantic Shores is also committed to the following proposed environmental protection measures:

- Atlantic Shores has worked in collaboration with local communities to site Project facilities and develop Project construction techniques and schedules that will avoid disruption to the maximum extent possible.
- Atlantic Shores will conduct onshore construction outside of the tourist season (Memorial Day to Labor Day).
- The construction schedule will be developed in accordance with municipal noise ordinances.

- Additional mitigation measures including those designed to mitigate potential visual effects, ensure navigational safety, and reduce community disruptions from facility noise and vibration are discussed in Sections 5.0 Visual Resources, 7.6 Navigation and Vessel Traffic, and 8.0 In-Air Noise and Hydroacoustics, respectively.

Recreational Fishing

- Atlantic Shores is committed to ensuring coexistence with recreational fishermen and has sited Project infrastructure to avoid concentrated areas of fishing effort to the maximum extent practicable and to accommodate vessel transit to local fishing ports and offshore fishing grounds. Atlantic Shores is also committed to the following proposed environmental protection measures:
- Atlantic Shores is a founding member of the ROSA, which advances regional research and monitoring of fishery and offshore wind interactions.
- Atlantic Shores signed a MOU with Stockton University to sponsor research to investigate technology development related to the development of offshore wind energy and to investigate potential fisheries benefits resulting from offshore wind structures. Findings from this research will be used to support the design and implementation of pre-, during, and post-construction fisheries monitoring.
- Information from industry conversations, direct data gathering exercises with fishermen, consultations with government agency representatives, and analysis of public data have been compiled and used to guide the siting, design, O&M, and decommissioning of the Projects.
- The proposed layout was developed in close coordination with fishermen and to align with the predominant flow of vessel traffic.
- Atlantic Shores will have the capability to mark each WTG, OSS, and met tower position (virtually or using physical transponders) with AIS. The number, location, and type of AIS transponders will be determined in consultation with USCG.
- Project infrastructure is being sited and oriented to avoid concentrated areas of recreational fishing activity (e.g., artificial reefs) to the maximum extent practicable.
- Offshore cables will be buried at a sufficient depth of 5 to 6.6 ft (1.5 to 2 m) to avoid interaction with fishing gear.
- To facilitate safe navigation, all offshore structures will include marine navigation lighting and marking in accordance with USCG and BOEM guidance. Atlantic Shores will continue to work with the USCG and BOEM to determine the appropriate marine lighting and marking schemes for the proposed offshore facilities.
- . Each permanent structure (including WTGs, OSSs, and the met tower) will include unique alphanumeric identification and lights that are visible in all directions. Sound signals will be installed on select foundations in accordance with the Marking and Lighting Plan that will be developed in consultation with the USCG.

- WTG, OSS, met tower, and met buoy positions will be maintained with PATONs.
- WTG and OSS foundations will be equipped with access ladders to allow distressed mariners access to an open refuge area above the splash zone. The presence of a person on the offshore structure will be detected, for example, by cameras or intrusion detectors.
- A Fisheries Communication Plan has been developed that defines outreach and engagement with fishing interests during all phases of the Projects, from development through decommissioning.
- Atlantic Shores has hired Community Liaison Officers (CLOs) to help inform the public of Project activities and to support productive and effective dialogue with stakeholders.
- Atlantic Shores employs an active commercial fisherman, Captain Kevin Wark, as the FLO and an active recreational fisherman, Captain Adam Nowalski, as the Recreational FIR to support communication and feedback from the fishing community. Atlantic Shores is the first and only developer to hire a Recreational FIR.
- A "For Mariners" Project webpage (www.atlanticshoreswind.com/mariners/) has been developed that contains the latest news and events, real-time Project buoy data display and Project vessel tracking chart, Project vessel schedules, and FLO and Recreational FIR contact information.
- Updated asset and operational awareness bulletins will be regularly distributed showing the development area, depicted on local nautical charts, with a description of the assets in the area, the activities taking place, timelines, and relevant contact information. Atlantic Shores will also publish announcements and share updates with print and online industry publications and local news outlets.
- Specific methods for communicating with offshore fishermen while they are at sea are being established, including a 24-hour phone line to address any real-time operational conflicts and/or safety issues.
- A Marine Coordinator will be employed to monitor daily vessel movements, implement communication protocols with external vessels both in port and offshore to avoid conflicts, and monitor safety zones. Daily coordination meetings between contractors are expected to be held to avoid conflicting operations at port facilities and transit routes to the Offshore Project Area. The Marine Coordinator will be responsible for coordinating with the USCG for any required NTMs.

7.4 Commercial Fisheries and For-Hire Recreational Fishing

This section describes commercial fisheries and for hire recreational fishing in the Atlantic Shores Offshore Project Area, associated impact producing factors (IPFs), and measures to avoid, minimize, or mitigate potential effects to these resources during construction, operations and maintenance (O&M), and decommissioning. The waters offshore New Jersey are used by a variety of commercial and for-hire recreational fishermen. Atlantic Shores recognizes the importance of fisheries and marine resources and is committed to ensuring coexistence with commercial and for-hire recreational fishermen operating within the Wind Turbine Area (WTA).

Atlantic Shores has dedicated considerable resources to solicit input from commercial and for-hire recreational fishermen and boaters regarding potential Project-related effects. Atlantic Shores has developed a detailed Fisheries Communication Plan (see Appendix II-R) and has hired a Fisheries Liaison Officer (FLO) and a Recreational Fishing Industry Representative (FIR); both of whom are local, New Jersey fishermen. Supported by the FLO and Recreational FIR, Atlantic Shores has engaged with the industry to collect data directly from the fishing community; consulted with government agency representatives; and analyzed publicly available data to inform this assessment of commercial and for-hire recreational fisheries. This information also guides the siting, design, O&M, and decommissioning of the Projects.

In addition to promoting communication, Atlantic Shores is dedicated to helping to preserve and understanding New Jersey's marine resources both through interpreting existing data and by conducting new collaborative research where data gaps exist. Atlantic Shores is a founding member of, and contributor to, the Responsible Offshore Science Alliance (ROSA), which shares Atlantic Shores' commitment to improve understanding of ocean and coastal ecosystems by advancing regional research and monitoring of fishery and offshore wind interactions. Atlantic Shores is also a sponsor of research with Stockton University to investigate potential fisheries benefits from offshore wind structures (see Section 1.4.2 of Volume I). Additionally, Atlantic Shores is working closely with the surf clam industry to better understand how the effects of climate change are influencing the distribution and abundance of surf clams within the Lease Area OCS-A 0499 (Lease Area) and the greater Mid-Atlantic Bight. In partnership with Rutgers University, Atlantic Shores is funding a multi-phase modeling study that evaluates the economics of the Atlantic surf clam fishery in response to current and future wind farm activity over the approximate 30-year Projects' life span. Preliminary study results of the oceanographic and biological forecasts suggest that Atlantic surf clam habitat may expand and stock biomass may increase across the shelf over the next three decades (Rutgers University 2023). Final results of the study which will evaluate the value of this stock expansion to the commercial fleet and associated fishing opportunities across the Offshore Project Area are pending.

In addition to this section on commercial fisheries and for-hire recreational fishing, Atlantic Shores has prepared a detailed assessment of Finfish, Invertebrates, and Essential Fish Habitat in Section 4.6. Recreation and Tourism (including not-for-hire recreational fishing) are discussed in Section 7.3. Atlantic Shores has also conducted a detailed Navigation Safety Risk Assessment (NSRA), which is included as Appendix II-S and summarized in Section 7.6.2.1.

7.4.1 Affected Environment

This section describes the fishing fleets, fishing ports, fishing activity, and the value of fish harvested in the Offshore Project Area, which includes the WTA, Monmouth Export Cable Corridor (ECC), and the Atlantic ECC (see Figure 1.0-1). The affected environment evaluated in this section includes waters that are fished or transited by fishermen operating primarily from ports in New Jersey, though fishermen operating vessels from North Carolina to New Hampshire may fish in the continental shelf waters off the coast of New Jersey and utilize port facilities within the State. This section focuses particularly on fishing activities that occur within the WTA and ECCs.

This section uses multiple sources of information and data to assess and characterize commercial and for-hire recreational fishing activity. Primary sources used to evaluate commercial and for-hire recreational fishing activity include, but are not limited to the following:

- mapping of Vessel Trip Report (VTR) and Vessel Monitoring System (VMS) data by the Northeast Regional Ocean Council (NROC) and the Mid-Atlantic Regional Council on the Ocean (MARCO);
- mapping and analysis of Automatic Identification System (AIS) data for commercial fishing data (see also Appendix II-S, NSRA);
- analysis of a National Marine Fisheries Service (NMFS) dataset that includes modeled results of VTRs and clam logbook data linked to dealer data for value and landings information that were then queried for spatial overlap with the WTA and ECCs;
- technical reports funded by the Bureau of Ocean Energy Management (BOEM) and prepared by NMFS, as well as other academic and government-funded studies and reports; and
- outreach and engagement to commercial fisheries stakeholders.

Additional information about these sources is provided in Section 7.4.2.1.

Section 7.4.2 describes commercial fisheries, which are regional in nature, such that species of interest often span across large areas in the ocean and fishermen catching those species may port along the Atlantic coastline. Based on currently available data, vessels operating from New Jersey commercial fishing ports are the primary commercial fishing vessels operating in the Offshore Project Area. Vessels operating from North Carolina to New Hampshire may have some presence within the WTA and ECCs; however, available data indicates that ports and fishing fleets outside of New Jersey are not expected to have meaningful economic exposure within the Offshore Project Area and are, therefore, described briefly in this section.

Section 7.4.3 describes for-hire recreational fishing activities in the waters offshore New Jersey.

7.4.1.1 New Jersey Commercial Fishing Ports

Statewide between 2015 and 2019 New Jersey commercial fisheries landed an annual average of 168.6 million pounds of catch, worth approximately $178.7 million. At New Jersey ports the primary landings by volume and value are typically Atlantic sea scallops (*Placopecten magellanicus)*, surf clam (*Spisula solidissima)* and ocean quahog (*Arctica islandica*), and menhadens (*Brevoortia spp.*). Like many coastal states, however, New Jersey hosts a diverse commercial fishery with many species that are important to its fishing fleets and ports. Table 7.4-1 shows those species of regional significance landed in New Jersey with an average annual value more than $1.0 million for the period 2015 to 2019. The primary gear utilized in these fisheries are dredges, trawls, gillnets, pots/traps, purse seines and hook/line.

Table 7.4-1 Primary New Jersey Commercial Species, 2015–2019

Species	Average Annual Landings (lb)	Average Annual Value (U.S. Dollars [USD], Nominal)
Sea Scallop (*Placopecten magellanicus*)	9,793,879	$100,007,317
Menhadens (*Brevoortia* spp.)	77,272,224	$12,459,675
Atlantic Surf Clam (*Spisula solidissima*)/Ocean Quahog (*Arctica islandica*)	13,881,986	$11,074,024
Blue Crab (*Callinectes sapidus*)	6,244,608	$7,990,454
Shortfin Squid (*Illex illecebrosus*)	15,520,088	$7,119,096
Summer Flounder (*Paralichthys dentatus*)	1,317,004	$4,888,203
Longfin Squid (*Doryteuthis [Amerigo] pealeii*)	3,500,448	$4,562,628
Black Sea Bass (*Centropristis striata*)	662,447	$2,403,619
American Lobster (*Homarus americanus*)	367,924	$2,023,568
Monkfish (*Lophius americanus*)	1,758,066	$1,831,241
Scup (*Stenotomus chrysops*)	2,294,371	$1,480,810
Bigeye Tuna (*Thunnus obesus*)	270,568	$1,256,213
Total	**133,271,542**	**$158,377,413**
Golden Tilefish (*Lopholatilus chamaeleonticeps*)	387,929	$1,280,565

Source: National Oceanic and Atmospheric Administration (NOAA), 2020.

There are four primary commercial fishing ports in New Jersey: Atlantic City, Cape May/Wildwood, Long Beach/Barnegat, and Point Pleasant. Commercial fishing vessels active in the Offshore Project Area are understood to be operating predominantly from the New Jersey ports listed on Table 7.4-2.

Table 7.4-2 Commercial Landings at New Jersey Ports[1]

Port	2015		2016		2017		2018		2019	
	lb[2]	USD[2]	lb[2]	USD[2]	lb[2]	USD[2]	lb[2]	USD[2]	lb[2]	USD[2]
Atlantic City	25.9	$19.6	24.3	$19.7	24.7	$18.6	24.8	$18.2	23.5	$17.2
Cape May-Wildwood	77.2	$71.6	46.6	$84.7	101.6	$81.0	101.2	$66.3	94.5	$90.0
Long Beach-Barnegat	6.3	$25.4	7.2	$26.9	7.6	$24.7	6.3	$24.3	7.0	$24.9
Point Pleasant	24.4	$28.2	26.3	$32.1	37.5	$35.3	43.3	$32.4	37.3	$35.4
Total	**133.8**	**$144.8**	**104.4**	**$163.4**	**171.4**	**$159.6**	**175.6**	**$141.2**	**162.3**	**$167.5**

[1]Source: NOAA 2020

[2]Values are shown in millions (pounds of fish and U.S. dollars)

Atlantic City

The Atlantic City commercial fishery consists of a sizable fleet of vessels harvesting surf clams and ocean quahogs alongside a smaller number of inshore crab, hard clam, net, and pot vessels. The clam fleet has reportedly declined in recent years due to changes in Federal law allowing the consolidation, lease, and transfer of individual quotas (New Jersey Department of Agriculture 2020). Nonetheless, in 2020, 30 federally permitted vessels listed Atlantic City as their principal port, 27 of which hold permits for ocean quahogs and surf clam.

In 2019, commercial fishing vessels landed 23.5 million pounds of catch worth an estimated $17.2 million in Atlantic City, making it the 60th most valuable port in the U.S. Most of Atlantic City's commercial fishing revenue comes from surf clam, ocean quahog, and scallops (NEFSC 2014). Over the 5-year period of 2014 to 2018, an annual average of approximately $670,000 of all species harvested from the Lease Area were landed in Atlantic City (NMFS 2021a). As further discussed in Section 7.4.2.4, during the same 5-year period, an annual average of approximately $250,000 of all species harvested from within the smaller geographic area of the WTA were landed in Atlantic City. Atlantic City's annual average landings from the WTA during this 5-year period accounted for approximately 1.3% of the port's total average annual landings. The five most recent years of all commercial landings in Atlantic City are summarized in Table 7.4-2 and are discussed relative to the Offshore Project Area in Section 7.4.2.4.

Cape May/Wildwood

The Port of Cape May/Wildwood is the largest commercial fishing port in New Jersey. The port serves as the center of fish processing and freezing in New Jersey and has numerous shore side support and supply services. Cape May is home to Garden State Seafood Association (GSSA) whose membership includes 92 commercial fishing vessels. Cape May has an active trawler fleet in addition to scallop and surf clam dredge vessels, pot boats, handgear, and purse seiners (New Jersey Department of Agriculture 2020).

The Cape May/Wildwood commercial fishing industry landed 94.5 million pounds of catch in 2019 worth an estimated $90.0 million, making it the eighth-most valuable port in the U.S. Over the 5-year period from 2014 to 2018, an annual average of approximately $92,000 of all species harvested from the Lease Area were landed in Cape May (NMFS 2021a). As further discussed in Section 7.4.2.4, during the same 5-year period, an annual average of approximately $60,000 of all species harvested from within the smaller geographic area of the WTA were landed in Cape May/Wildwood. Cape May/Wildwood’s average annual landings from the WTA during this 5-year period accounted for approximately 0.1% of the port’s total annual average landings. The five most recent years of all commercial landings in Cape May/Wildwood are summarized in Table 7.4-2 and are discussed relative to the Offshore Project Area in Section 7.4.2.4.

Long Beach/Barnegat

Barnegat Light is the primary commercial seaport on Long Beach Island and is the homeport to approximately 36 commercial vessels. Barnegat Light's two commercial docks are home to several scallop vessels, longliners, and a fleet of smaller inshore gillnetters (New Jersey Department of Agriculture 2020).

In 2019 the Barnegat/Long Beach commercial fishing industry landed 7.0 million pounds of catch worth an estimated $24.9 million, making it the 43rd most valuable port in the U.S. Over the 5-year period of 2014 to 2018, an annual average of approximately $68,000 of all species harvested from the Lease Area were landed in Barnegat (NMFS 2021a). As further discussed in Section 7.4.2.4, during the same 5-year period, an annual average of approximately $14,000 of all species harvested from within the smaller geographic area of the WTA was landed in Long Beach/Barnegat. Long Beach/Barnegat’s average annual landings from the WTA during this 5-year period accounted for approximately 0.1% of the port’s total annual average landings. The five most recent years of all commercial landings in Long Beach/Barnegat are summarized in Table 7.4-2 and are discussed relative to the Offshore Project Area in Section 7.4.2.4.

Point Pleasant

The Point Pleasant commercial fishing fleet includes dredge and gillnet vessels as well as day boat trawlers. The Fishermen’s Dock Cooperative located in Point Pleasant operates two docks, an ice-making machine, cold storage facility, retail store, and a truck-loading station. It is one of two active fishing cooperatives in New Jersey.

In 2019 the Point Pleasant commercial fishing industry landed 37.3 million pounds of catch worth an estimated $35.5 million, making it the 33rd most valuable port in the United States. Over the 5-year period from 2014 to 2018, an annual average of approximately $5,300 of all species harvested from the Lease Area were landed in Point Pleasant (NMFS 2021a). As further discussed in Section 7.4.2.4, during the same 5-year period, an annual average of approximately $1,900 of all species harvested from within the smaller geographic area of the WTA was landed in Point Pleasant. Point Pleasant's average annual landings from the WTA during this 5-year period accounted for <0.1% of the port's total annual average landings. The five most recent years of all commercial landings in Point Pleasant are summarized in Table 7.4-2 and are discussed relative to the Offshore Project Area in Section 7.4.2.4.

7.4.1.2 Other States

Based on currently available data, vessels landing catch at New Jersey ports are the primary vessels operating in the Offshore Project Area. Though landings from the Offshore Project Area at ports in other states do occur, they are modest in comparison to the New Jersey ports. According to the National Oceanic and Atmospheric Administration (NOAA) VTR data, from 2014 to 2018, out-of-state vessels were operating from up to 56 different ports in Connecticut, Delaware, Massachusetts, Maryland, Maine, North Carolina, New Hampshire, New York, Rhode Island, and Virginia. However, the annual average landings harvested from the Offshore Project Area (i.e., WTA and both ECCs) and landed at ports in all states other than New Jersey account for approximately $71,000 or 11.7% of average annual landings from within the Offshore Project Area. (Combined annual landings at ports in states other than New Jersey from within the Offshore Project Area ranged from approximately $43,000 to $108,000 in 2014 to 2018.)

Other than the New Jersey ports described in Section 7.4.1.1, only New Bedford, Massachusetts and Newport News, Virginia reported annual average landings from the WTA in excess of $5,000. Due to the minimal value landed, ports with annual average landings from the WTA of less than $5,000 are not described further in this section.

New Bedford, Massachusetts

New Bedford is home to a large commercial fishing fleet with access to the port's well-established shoreside infrastructure that includes seafood wholesale and processing companies and other related shoreside industries that serve several active fisheries. Much of New Bedford's commercial fishing revenue comes from the sea scallop fishery, which landed 41.9 million pounds of sea scallops in Massachusetts worth over $397 million in 2019. In total, New Bedford commercial fishing vessels landed 115.8 million pounds of fish in 2019, worth an estimated $450.8 million, making it the most valuable port in the U.S.

Over the 5-year period from 2014 to 2018, an annual average of approximately $31,000 of all species harvested from the Lease Area were landed in New Bedford (NMFS 2021a). As further discussed in Section 7.4.2.4, during the same 5-year period, an annual average of approximately $17,000 of all species harvested from within the smaller geographic area of the WTA was landed in New Bedford. New Bedford's average annual landings from the WTA during this 5-year period accounted for <0.1% of the port's total annual average landings.

Newport News, Virginia

Newport News is home to the Seafood Industrial Park, a cluster of seafood processing and packing facilities and businesses servicing the commercial fishing fleet, which includes more than 70 ocean-going trawlers and 20 inshore fishing vessels in recent years. The Seafood Industrial Park is owned and managed by the City of Newport News (City of Newport News 2021). The predominant fishery, by landed value, in Newport News is the scallop fishery (NOAA 2014).

Over the 5-year period from 2014 to 2018, an annual average of approximately $11,600 of all species harvested from the Lease Area were landed in Newport News (NMFS 2021a). As further discussed in Section 7.4.2.4, during the same 5-year period, an annual average of approximately $7,600 of all species harvested from within the smaller geographic area of the WTA was landed in Newport News. Newport News' average annual landings from the WTA during this 5-year period accounted for <0.1% of the port's total annual average landings.

7.4.1.3 Fisheries Management

Fisheries in waters 0 to 3 nautical miles (nm) (0 to 5.6 kilometers [km]) from shore are under State authority while waters 3 to 200 nm (4.8 to 370 km) from shore encompass the Exclusive Economic Zone (EEZ) of the United States, which is managed under the Federal authority of NOAA Fisheries also known as the NMFS. Federal management of fisheries under the Magnuson-Stevens Fishery Conservation and Management Act, the primary mechanism governing fishing in the EEZ along the Atlantic coast, is split among three regional fishery management councils: The New England, Mid-Atlantic, and South Atlantic Fishery Management Councils. Each council develops fisheries policy for its region. The NOAA Fisheries Greater Atlantic Region Fisheries Office (GARFO) has authority for final approval of all recommended management actions by the New England and Mid-Atlantic Councils. In addition, the Atlantic States Marine Fisheries Commission (ASMFC) manages 27 shellfish, diadromous, and marine species, some of which are managed solely by the Commission and the Atlantic States (e.g., menhaden and American lobster) while other species (e.g., Atlantic herring [*Clupea harengus*] and summer flounder [*Paralichthys dentatus*]) are cooperatively managed by the GARFO and the ASMFC, and the regional commissions.

Certain commercially harvested fish species are managed through species-specific Fisheries Management Plans (FMPs) developed by the regional councils and some FMPs include multiple species because they share habitat and are often fished using the same gear type. In the Offshore Project Area, species are managed through FMPs by the New England Fishery Management Council (NEFMC), the Mid-Atlantic Fishery Management Council (MAFMC), the ASMFC, or some combination of these. In addition to cooperative management of certain species with the ASMFC, the State waters of New Jersey within the Offshore Project Area are managed by the New Jersey Department of Environmental Protection (NJDEP) Division of Fish & Wildlife.

As noted previously, the ASMFC coordinates interstate management of the American lobster fishery from 0 to 3 nm (0 to 5.6 km) offshore while management authority in the EEZ from shore lies with the GARFO. Three separate stocks of lobsters are managed: The Gulf of Maine, Georges Bank, and Southern New England, with each stock further divided into seven management areas. The Offshore Project Area is within Lobster Management Area 5.

7.4.2 Assessment of Commercial Fishing Activity in the Offshore Project Area

This section describes sources of data that provide information on commercial fishing activities within the Offshore Project Area. This section further describes baseline estimates of the economic value of those commercial fishing activities. The data sources used to quantify relative commercial fishing effort include mapping of those activities based on VTRs, VMS data, AIS data, and commercial fishing data visualization products maintained by NROC and MARCO. This summary of commercial fisheries exposure is based on data from Federal VTRs made available by NMFS (2020).

Estimates of the economic value of commercial fishing activity in the Offshore Project Area presented in the following sections represent the potential economic exposure, or maximum potential economic value, of commercial fisheries. These estimates of economic exposure do not represent actual or expected economic impacts. Most, if not all, existing fishing effort in the Offshore Project Area would be expected to continue throughout the construction, O&M, and decommissioning of the Projects.

7.4.2.1 Description of Commercial Fishing Data Sources

The following section describes the sources, uses, limitations, and geographic extent of commercial fishing data that were used to support the assessment of commercial fishing in the Offshore Project Area.

VTR Data

Except for vessels holding only a lobster permit(s), NMFS requires every federally permitted fishing vessel to submit a VTR for every fishing trip. Among other data, VTRs provide information on the time and location of most of the reported fishing. Each VTR also provides the trip date, number of crew on board the vessel, species and quantities caught, and the trip location. Each vessel's permit data additionally include a "principal port" and other data related to the vessel (e.g., length and horsepower). The NMFS VTR dataset provides a comprehensive overview of fishing activity for many of the commercial fisheries active in the Offshore Project Area.

NOAA's Fisheries Statistics Division and the Atlantic Coastal Cooperative Statistics Program each maintain a publicly accessible automated data summary program of U.S. commercial fisheries landings in Federal waters based on VTRs. These data summary programs can be queried for commercial landings in several formats including pounds and dollar value of commercial landings by year, State, and species from 1990 onwards.

NROC and MARCO have developed commercial fishing data visualization products using VTRs. The VTR-based maps characterize both fixed and mobile gear fisheries within the Offshore Project Area by using trip location point data as inputs to create density polygons representing vessel visitation frequency. Over different multi-year periods, the VTR-based maps depict total labor including crew time and time spent transiting to and from fishing locations. According to MARCO, VTR data were aggregated to the "community" level and none of the resultant maps represent a fishing area of any individual fishing vessel. Similarly, these data are aggregated across years (i.e., 2011–2015) which masks interannual trends in fishing activity.

The NROC or MARCO data portals allow users to query the VTR maps to display additional information about specific geographic locations (for example, the various port communities that have recorded a significant level of fishing activity at that location). The NROC and MARCO datasets can also be queried by port, which will then identify the geographic area in which 90% of that port's fishing effort is located. According to MARCO, drafts of the maps were reviewed with a diverse range of fishermen and fishing industry managers throughout the Mid-Atlantic and New England States including at MAFMC and NEFMC meetings. MARCO (2020) also notes that overlay comparison of their VTR-based maps with VMS-based maps (see following section) reveals substantial agreement between the two, with the VMS maps providing additional useful precision for fisheries where both VTR and VMS data are available.

VMS Data

VMS data are collected through a satellite monitoring system that is primarily used for monitoring the location of certain commercial fishing vessels active in U.S. Federal waters. According to NOAA, the monitoring system uses satellite-based communications from onboard transceiver units that certain vessels are required to carry, including certain vessels harvesting scallop, squid, and mackerel. The transceiver units typically send position reports once per hour including vessel identification, time, date, and location. These data make it possible to calculate the approximate speed a vessel is travelling which can then be filtered by estimated vessel-speed, depending on the gear and fishery, to indicate areas where a vessel is likely fishing rather than transiting. However, such filtering is not an absolute indicator of fishing activity as vessels may operate in harbors and other confined waters at speeds consistent with fishing activity.

Landings data are not associated with the VMS point locations. Rather, the VMS maps provide a qualitative assessment of the intensity of fishing activity in the Offshore Project Area and should be evaluated alongside other data sources. Characterizing fishing effort with VMS data is also complicated by the fact that VMS is used differently in separate fisheries. For example, the monkfish (*Lophius americanus)* fishery only requires VMS for vessels reporting days-at-sea under limited access permits for the offshore monkfish fishery but, otherwise, vessels may elect to report days-at-sea under different monkfish permit categories.

Nonetheless, VMS is a good data source for understanding the spatial distribution of fishing vessels in the Offshore Project Area. In 2018, 912 VMS equipped vessels operating across all fisheries in the Northeast U.S. represented 71% to 87% of summer flounder, scup (*Stenotomus chrysops*), black sea bass (*Centropristis striata*), and skate landings and greater than 90% of landings for scallops, squids, monkfish, herring, mackerel, large mesh multispecies, whiting, surf clam, and ocean quahogs (BOEM 2020).

NROC and MARCO have developed commercial fishing data visualization products using that make use of VMS data. The VMS datasets and associated mapping made available by NROC and MARCO qualitatively characterize the density of commercial fishing vessel activity for seven fisheries[54] in the northeast and Mid-Atlantic regions (Fontenault 2018) for the years 2006 to 2016.

To increase the likelihood of identifying active fishing rather than fishing vessels engaged in non-fishing activity, the NROC and MARCO mapping characterize VMS data from vessels operating at or below a vessel speed consistent with gear deployment for that fishery. According to NROC, the speed thresholds were vetted through engagement with fishermen in each fishery. The speed threshold, however, does not perfectly isolate fishing activity because non-fishing activities such as processing catch, sorting, drifting, or idling in port may occur at low vessel speeds and are still shown by the datasets. The resulting density grids represent a “heat map” of the vessel activity, which indicate a relative level of vessel presence and spatially represent specific fisheries over clear timespans. VMS data are subject to strict confidentiality restrictions. The process of removing confidential vessel locations follows the “rule of three”[55] by using a screening grid to identify which grid cells contained three or more VMS records. Per the NMFS “rule of three,” any record within a cell that contains fewer than three VMS records was eliminated from the analysis.

The NSRA (see Appendix II-S) provides a detailed assessment of existing vessel traffic, including commercial fishing vessels, in the Offshore Project Area by means of AIS and VMS datasets.

AIS Data

AIS is, in part, a shipborne mobile equipment system that typically consists of integrated very high frequency (VHF) radio and Global Positioning Systems (GPS) which broadcast a vessel’s name, dimensions, course, speed, and position as well as destination and estimated time of arrival, amongst other vessel characteristics. The primary use of AIS is to allow vessels to monitor marine traffic in their area and to broadcast their location to other vessels with AIS equipment onboard. Broad categories of vessel type, including fishing vessels, can also be identified using the information contained in a vessel’s AIS transmissions. As of 2016, Federal regulations require self-propelled commercial fishing vessels greater than 65 feet (ft) (20 meters [m]) in length to operate an AIS Class B device to broadcast vessel information (33 CFR Part 164.46; USCG NAVCEN 2017).

---

54 The fisheries include northeast multispecies, monkfish, herring, scallop, surf clam/ocean quahog, herring, squid, and mackerel.

55 The process of removing sensitive vessel locations followed the “rule of three” mandated by NMFS Office of Law Enforcement by using a screening grid to identify which grid cells contained three or more VMS records. VMS records within cells that contain fewer than three VMS records were not included in the analysis.

Because of the autonomous and continuous nature of AIS data, it can also be compiled to establish a record of vessel operating history.

The NSRA (see Appendix II-S) provides a detailed assessment of existing vessel traffic, including commercial fishing vessels, in the Offshore Project Area by means of AIS and VMS datasets.

Summary of Commercial Fishing Data Sources Used in Assessment

Table 7.4-3 summarizes the primary data sources used in the assessment, which include AIS, VMS, and VTR data, as well as information from fishing industry representatives.

Table 7.4-3 Primary Data Sources for Assessment of Commercial Fishing Activity in the Offshore Project Area

Source	Date	Title/Description
MARCO	2016	VTR Commercial Fishing – Communities at Sea • Original Data Provided by NOAA NMFS Northeast Fisheries Science Center (NEFSC) • Data Processed by the Grant F. Walton Center for Remote Sensing and Spatial Analysis, Rutgers University
Kirkpatrick, et al.	2017	Socio-Economic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the U.S. Atlantic
NROC	2018	VMS Commercial Fishing Density Northeast and Mid-Atlantic Regions • Original Data Provided by NOAA NMFS Office of Law Enforcement • Data Processed by RPS Group
NMFS	2020	Landings and Value for Vessel Trips that Occurred within WTA and ECCs, Modeled Results of Federal VTR, Clam Logbook Data, Dealer Data
Azavea/Last Tow, LLC	2020	Fishing Route Analytics Report, VMS Point Data
W.F. Baird & Associates Coastal Engineers Ltd	2021	Atlantic Shores Offshore Wind – Navigation Safety Risk Assessment (Appendix II-S)

7.4.2.2 Commercial Fishing Vessel Activity in the Offshore Project Area

This section provides an overview of commercial fishing vessel activity in the Offshore Project Area using AIS, VTR, and VMS data. AIS data provide a quantitative assessment of vessel activity in the WTA, while VTR and VMS data provide qualitative representations of commercial fishing vessel activity within the WTA and along ECCs.

AIS Data

A 3-year (2017–2019) AIS-based analysis of commercial fishing vessel traffic within the WTA is provided in the NSRA (see Appendix II-S). This analysis separates commercial fishing vessel traffic into two categories based on vessel speed: (1) vessels operating at speeds greater than 4 knots (2.1 meters per second [m/s]) and assumed to be engaged in non-fishing activities such as transiting; and (2) vessels operating at speeds less than 4 knots (2.1 m/s) and assumed to be engaged in fishing or towing (i.e., fishing gear deployed).

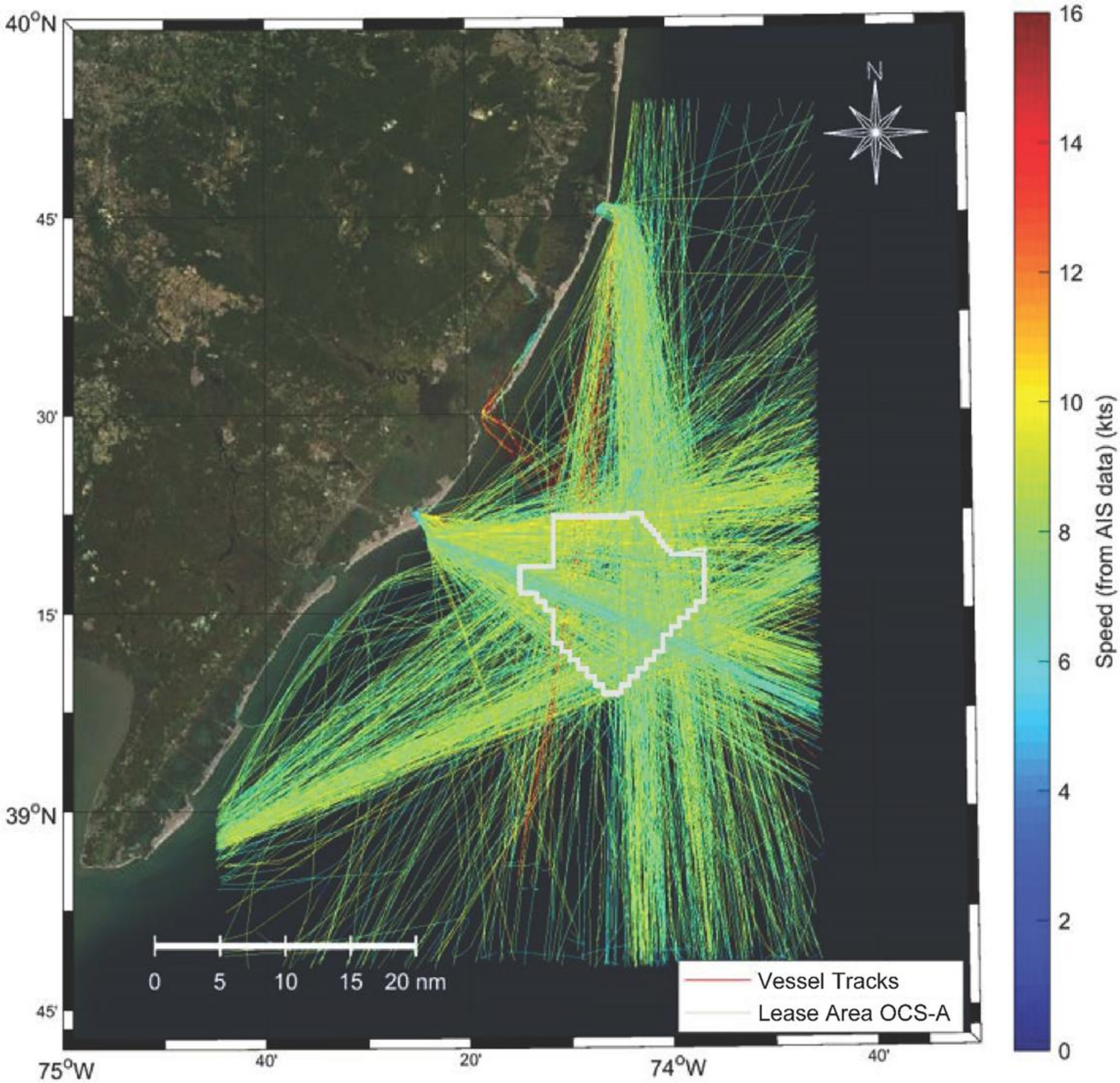
The NSRA identified a total of 329 unique commercial fishing vessels that transited the WTA during the 3-year AIS data record (2017–2019). A total of 5,053 commercial fishing vessel tracks transiting through the WTA at speeds greater than 4 knots (2.1 m/s) were recorded during the 3-year period. Figure 7.4-1 identifies the vessel tracks of commercial fishing vessels that transected the WTA during their transit. Based on the 3-year data record, an average of approximately 217 unique commercial fishing vessels transit the WTA each year, with each vessel transiting the WTA an average of 7.8 times per year[56] (see Tables 6.2 and 6.8 in Appendix II-S). Most of these transits occur during the late spring through autumn (May to October). Tracks of these vessels are spread across a range of directions through the WTA, with 20% of tracks in northeast to southwest and east-northeast to west-southwest directions, likely originating from Cape May/Wildwood, and 36% of tracks are aligned east to west and just south of east to west, likely originating from Atlantic City. A notable number of vessel tracks in a north-south direction also transit the WTA, likely indicating vessels originating from Long Beach-Barnegat.

The NSRA identified a total of 119 unique commercial fishing vessels that were engaged in fishing in the WTA during the 3-year AIS data record (2017–2019). Based on the 3-year data record, an average of approximately 55 unique commercial fishing vessels engage in fishing within the WTA each year, with each vessel engaged in fishing within the WTA an average of approximately 4.3 times per year[57] (Figure 7.4-2), predominantly during the summer and autumn (August to October). Density of vessels engaged in fishing in the waters of the WTA is presented in Figure 7.4-2 and shows that the relative vessel density within the WTA is lower than the surrounding waters. The highest fishing vessel density within the WTA is in the northeasterly portion of the

---

56 As shown in Table 6.8 of the NSRA, there is an annual average of 1,688 unique tracks and 217 unique fishing vessels transiting.

57 As shown in Table 6.8 of the NSRA, there is an annual average of 236 unique tracks and 54.7 unique fishing vessels fishing.



ATLANTIC SHORES offshore wind

Figure 7.4-1

AIS Fishing Vessel Tracks Transiting Through the Lease Area (Greater Than 4 Knots)

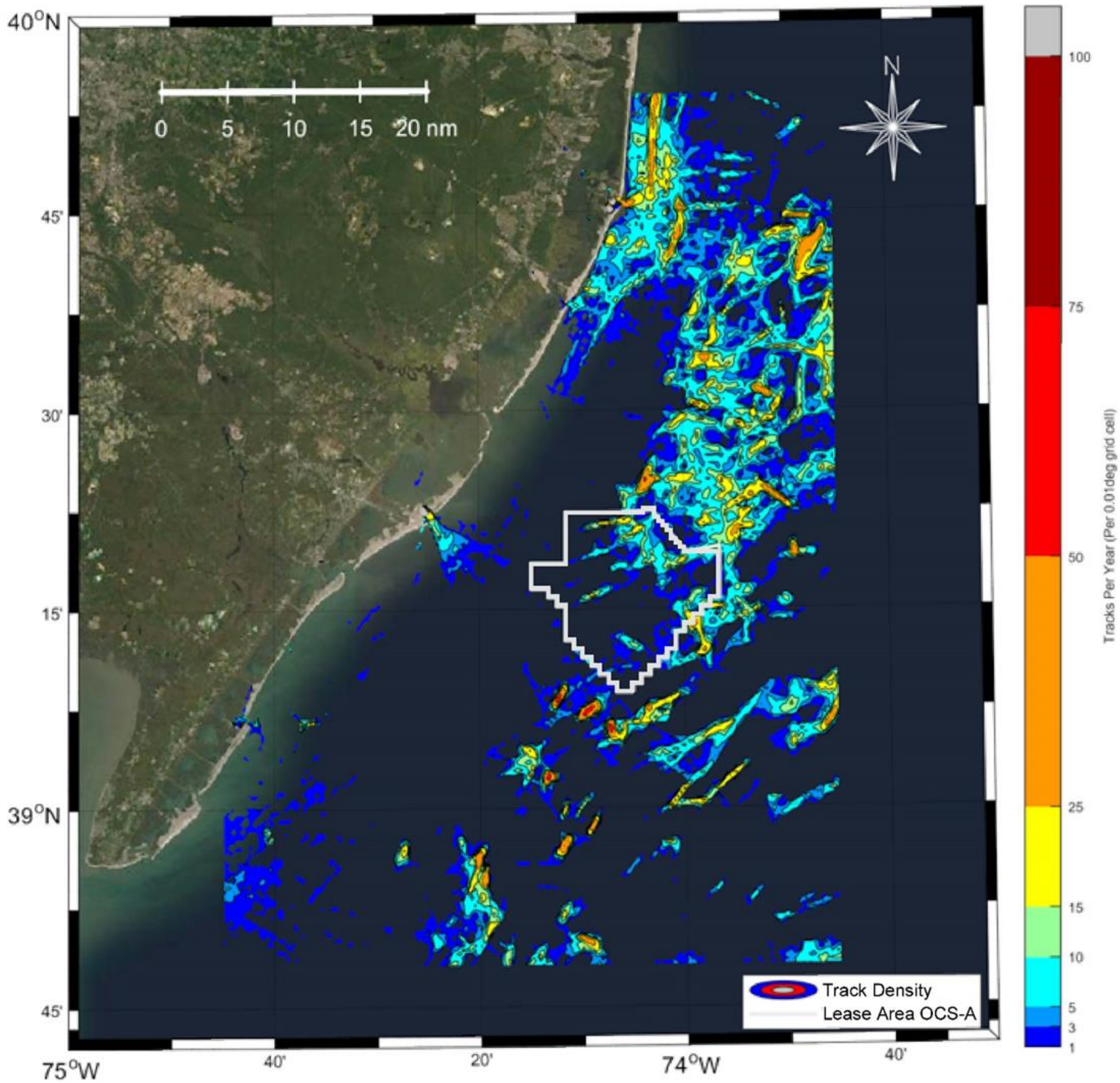


Figure 7.4-2

AIS Fishing Vessel Track Density (Less Than 4 Knots) in the Offshore Project Area

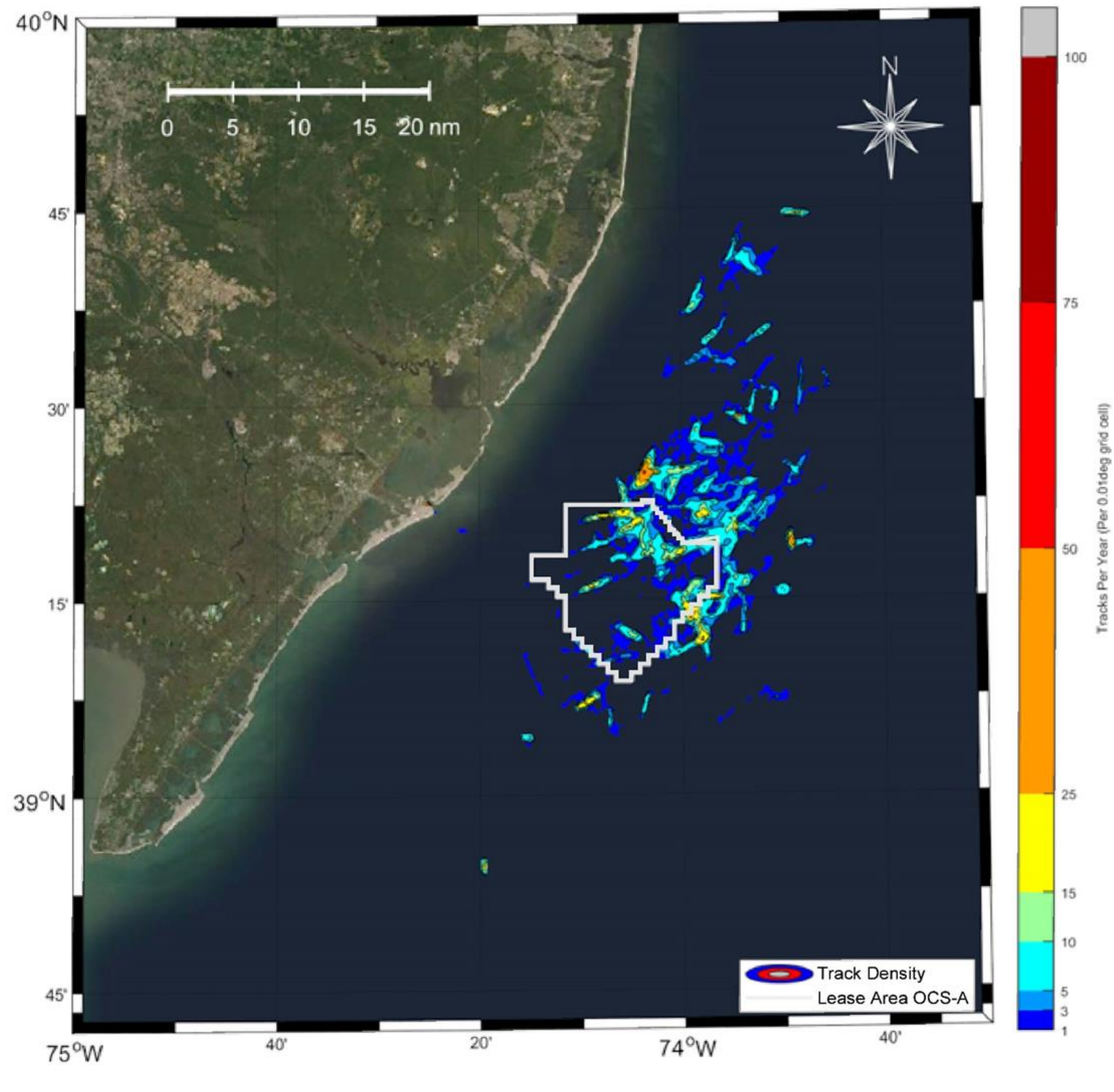


Figure 7.4-3

AIS Fishing Vessel Track Density (Less Than 4 Knots) in the Lease Area

WTA. Figure 7.4-3 shows the fishing vessel track density for tracks that fish within the WTA and indicates that vessels predominantly fish in the north and easterly portion of the WTA.

The VTR datasets produced qualitative representations of vessel activity within the bottom trawl, dredge, gillnet, longline, and pots and traps fisheries (excluding American lobster and Jonah crab [*Cancer borealis*]). Figures 7.4-4 through 7.4-9 are VTR-based maps depicting those fisheries. The VTR-based mapping of the bottom trawl fishery is further divided into two categories: vessels less than 65 ft (20 m) in length (Figure 7.4-5) and vessels greater than 65 ft (20 m) in length (Figure 7.4-6). The VTR datasets indicate the following regarding levels of fishing effort within the WTA:

- During the years analyzed, limited areas of low fishing effort by vessels deploying dredge gear occur within the northeasterly portion of the WTA and along the Monmouth ECC (see Figures 7.4-4).58 Although the VTR dredge data suggest limited areas of low fishing effort by dredge vessels, Section 7.4.2.4 describes how the surf clam/ocean quahog fishery is active in the Offshore Project Area.

- During the years analyzed, only limited areas of low fishing effort by bottom trawl vessels are reflected in the Offshore Project Area, though northerly portions of the Monmouth ECC indicate low to moderate presence of bottom trawl vessels (see Figures 7.4-5 and 7.4-6).59 VTR bottom trawl data for vessels less than 65 ft (20 m) suggest little to no fishing occurs in the WTA, though areas of elevated density occur in the nearshore waters to the west of the Monmouth ECC. VTR bottom trawl data for vessels greater than 65 ft (20 m) in length suggest that the areas of highest activity are east of the Offshore Project Area along the edge of the continental shelf break.

- During the years analyzed, moderate to high fishing effort by gillnet vessels is reflected in the nearshore waters in proximity to and along the Monmouth ECC (see Figures 7.4-7).60 Species sought by gillnetters in New Jersey include bluefish, monkfish, weakfish (Cynoscion regalis), and dogfish (GSSA 2020).

- During the years analyzed, no fishing effort by longline vessels, typically targeting pelagic species, occur within the WTA. Near the Monmouth ECC, areas of low to moderate longline vessel activity occur in proximity to the Axle Carlson artificial reef, offshore of Tom's River, and in proximity to the Barnegat Light artificial reef (see Figures 7.4-9). Artificial reefs are shown on Figure 7.4-1.

- During the years analyzed, deployment of pots and traps occurred predominantly within southwestern portion of the WTA and along the Atlantic ECC. Except for a small

[58] Dredge gear types include: ocean quahog/Atlantic surf clam dredge, mussel dredge, Atlantic sea scallop dredge, and urchin dredge.

[59] Bottom trawl gear includes: haddock separator otter trawl, beam otter trawl, bottom otter trawl, Atlantic sea scallop trawl, Ruhle otter trawl, bottom pair trawl, and Scottish seine.

[60] Gill net gear includes: drift gill net, large and small mesh, runaround gill net, sink gill net, drift gill net.

geographic area southeast of the Axle Carlson artificial reef, little to no pot and trap fishing effort is reflected along the Monmouth ECC (see Figures 7.4-9).

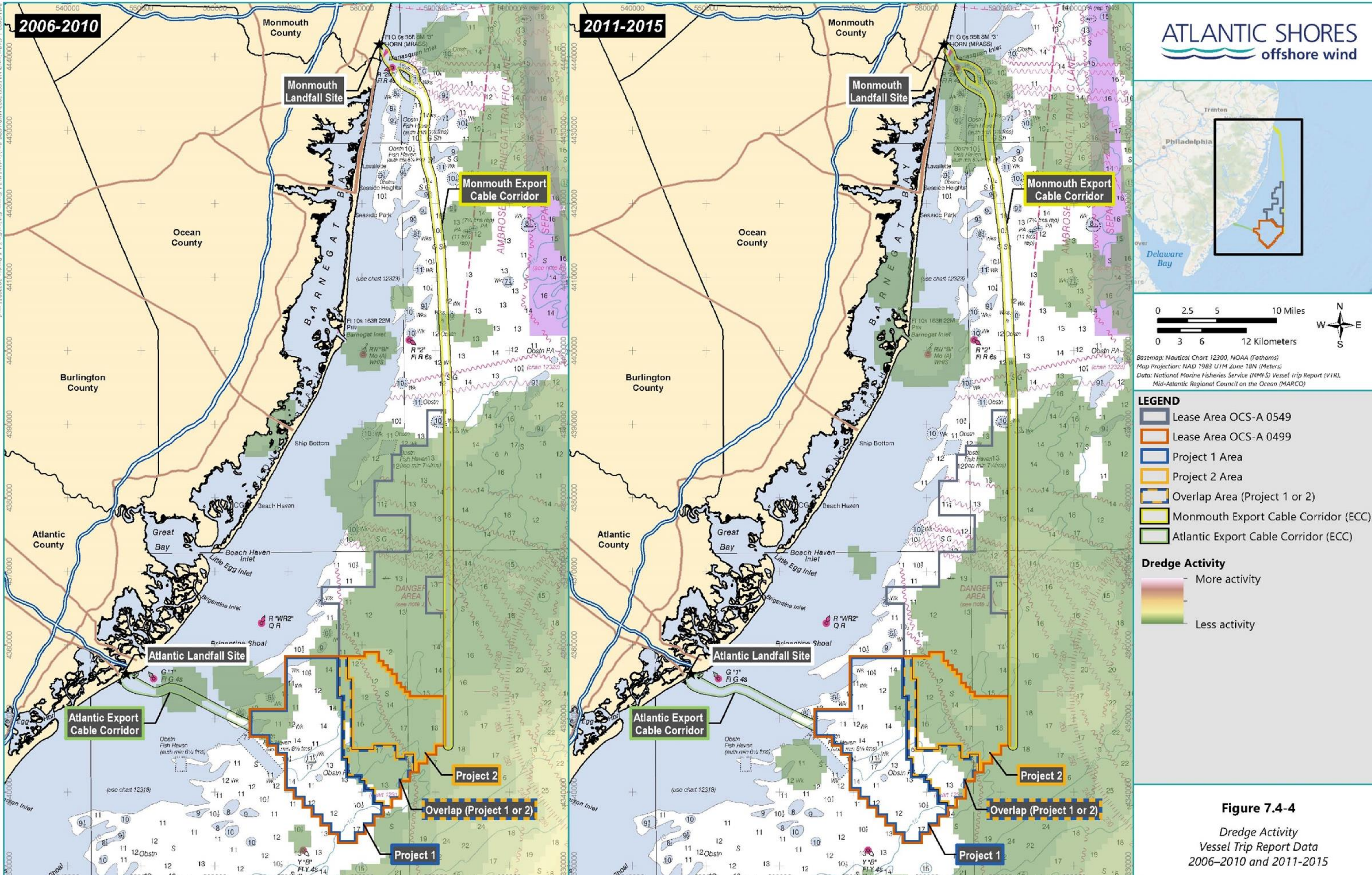


Figure 7.4-4

Dredge Activity
Vessel Trip Report Data
2006–2010 and 2011-2015

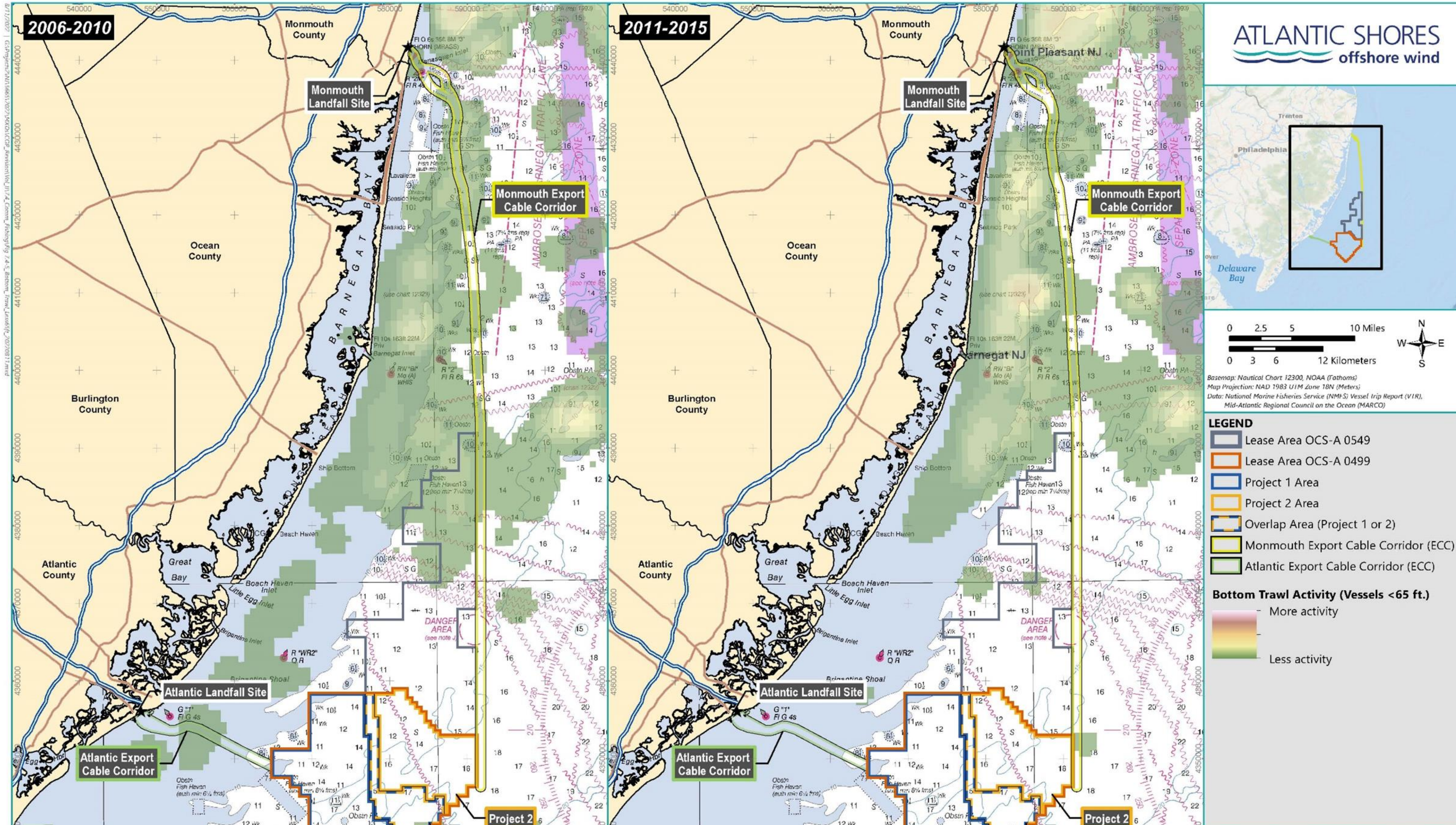


Figure 7.4-5

Bottom Trawl Activity (Vessels <65 ft.) Vessel Trip Report Data 2006–2010 and 2011-2015

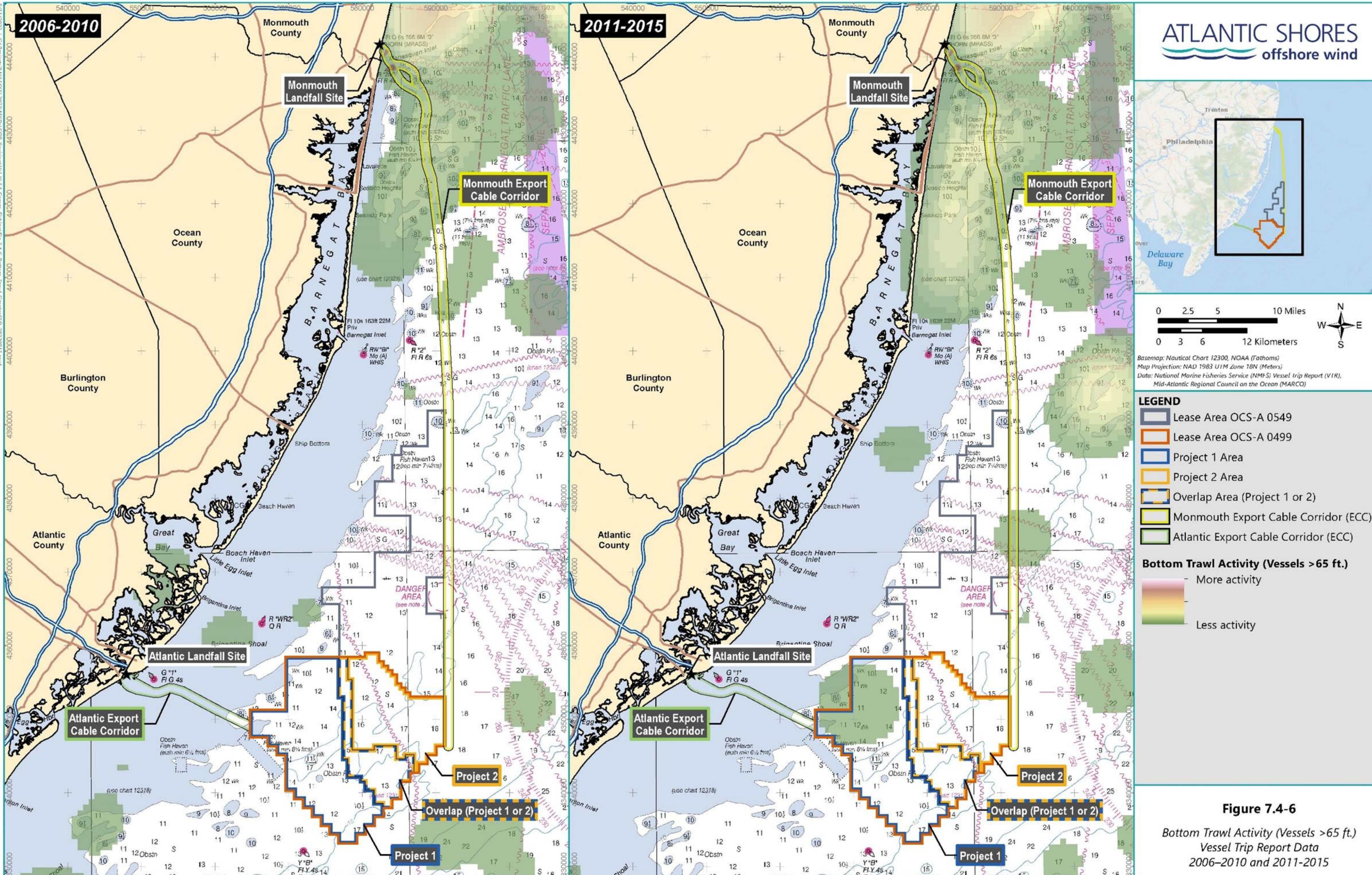


Figure 7.4-6

Bottom Trawl Activity (Vessels >65 ft.) Vessel Trip Report Data 2006–2010 and 2011-2015

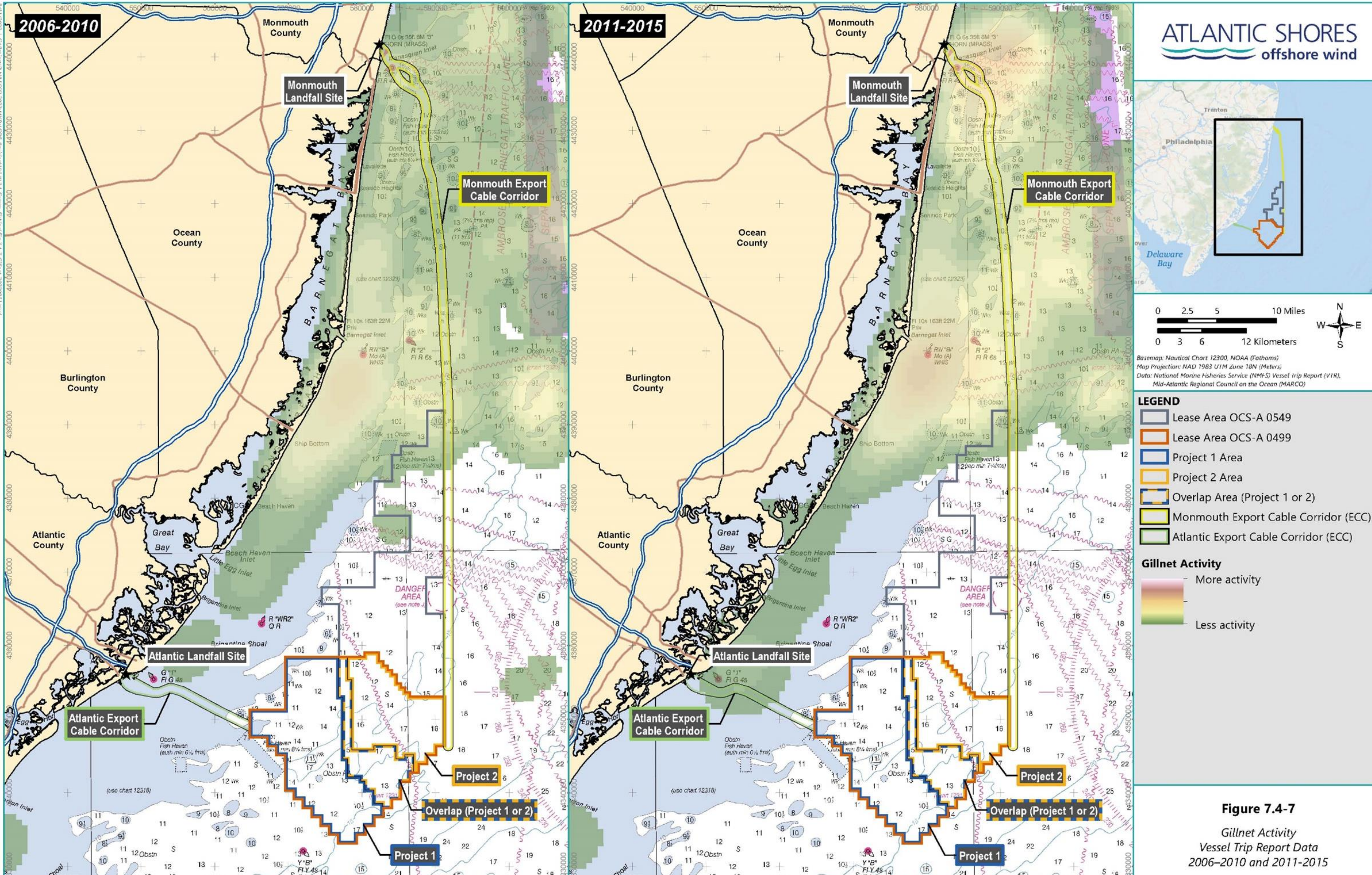


Figure 7.4-7

Gillnet Activity
Vessel Trip Report Data
2006–2010 and 2011-2015

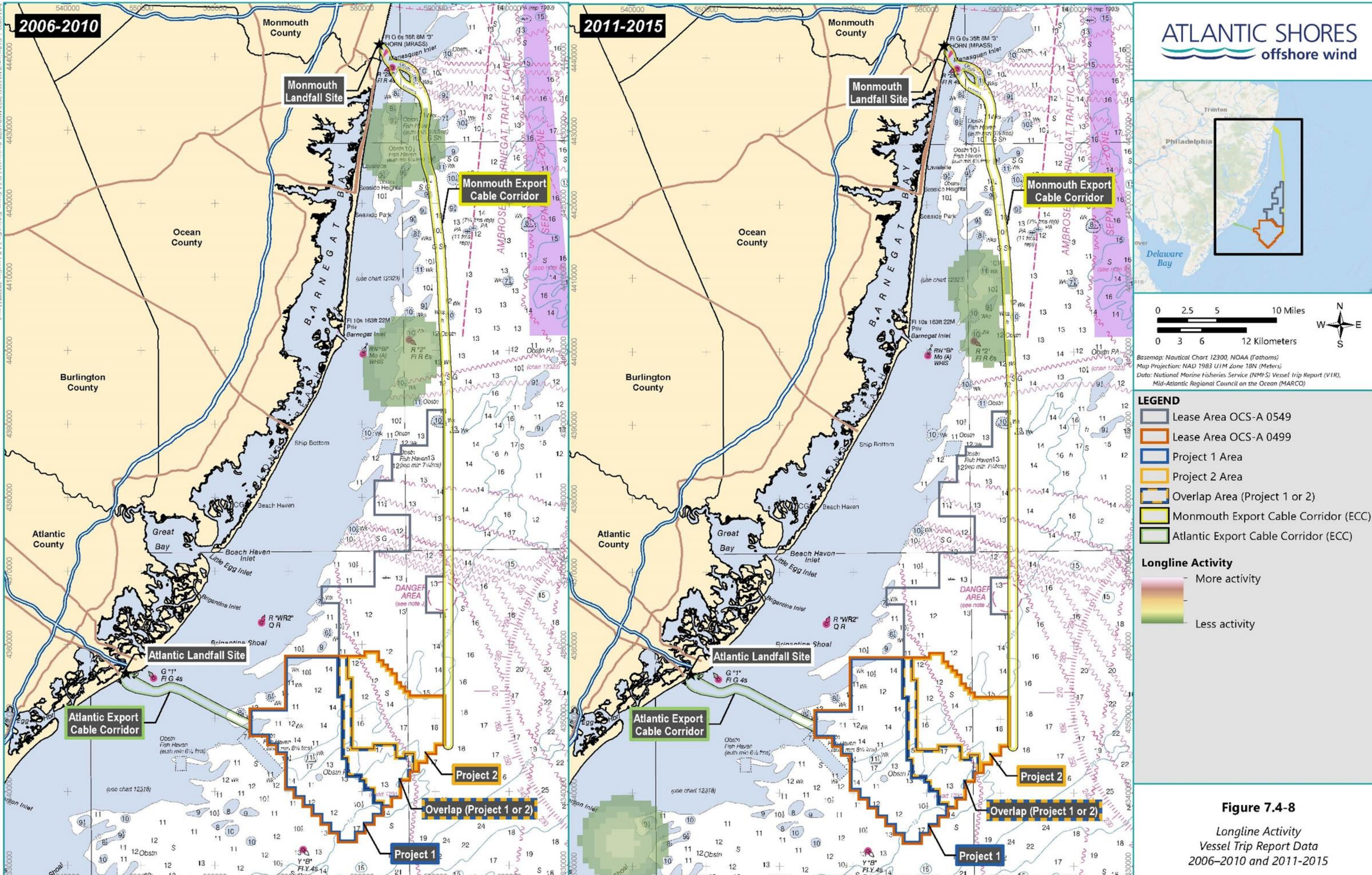


Figure 7.4-8

Longline Activity Vessel Trip Report Data 2006–2010 and 2011-2015

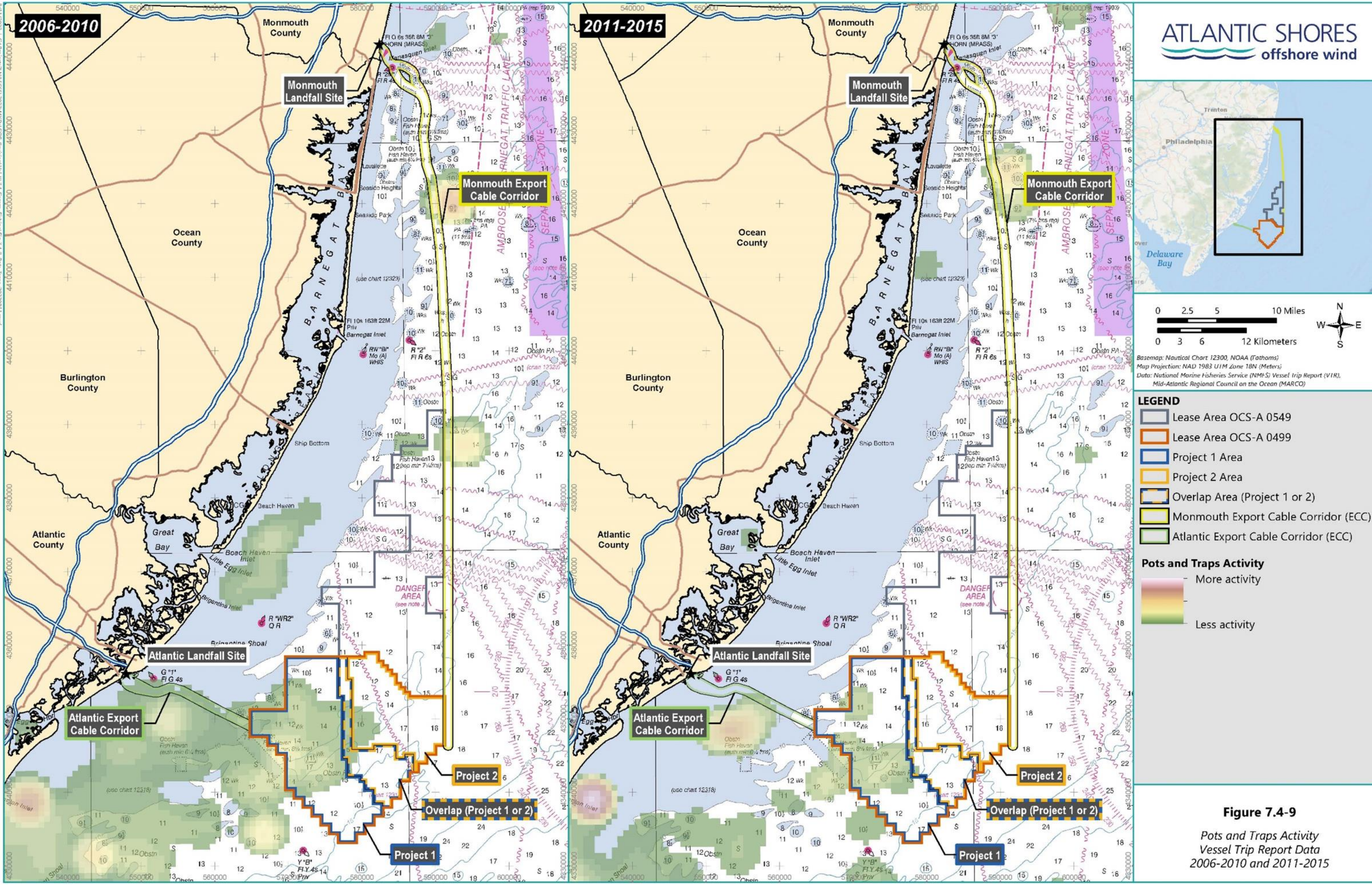


Figure 7.4-9

Pots and Traps Activity Vessel Trip Report Data 2006-2010 and 2011-2015

VMS Data

As noted in Section 7.4.2.1, NROC and MARCO have developed commercial fishing data visualization products that use VMS data to qualitatively characterize the density of commercial fishing vessel activity of seven fisheries in the Northeast and Mid-Atlantic regions for the years 2006 to 2016. The mapping of VMS data identifies active fishing, rather than fishing vessels transiting the Offshore Project Area, by mapping vessels operating at or below a vessel speed consistent with gear deployment for that fishery. Figures 7.4-10 through 7.4-16 depict a standardized density of commercial fishing vessel activity within the Northeast Multispecies,[61] monkfish, herring, scallop, surf slam/ocean quahog, mackerel, and squid fisheries in the northeast and Mid-Atlantic regions of the United States based on VMS data for the years 2015 and 2016.

The VMS figures depict relative vessel density between 2015 and 2016 as distinct from the VTR figures (Figures 7.4-4 through 7.4-9) which have been aggregated, separately, for 2006 to 2010 and 2011 to 2015.

The VMS-based analysis of the Offshore Project Area (i.e., the WTA and ECCs) shows the following results for the years analyzed:

- Vessels targeting surf clam/ocean quahogs appear to be active throughout the Offshore Project Area during the years analyzed. Areas of Medium-High to High density occur in the northeasterly portion of the WTA and along the Monmouth ECC (see Figure 7.4-10). These represent all VMS data between 2015 and 2016 reported by vessels with a Federal surf clam/ocean quahog permit. As described in additional detail in Section 7.4.2.3 and Section 7.4.2.4, this is the predominant fishery in the Offshore Project Area and the high density of vessels targeting these species is consistent with other data sources. The terms "Medium-High" or "High" are not specifically defined, rather they indicate the relative density of vessel traffic as classified by the underlying model (Fontenault 2018).

- No Northeast Multispecies vessel activity occurs within the Offshore Project Area (see Figure 7.4-11). These represent VMS data between 2015 and 2016 reported under the multispecies fisheries. Multispecies VMS data include fisheries with a limited access multispecies permit fishing under a Category A or B days-at-sea, catch-regulated species, ocean pout (Zoarces americanus) while on a sector trip, or those with a limited access northeast multispecies small vessel category or Handgear A permit that fish in multiple northeast multispecies broad stock areas.[62]

---

61 American plaice (Hippoglossoides platessoides), Atlantic cod (Gadus morhua), Atlantic halibut (Hippoglossus hippoglossus), haddock (Melanogrammus aeglefinus), ocean pout, Pollock (Pollachius virens), redfish (Sebastes fasciatus), white hake (Urophycis tenuis), windowpane flounder (Scophthalmus aquosus), winter flounder (Pseudopleuronectes americanus), witch flounder (Glyptocephalus cynoglossus), and yellowtail flounder (Limanda ferruginea).

62 50 CFR Part 648.10

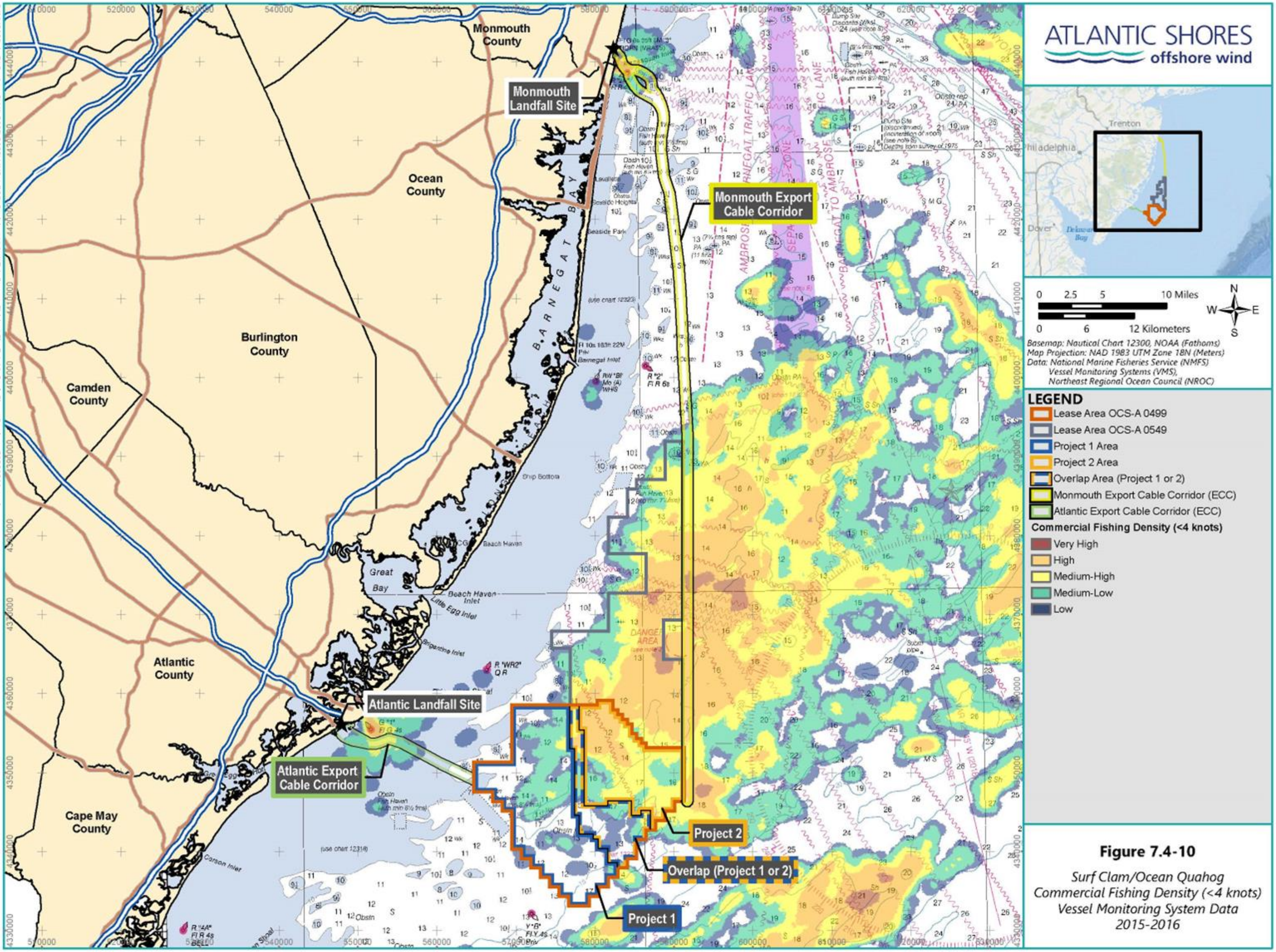


Figure 7.4-10

Surf Clam/Ocean Quahog Commercial Fishing Density (<4 knots) Vessel Monitoring System Data 2015-2016

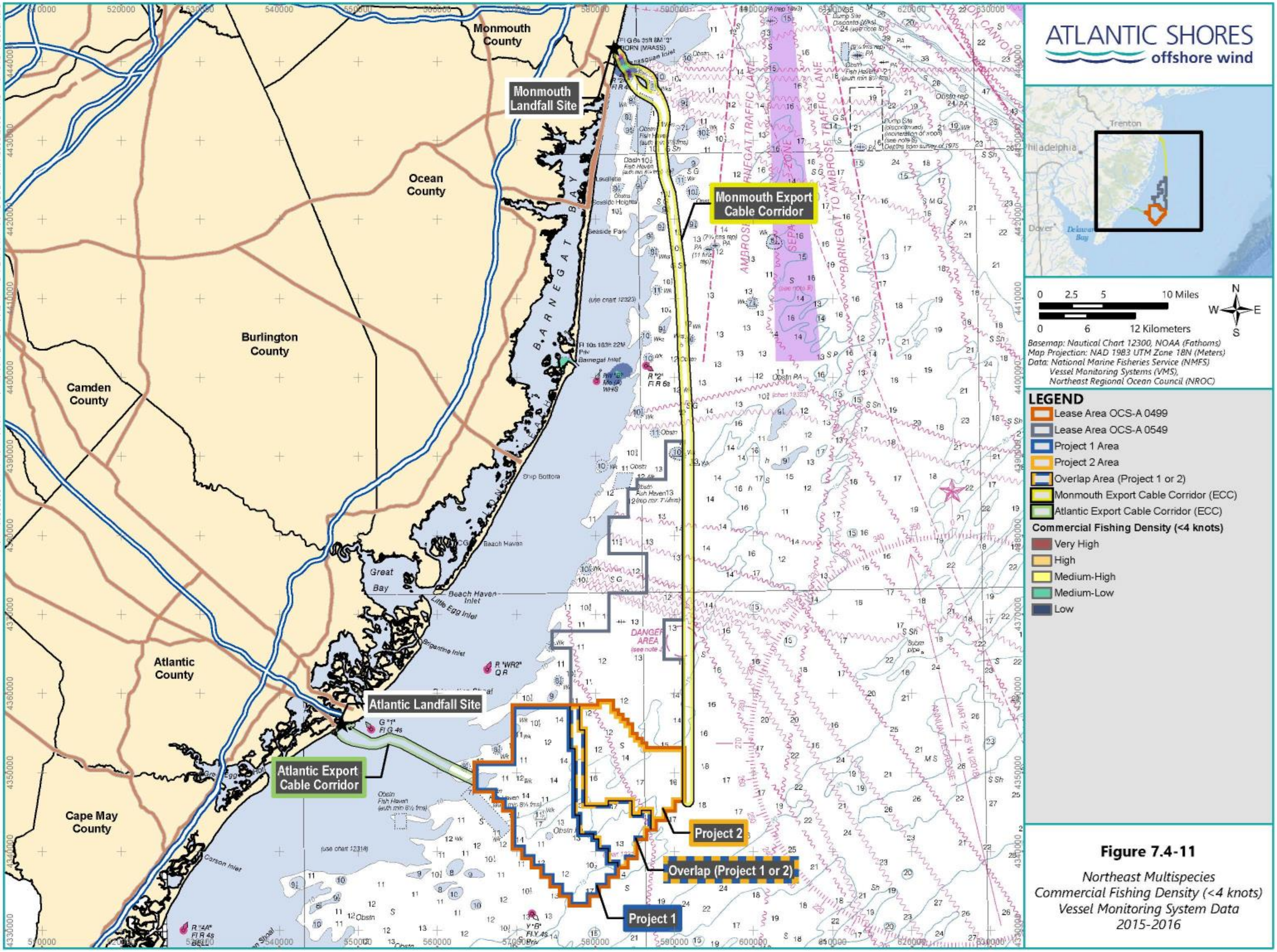


Figure 7.4-11

Northeast Multispecies Commercial Fishing Density (<4 knots) Vessel Monitoring System Data 2015-2016

- Vessels targeting monkfish (see Figure 7.4-12) appear to be active in limited areas of the Monmouth ECC during the years analyzed. This activity, characterized as Medium-High to High, predominantly occurs within proximity to the Axle Carlson and Manasquan Inlet artificial reefs. The distribution of monkfish effort depicted on the NROC and MARCO maps extends into the nearby Manasquan Inlet, suggesting that some, if not all, of this effort may reflect vessels departing or arriving at Manasquan while transiting at speeds less than four knots. Four knots is the threshold speed used to separate monkfish vessels actively fishing from vessels engaged in other non-fishing activities.

- Scallop vessel density during the years analyzed is generally Medium-Low within the Offshore Project Area, though elevated areas of vessel density occur in proximity to ports (see Figure 7.4-13).63 Again, this suggests these are transit locations at or below the threshold speed of five knots for scallop vessels. Five knots is the threshold speed used to separate scallop vessels actively fishing from vessels engaged in other non-fishing activities. High levels of scallop vessel density occur further offshore, to the east of the Offshore Project Area, which also suggests scallop fishing did not regularly occur in the Offshore Project Area during the years analyzed. Scallop vessel density represents all VMS data between 2015 and 2016 reported by vessels with a Federal Atlantic sea scallop permit, which includes limited access vessels and general access category vessels in the Atlantic sea scallop fishery.

- Very little squid vessel effort occurs in the Offshore Project Area, though there are areas of High vessel density to the west of the Monmouth ECC offshore of Barnegat Bay and along the Monmouth ECC, offshore of the Manasquan Inlet (see Figure 7.4-14).

- Vessels targeting mackerel and herring do not appear to deploy gear in the WTA (see Figure 7.4-15 and Figure 7.4-16).

7.4.2.3 Economic Exposure of Commercial Fisheries in the New Jersey Wind Energy Area

This section provides a regional view of commercial fisheries in the waters offshore New Jersey by reviewing the economic exposure of commercial fisheries within the New Jersey Wind Energy Area (NJWEA). The NJWEA, which encompasses approximately 343,833 acres (1,391.4 square kilometers [km^2]), includes two lease areas, OCS-A 0498 and OCS-A 0499 (Figure 7.4-17). The approximately 102,124-acre (413.3 km^2) WTA is in the southern portion of the Lease Area and represents only

[63] VMS activity in Mid-Atlantic areas that are identified during periods when the fishery is closed likely reflects scallop permit holders actually targeting summer flounder, scup, and black seabass.

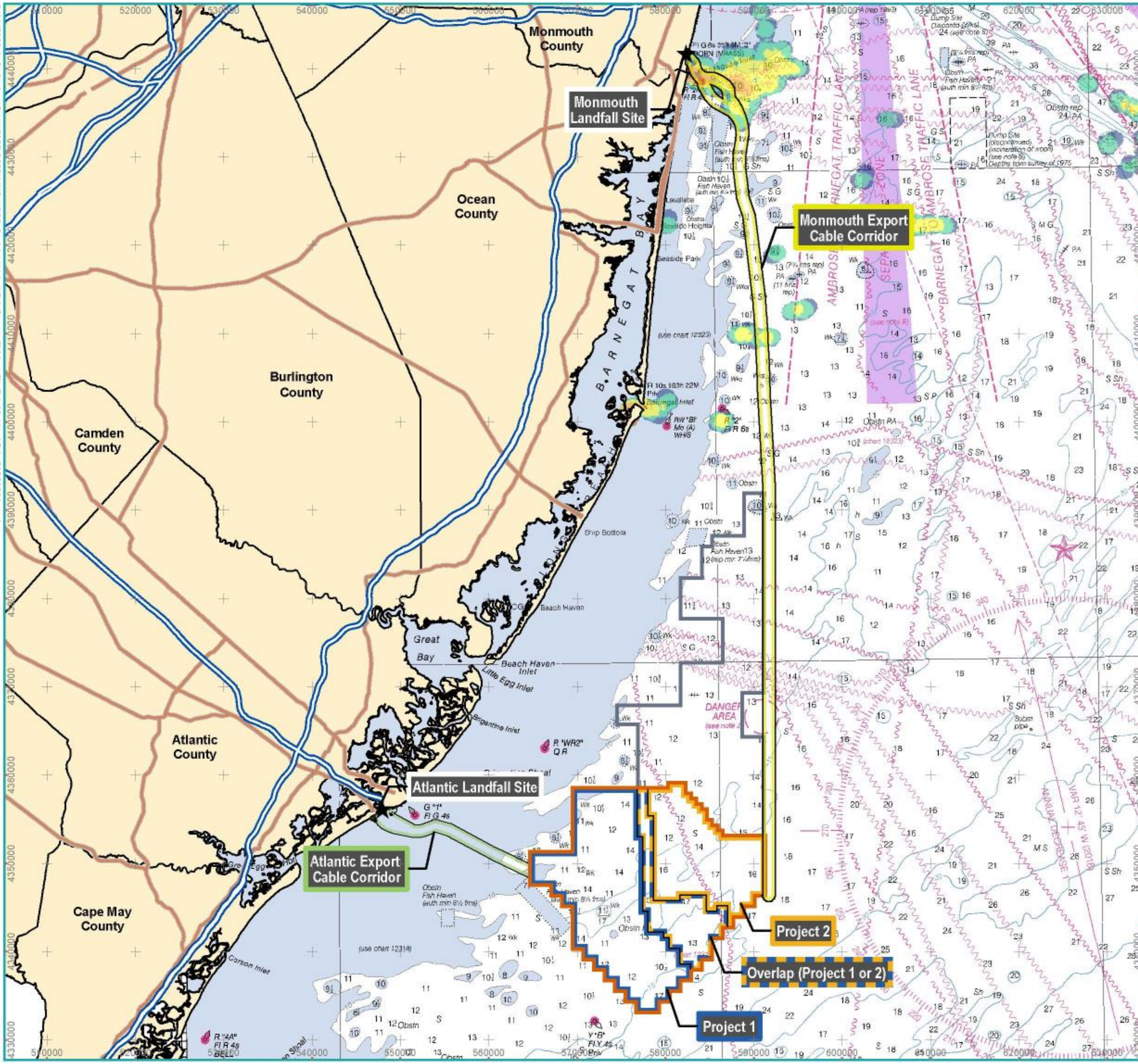


Figure 7.4-12

Monkfish
Commercial Fishing Density (<4 knots)
Vessel Monitoring System Data
2015-2016

8/11/2022 | G:\Projects2\NJ\5665\2022\MXDs\COP_Revision\Vol_II\7.4_Comm_Fishing\Fig 7.4-12_Monkfish_20220811.mxd

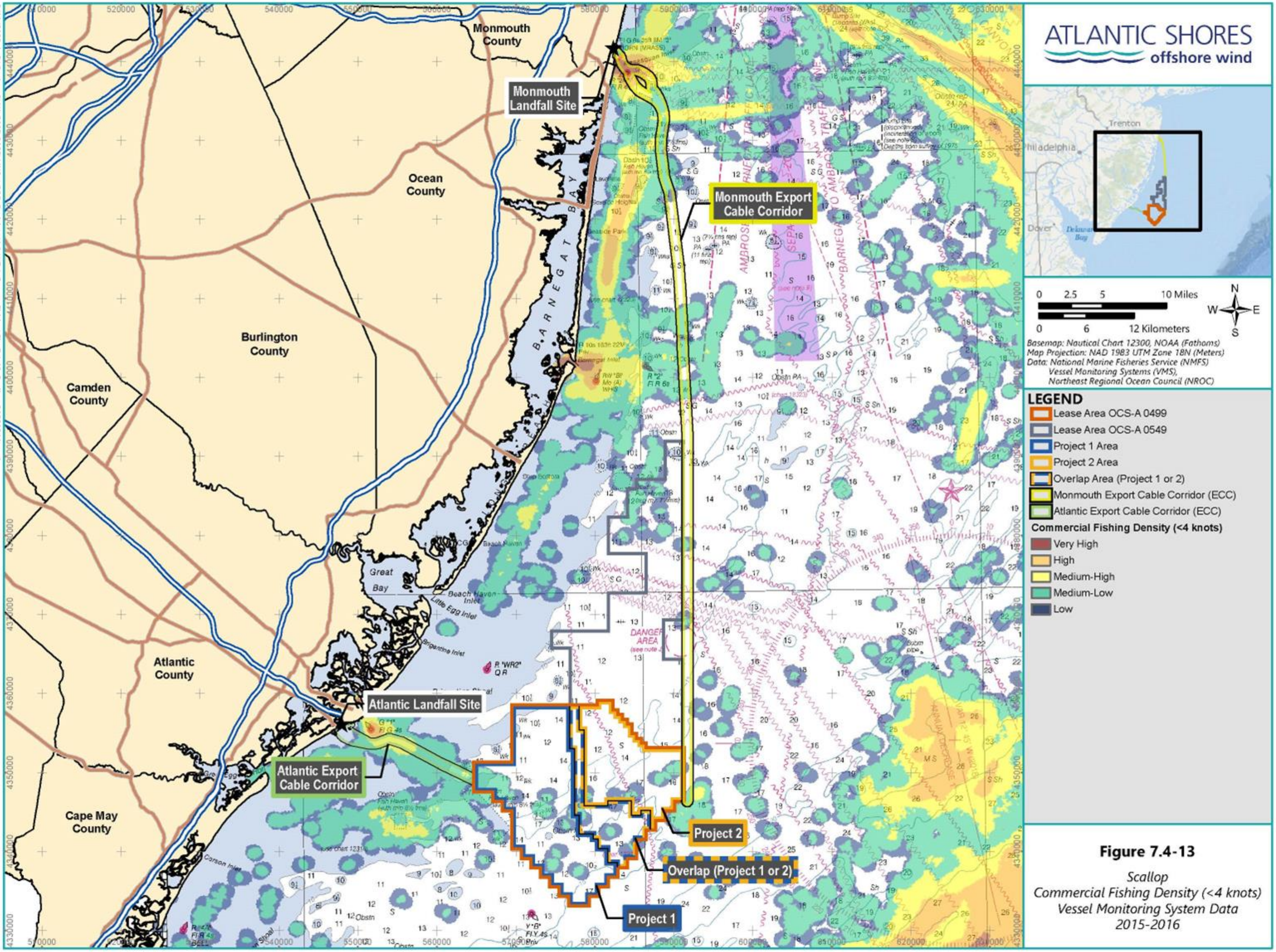


Figure 7.4-13

Scallop
Commercial Fishing Density (<4 knots)
Vessel Monitoring System Data
2015-2016

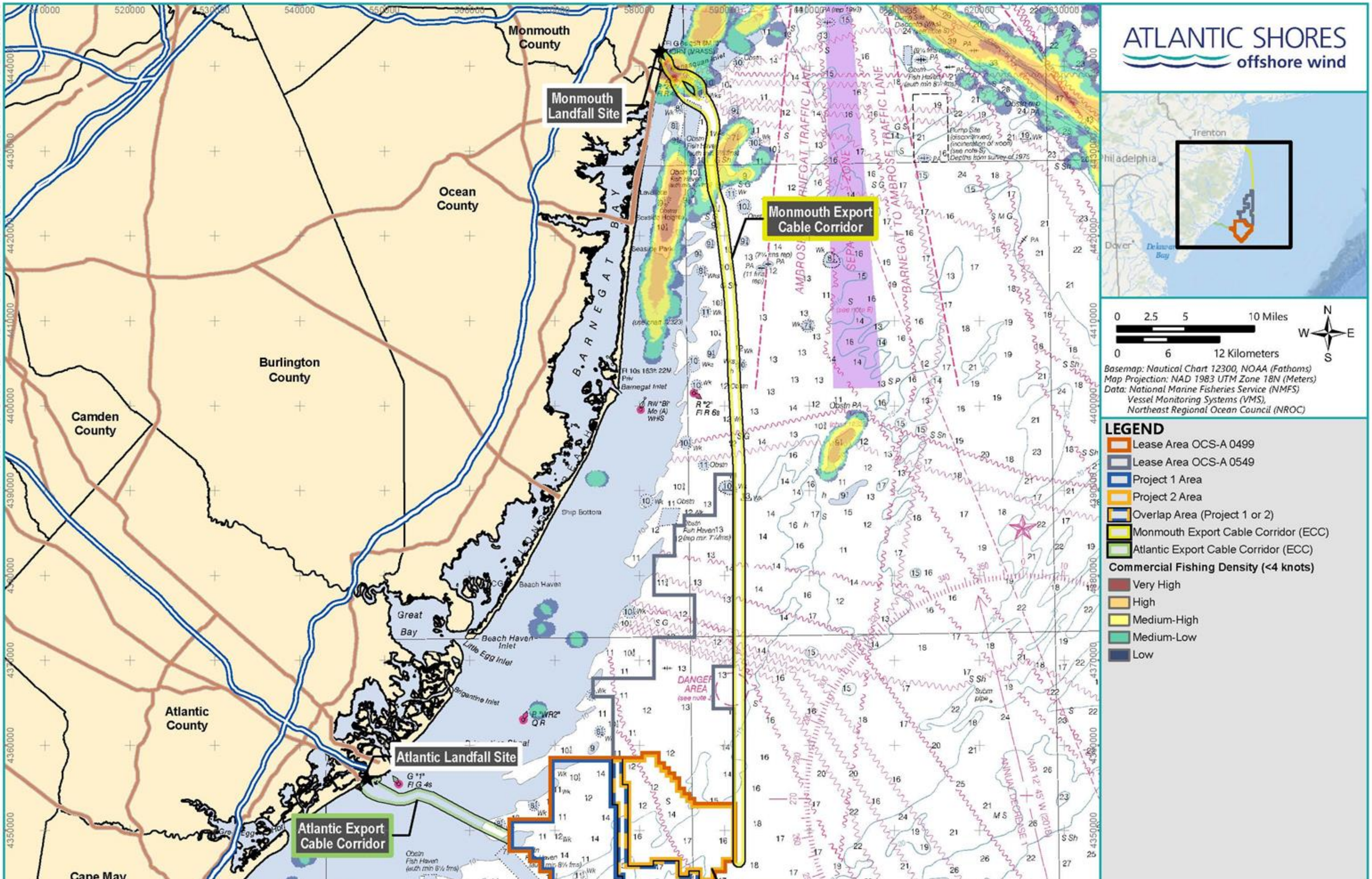


Figure 7.4-14

Squid
Commercial Fishing Density (<4 knots)
Vessel Monitoring System Data
2015-2016

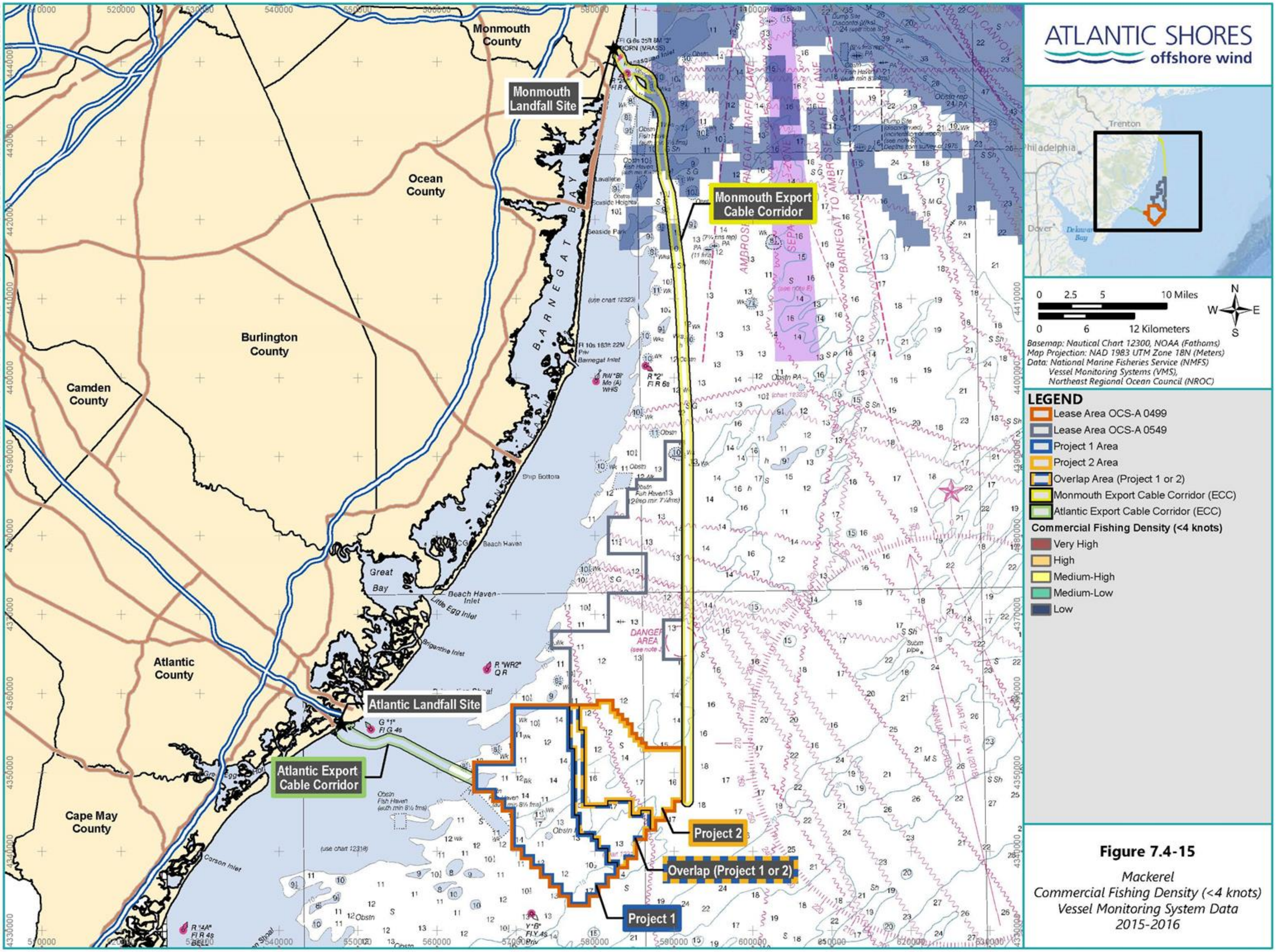


Figure 7.4-15

Mackerel
Commercial Fishing Density (<4 knots)
Vessel Monitoring System Data
2015-2016

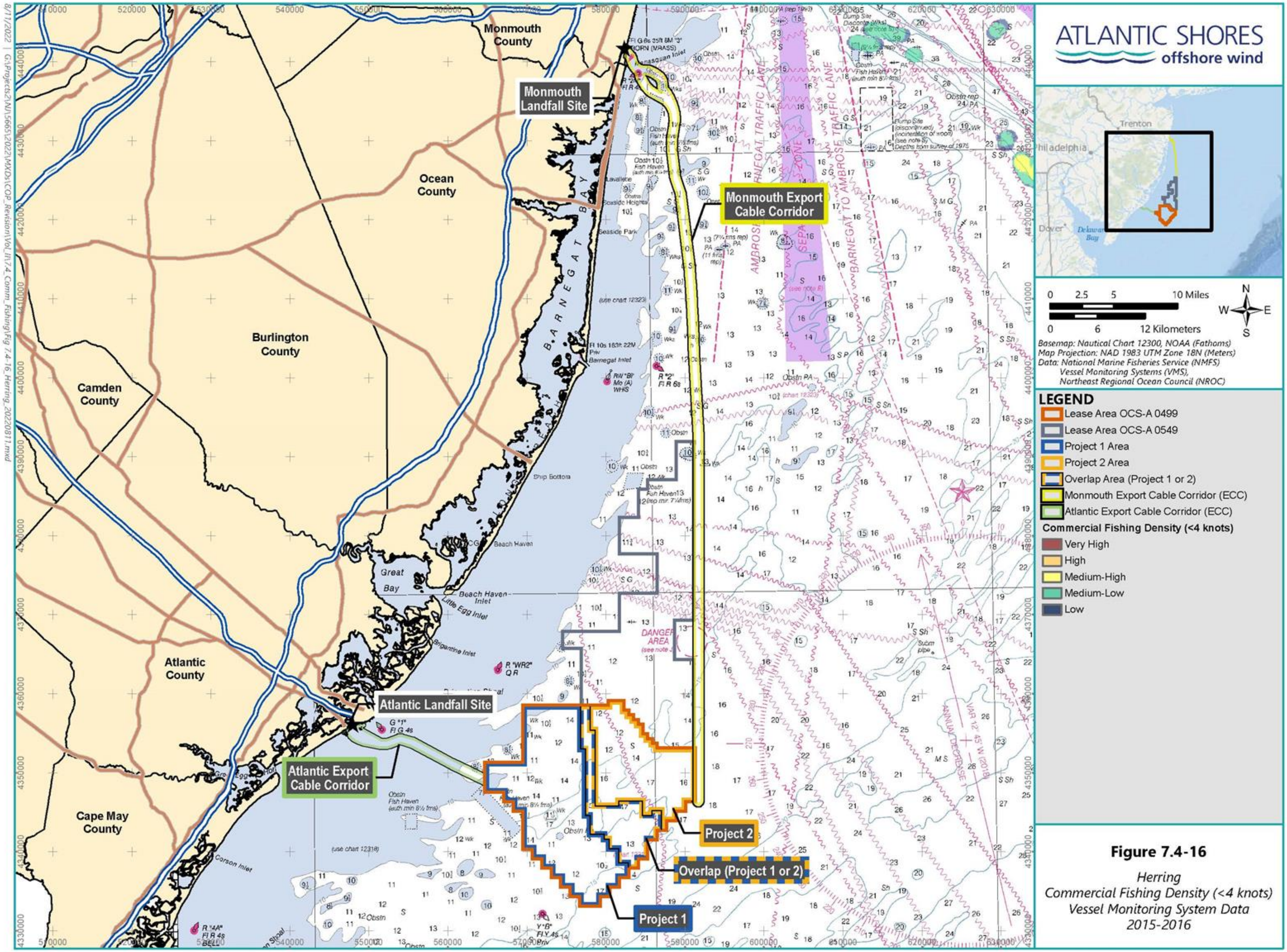
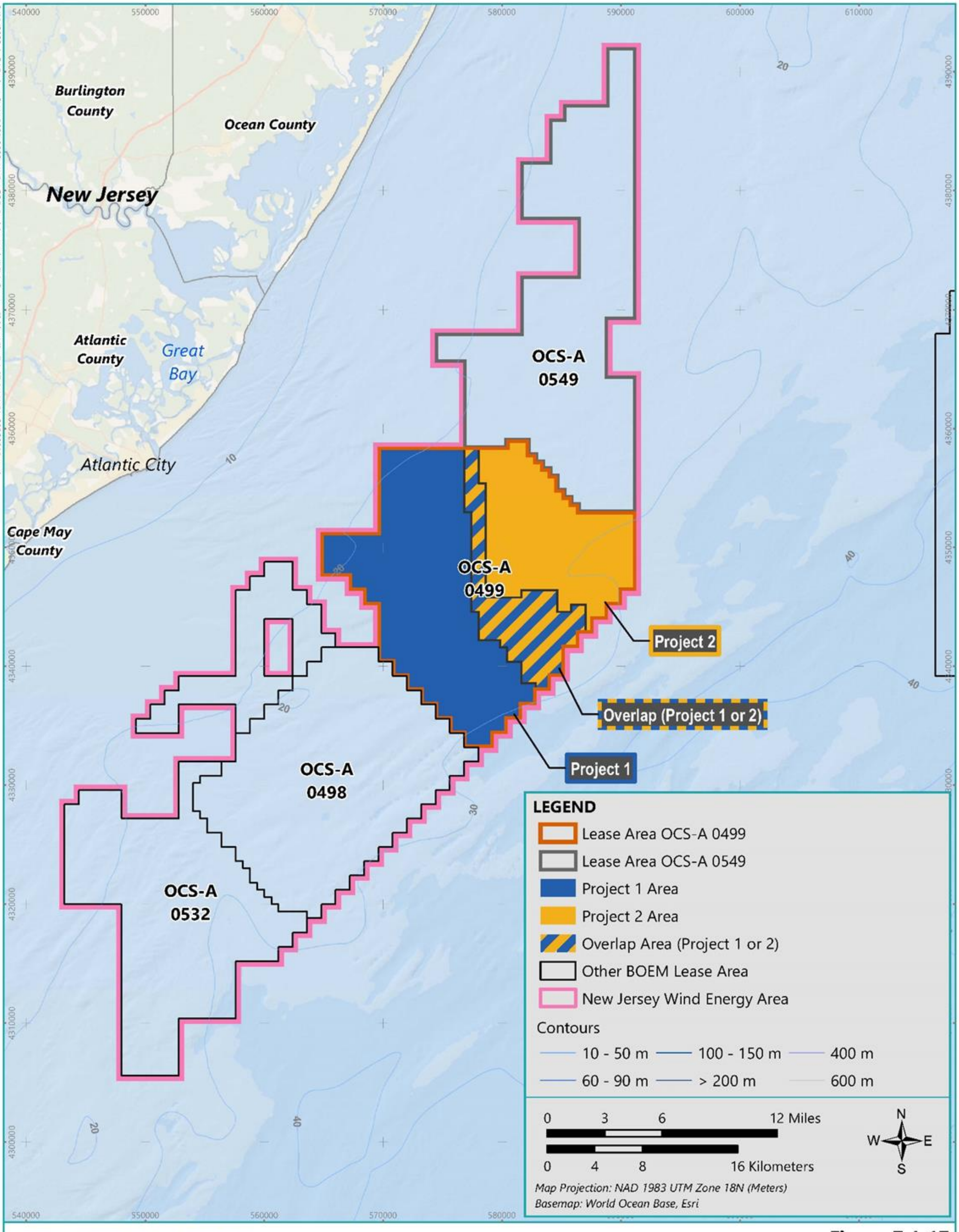


Figure 7.4-16

Herring
Commercial Fishing Density (<4 knots)
Vessel Monitoring System Data
2015-2016



ATLANTIC SHORES offshore wind

Figure 7.4-17
New Jersey Wind Energy Area
Offshore New Jersey

29.7% of the footprint of the NJWEA. Economic exposure of commercial fisheries within the WTA, therefore, will be a fraction of the estimated revenue exposure of the NJWEA.

The analysis of the larger NJWEA provides useful context for understanding regional commercial fishing activities. A separate analysis of the economic exposure of commercial fisheries in the WTA and ECCs is presented in Section 7.4.2.4 and was prepared using VTR data provided by NMFS, including landings and value for trips that occurred within the WTA and ECCs.

An assessment of federally permitted fishing activity within the NJWEA is provided in a BOEM-funded study conducted by NOAA's Northeast Fisheries Science Center (NEFSC). In the study, Kirkpatrick et al. (2017) details the value of species harvested during a 6-year period between 2007 and 2012 and identifies the ports, gear type, and species supporting that fishing activity in the entire NJWEA. Making use of VTR data, spatial data from the Northeast Fisheries Observer Program database, and VMS data,[64] Kirkpatrick et al. (2017) provides information on commercial harvested species, gear types used in those fisheries, and the ports at which species are landed. Haul locations recorded by observers from 2004–2012 were used to model the area associated with the reported VTR point and identify the proportion of catch that are sourced from within a specific geographic area from any VTR record or groups of VTR records. This analysis ultimately produced an estimate of revenue exposure within discrete geographic areas, including the NJWEA. Table 7.4-4 identifies the commercial ports most exposed to the NJWEA. The ports with the total revenue from the NJWEA are those that process clams in the region—Atlantic City, New Jersey; Cape May, New Jersey; and Newport News, Virginia (Kirkpatrick et al. 2017). Although Kirkpatrick et al. (2017) notes that clam landings, in general, have been declining in the Mid-Atlantic region since 2007, they are still sourced from within the NJWEA.

Table 7.4-4 Landed Value from the New Jersey Wind Energy Area, by Port (2007–2012)

Port	Average Annual Revenue from NJWEA (USD, Nominal)	Average Total Annual Port Revenue (USD, Nominal)	Percent Of Total Port Revenue from NJWEA
Atlantic City, New Jersey	$3,073,911	$27,890,274	11.0%
Sea Isle City, New Jersey	$28,920	$912,124	3.2%
Wildwood, New Jersey	$28,188	$2,893,981	1.0%
Long Beach, New Jersey	$34,604	$6,226,706	0.6%
Cape May, New Jersey	$235,212	$75,665,163	0.3%
Newport News, Virginia	$115,741	$38,319,620	0.3%
Barnegat, New Jersey	$35,637	$16,706,499	0.2%

64 "Because the VMS is used to generate high resolution vessel-specific spatial data, VMS data were used only to analyze specific impacts where appropriate" (Kirkpatrick et al. 2017).

Table 7.4-4 Landed Value from the New Jersey Wind Energy Area, by Port (2007–2012) (Continued)

Port	Average Annual Revenue from NJWEA (USD, Nominal)	Average Total Annual Port Revenue (USD, Nominal)	Percent Of Total Port Revenue from NJWEA
Gloucester, Massachusetts	$63,324	$43,210,602	0.1%
Point Pleasant, New Jersey	$44,351	$30,335,241	0.1%
New Bedford, Massachusetts	$43,678	$292,229,242	0.0%

Source: Kirkpatrick et al. (2017)

Table 7.4-5 identifies the number of permits and revenue, by gear type, potentially exposed to development of the NJWEA as provided in Kirkpatrick et al. (2017). According to Kirkpatrick et al. (2017), gear categories presented in Table 7.4-5 are not mutually exclusive and an individual fisherman can be represented in multiple gear categories. The NJWEA is fished predominantly by vessels deploying dredge gear, with a total of $3.41 million per year on average sourced from the NJWEA. According to Kirkpatrick et al. (2017), seine fishing also occurs in the NJWEA, and it is likely that menhaden fishing occurs in this area but is not represented in the data.

Table 7.4-5 Number of Permits and Revenue, by Gear, Exposed to Development of the NJWEA, 2007–2012[1]

Gear	Permits	Average Annual Revenue (USD, Nominal)	Average Annual Revenue from NJWEA (USD, Nominal)	Percent Revenue From NJWEA	Top Four FMPs	Top Five Port Groups
Dredge	286	$486,160,813	$3,410,005	0.7%	Surf clam (*Spisula solidissima*);[2] ocean quahog (*Arctica* islandica);[2] sea scallop (*Placopecten* magellanicus);[3] monkfish (*Lophius americanus*);[4] summer flounder (*Paralichthys dentatus*), scup (*Stenotomus chrysops*), black sea bass (*Centropristis striata*)[b]	Atlantic City, New Jersey; Cape May, New Jersey; Newport News, Virginia; Point Pleasant, New Jersey; New Bedford, Massachusetts
Gillnet	61	$34,164,385	$51,037	0.15%	Monkfish (*Lophius americanus*);[4] skates;[3] unmanaged;[5] bluefish (*Pomatomus saltatrix*)[2]	Barnegat, New Jersey; Long Beach, New Jersey; Waretown, New Jersey; Point Pleasant, New Jersey; Ocean County, New Jersey
Handgear	10	$8,339,830	$1,513	0.02%	Summer flounder (*Paralichthys dentatus*), scup (*Stenotomus chrysops*), black sea bass (*Centropristis striata*);[2] spiny dogfish (*Squalus* acanthias);[4] unmanaged;[5] bluefish (*Pomatomus saltatrix*)[2]	Barnegat, New Jersey; Sea Isle City, New Jersey; Long Beach, New Jersey; Point Lookout, New York; Cape May, New Jersey

Table 7.4-5 Number of Permits and Revenue, by Gear, Exposed to Development of the NJWEA, 2007–2012[1] (Continued)

Gear	Permits	Average Annual Revenue (USD, Nominal)	Average Annual Revenue from NJWEA (USD, Nominal)	Percent Revenue from NJWEA	Top Four FMPs	Top Five Port Groups
Longline	3	$7,399,976	$38	~0%	Highly Migratory Species (HMS)[6]; spiny dogfish (*Squalus acanthias*)[5]; unmanaged[5]	Ocean County, New Jersey; Barnegat, New Jersey
Pot	34	$11,071,430	$97,972	0.9%	Summer flounder (*Paralichthys dentatus*), scup (*Stenotomus chrysops)*, black sea bass (*Centropristis striata*)[2]; unmanaged[5]; red crab (*Chaceon quinquedens*)[2]; large mesh multispecies[3]	Atlantic City, New Jersey; Sea Isle City, New Jersey; Cape May, New Jersey; Wildwood, New Jersey; Point Pleasant, New Jersey
Lobster Pot	18	$213,321,675	$2,368	~0%	Unmanaged[5]; summer flounder (*Paralichthys dentatus*), scup (*Stenotomus chrysops*), black sea bass (*Centropristis striata*)[2]; small mesh multispecies[3]; skate[3]	Sea Isle City, New Jersey; Waretown, New Jersey; Neptune, New Jersey; Atlantic City, New Jersey; Other, New York
Seine	18	$10,258,052	$137,765	1.3%	Unmanaged[5]	Cape May, New Jersey; Gloucester, Massachusetts; Atlantic City, New Jersey; Fall River, Massachusetts

Table 7.4-5 Number of Permits and Revenue, by Gear, Exposed to Development of the NJWEA, 2007–2012[1] (Continued)

Gear	Permits	Average Annual Revenue (USD, Nominal)	Average Annual Revenue from NJWEA (USD, Nominal)	Percent Revenue from NJWEA	Top Four FMPs	Top Five Port Groups
Bottom Trawl	149	$174,094,198	$82,736	0.1%	Summer flounder (*Paralichthys dentatus*), scup (*Stenotomus chrysops*), black sea bass (*Centropristis striata*);[2] squid, mackerel, butterfish (*Peprilus triacanthus*);[2] unmanaged[5]; sea scallop (*Placopecten magellanicus*)[3]	Cape May, New Jersey; Long Beach, New Jersey; Chincoteague, Virginia; Barnegat, New Jersey; Newport News, Virginia
Midwater Trawl	13	$21,384,152	$5,396	~0%	Squid, mackerel, butterfish (*Peprilus triacanthus*);[2] Atlantic herring (*Clupea harengus*);[3] unmanaged;[5] HMS[6]	Cape May, New Jersey; New Bedford, Massachusetts; Worcester County, Maryland; Ocean County, New Jersey; Cape May County, New Jersey

[1]Source: Kirkpatrick et al. (2017)
[2]MAFMC management
[3]NEFMC management
[4]Joint NEFMC and MAFMC management
[5]Unmanaged species indicates revenue generated from species that are not included in a NMFS FMP.
[6]HMS management

Kirkpatrick et al. (2017) identified which FMPs, as a percentage of the total average revenue generated from that FMP, were most exposed within the NJWEA. Table 7.4-6 identifies those species.

Table 7.4-6 Landed Value from the New Jersey Wind Energy Area, by Fishery Management Plan (2007–2012)[1]

FMP	Jurisdiction	Average Annual Revenue from NJWEA (USD, Nominal)	Average Total Annual Revenue (USD, Nominal)	Percent Total Revenue Exposed
Surf Clam (*Spisula solidissima*) and Ocean Quahog (*Arctica islandica*)	MAFMC	$3,048,870	$64,967,095	4.7%
Summer Flounder (*Paralichthys dentatus*), Scup (*Stenotomus chrysops*), Black Sea Bass (*Centropristis striata*)	MAFMC	$103,854	$33,166,172	0.3%
Monkfish (*Lophius americanus*)	NEFMC, MAFMC	$38,816	$19,759,447	0.2%
Bluefish (*Pomatomus saltatrix*)	MAFMC	$2,517	$1,578,705	0.2%
Skate	NEFMC	$8,760	$7,796,915	0.1%
Sea Scallop (*Placopecten magellanicus*)	NEFMC	$363,559	$428,413,267	0.1%
Unmanaged[3]		$193,494	$248,316,185	0.1%
Squid, Mackerel (*Scomber scombrus*), Butterfish (*Peprilus triacanthus*)	MAFMC	$23,722	$40,849,295	0.1%
Atlantic Herring (*Clupea harengus*)	NEFMC	$2,225	$23,241,713	~0%
Small Mesh Multispecies[2]	NEFMC	$998	$10,675,728	~0%

[1]Source: Kirkpatrick et al. (2017)

[2]Small-Mesh Multispecies consist of two stocks of whiting (silver hake [*Merluccius bilinearis*]), two stocks of red hake (*Urophycis chuss*), and one stock of offshore hake (*Merluccius albidus*). Landings of silver and offshore hake are known as "whiting," while the fishery that harvests any of these species is known as the "whiting fishery."

[3]The "unmanaged" category indicates revenue generated from unmanaged species that do not fall under a Fishery Management Plan (e.g., Jonah crab [*Cancer borealis]*, rock crab [*Cancer irroratus*], chub mackerel [*Scomber colias*]).

Kirkpatrick et al. (2017) identified which species, as a percentage of the total average revenue generated from that species, were most exposed within the NJWEA. Table 7.4-7 identifies those species.

Table 7.4-7 Landed Value from the New Jersey Wind Energy Area, by Species (2007–2012)

Species	Species Revenue from NJWEA (USD, Nominal)	Species Average Total Revenue (USD, Nominal)	Percentage of Species Total Revenue
Surf Clam (*Spisula solidissima*)	$3,031,617	$35,291,040	8.6%
Menhaden (*Brevoortia* spp.)	$137,788	$3,870,799	3.6%
Black Sea Bass (*Centropristis striata*)	$62,734	$5,422,180	1.2%
Channeled Whelk (*Busycotypus canaliculatus*)	$18,132	$2,419,819	0.7%
Atlantic Croaker (*Micropogonias undulatus*)	$13,179	$3,081,688	0.4%
Monkfish (*Lophius americanus*)	$38,816	$19,759,447	0.2%
Summer Flounder (*Paralichthys dentatus*)	$40,688	$22,019,367	0.2%
Squid (*Illex illecebrosus*)	$14,888	$9,961,263	0.1%
Sea Scallop (*Placopecten magellanicus*)	$363,559	$428,413,267	0.1%
Ocean Quahog (*Arctica islandica*)	$17,253	$27,233,867	0.1%

Source: Kirkpatrick et al. (2017)

As described in Kirkpatrick et al. (2017), actual economic impacts depend upon many factors, including the ability of a vessel to continue operating as permitted by regulation. Commercial fishing vessels are anticipated to operate within the Offshore Project Area as currently permitted, except during construction when temporary safety zones may be implemented in the immediate vicinity of Project vessels and/or equipment.

7.4.2.4 Economic Exposure of Commercial Fisheries in the Wind Turbine Area and Export Cable Corridors

In October 2020, NMFS provided Atlantic Shores with a report summarizing fisheries landings by weight and dollar values for vessel trips that occurred within Offshore Project Area (i.e., the WTA and ECCs) from 2014 to 2018. The NMFS dataset includes modeled results of VTRs and clam logbook data linked to dealer data for value and landings information that were then queried for spatial overlap with the WTA and ECCs. In brief, the modeled results of VTRs create a spatial scale of each fishing trip that is more representative of actual fishing effort, in part, by reducing the effect of location inaccuracy of VTRs. Additionally, rather than placing the entire value reported for each VTR at the reported point location, the model allocates a percentage of a trip's reported landings to a specific geographic area, such as within the WTA and ECCs. Additional details on the VTR modeling are described in DePiper (2014) and Benjamin, Lee, DePiper (2018).

The modeling efforts are useful to address some of the limitations associated with VTR data. VTR reporting only requires that a single geographic position (point location) be reported for each fishing trip. Vessels are required to record the position where most of the fishing occurred, but because a new VTR is necessary only when gear type changes or fishing occurs in a new statistical area, multiple tows within the same statistical area using the same gear will likely be assigned only a single point location. Consequently, point locations reported for fixed gear (e.g., gillnet, pots) may be more representative of the actual fishing location than point locations reported for mobile fishing gear (e.g., trawl, dredge). Similarly, VTRs from day trips may be more representative of fishing location than VTRs from multi-day trips. Absent efforts to improve the spatial representation of self-reported VTR point locations, as described in DePiper (2014) and Benjamin, Lee, DePiper (2018), the VTR point location may not be representative of where the fishing occurred. However, all summaries of VTR data provided by NMFS and used in this section incorporate the modeled results from VTR data and, therefore, are more representative of actual fishing effort. The VTR data used are built from percentages of a trip that overlapped spatially with the WTA and ECCs. These percentages were applied to landings and values for that trip and summed.

Landings and values for the approximately 102,124-acre (413.3 km^2) WTA were also scaled to the Project 1 and Project 2 areas to provide estimates of the exposure of commercial fishing to development of each project. Project 1 is located in the western 54,175 acres (219.2 km^2) of the WTA, and Project 2 is located in the eastern 31,847 acres (128.9 km^2) of the WTA, with a 16,102-acre (65.2 km^2) Overlap Area that could be used by either Project 1 or Project 2.

For purposes of this analysis, and to provide a conservative estimate of the potential economic exposure of each Project with the data currently available, the following estimates of commercial fishing exposure assume that both Project 1 and Project 2 will make use of the entire Overlap Area. Therefore, the estimates of commercial fishing exposure assume that Project 1 will be developed within an approximately 70,277 acre (284.7 km^2) area (the "Project 1 WTA," which includes the entire Overlap Area) and accounts for approximately 68.8% of all landings from the WTA, while Project 2 will be developed within an approximately 47,949 acre (194.4 km^2) area (the "Project 2 WTA," which includes the entire Overlap Area) and accounts for approximately 47.0% of all landings from the WTA.

Following the preparation of this assessment of commercial fisheries values in the ECCs, minor adjustments were made to the ECCs to avoid sand resource areas. For purposes of this analysis, due to the spatial resolution of the landings data available for the ECCs, it is assumed that the adjustments to the ECCs have a *de minimis* effect on the estimates of commercial fishing exposure to cable installation, O&M, and decommissioning within the ECCs.

The summaries presented in the following sections identify the probable portion of a vessel trip that overlapped spatially with the Offshore Project Area and, as a result, provide a measure of the economic exposure of commercial fisheries to the Projects. Tables 7.4-8 through 7.4-16 summarize landed weight and value by species, gear type, port, and state of landing. To meet data confidentiality requirements, records that did not meet the NMFS "rule of three" (i.e., greater than or equal to three unique dealers reports and greater than or equal to three unique vessel permits) were anonymized, which may result in modest discrepancies when comparing summarized data across certain groupings. Also, as previously noted, federally permitted lobster vessels possessing only lobster permits do not have a VTR requirement and are not reflected in this summary. There are also fisheries in New Jersey State waters that may not be reflected in data from Federal VTRs (e.g., whelk, bluefish). To aid in the comparison of the value of landings over time, the nominal values of landings provided by NMFS were updated to 2020 values using the Bureau of Labor Statistics, Producer Price Index for Commodity Code #0223, Unprocessed, and Prepared seafood.[65] The annual value in the following tables is in 2020 U.S. dollars, unless otherwise noted.

Table 7.4-8 identifies the states with landings from the WTA and the allocation of those landings within the Project 1 and Project 2 WTAs. In accordance with confidentiality requirements, landings from the WTA in certain states were combined by NMFS and identified as "All Other Ports." According to NMFS (2020) data, five different states are included in the "All Other States" category shown in Table 7.4-8.

Table 7.4-8 Landed Value and Weight from the WTA, by State (2014–2018)[1]

State	Total, All Years		Annual Average	
	Weight (lb)	Value[2]	Weight (lb)	Value[2]
WTA				
New Jersey	2,710,786	$1,691,419	542,157	$338,284
Virginia	14,645	$130,597	2,929	$26,119
Massachusetts	10,225	$87,451	2,045	$17,490
Rhode Island	51,863	$38,243	10,373	$7,649
Maryland	7,350	$9,004	1,470	$1,801
North Carolina	3,301	$8,604	660	$1,721
All Other States	1,942	$4,836	388	$967
Total	**2,800,112**	**$1,970,153**	**560,022**	**$394,031**
Project 1 WTA[3]				
New Jersey	1,865,021	$1,163,696	373,004	$232,739
Virginia	10,076	$89,851	2,015	$17,970
Massachusetts	7,035	$60,166	1,407	$12,033
Rhode Island	35,682	$26,311	7,136	$5,262
Maryland	5,057	$6,195	1,011	$1,239

65 The Producer Price Index (PPI) for 2020 was calculated using the average monthly index for January through October of 2020.

Table 7.4-8 Landed Value and Weight from the WTA, by State (2014–2018)[1] (Continued)

State	Total, All Years		Annual Average	
	Weight (lb)	Value[2]	Weight (lb)	Value[2]
Project 1 WTA[3]				
North Carolina	2,271	$5,919	454	$1,184
All Other States	1,336	$3,327	267	$665
Total	**1,926,477**	**$1,355,465**	**385,295**	**$271,093**
Project 2 WTA[4]				
New Jersey	1,274,069	$794,967	254,814	$158,993
Virginia	6,883	$61,381	1,377	$12,276
Massachusetts	4,806	$41,102	961	$8,220
Rhode Island	24,376	$17,974	4,875	$3,595
Maryland	3,455	$4,232	691	$846
North Carolina	1,551	$4,044	310	$809
All Other States	913	$2,273	183	$455
Total	**1,316,053**	**$925,972**	**263,211**	**$185,194**

[1]Source: VTR data provided by NMFS 2020.
[2]Nominal values of landings provided by NMFS were updated to 2020 values using the Bureau of Labor Statistics, Producer Price Index for Commodity Code #0223, Unprocessed, and Prepared seafood.
[3]Landings from the 54,175-acre (219.2 km^2) Project 1 WTA, which includes the 16,102-acre (65.2-km^2) Overlap Area.
[4]Landings from the 31,847-acre (128.9 km^2) Project 2 WTA, which includes the 16,102-acre (65.2 km^2) Overlap Area.

Table 7.4-9 identifies the states with landings from the Monmouth ECC. In accordance with confidentiality requirements, landings from the Monmouth ECC in certain states were combined by NMFS and identified as "All Other States." As part of this analysis, four states, North Carolina, Maryland, New York, and Connecticut, each had annual average landings from the Monmouth ECC of less than $1,000 that were added to the combined confidential port landings categorized as "All Other States." According to NMFS (2020) data, seven different states are included in the "All Other States" category shown in Table 7.4-9.

Table 7.4-9 Landed Value and Weight from the Monmouth ECC, by State (2014–2018)[1]

State	Total, All Years		Annual Average	
	Weight (lb)	Value[2]	Weight (lb)	Value
New Jersey	1,718,198	$923,786	343,640	$184,757
Massachusetts	13,843	$28,546	2,769	$5,709

Table 7.4-9 Landed Value and Weight from the Monmouth ECC, by State (2014–2018)[1] (Continued)

State	Total, All Years		Annual Average	
	Weight (lb)	Value[2]	Weight (lb)	Value
Virginia	3,396	$23,108	679	$4,622
Rhode Island	15,015	$9,735	3,003	$1,947
All Other States	9,546	$8,848	1,909	$1,770
Total	**1,759,998**	**$994,021**	**352,000**	**$198,804**

[1]Source: VTR data provided by NMFS 2020.
[2]Nominal values of landings provided by NMFS were updated to 2020 values using the Bureau of Labor Statistics, Producer Price Index for Commodity Code #0223, Unprocessed, and Prepared seafood.

Table 7.4-10 identifies the states with landings from the Atlantic ECC. In accordance with confidentiality requirements, landings from the Atlantic ECC in certain states were combined by NMFS and identified as "All Other States." As part of this analysis states with annual average landings from the Atlantic ECC of less than $1,000 were added to the combined confidential port landings categorized as "All Other States." Only New Jersey had average annual landings greater than $1,000. According to NMFS data, 10 states are included in the "All Other States" category shown in Table 7.4-10.

Table 7.4-10 Landed Value and Weight from the Atlantic ECC, by State (2014–2018)[1]

State	Total, All Years		Annual Average	
	Weight (lb)	Value[2]	Weight (lb)	Weight (lb)
New Jersey	25,374	$23,753	5,075	$4,751
All Other States	1,793	$2,977	359	$595
Total	**27,167**	**$26,730**	**5,433**	**$5,346**

[1]Source: VTR data provided by NMFS 2020.
[2]Nominal values of landings provided by NMFS were updated to 2020 values using the Bureau of Labor Statistics, Producer Price Index for Commodity Code #0223, Unprocessed, and Prepared seafood.

Table 7.4-11 identifies the commercial ports with landings from the WTA and the allocation of those landings to the Project 1 WTA and Project 2 WTA. To meet confidentiality requirements, landings at certain ports were combined by NMFS and identified as "All Other Ports." As part of this analysis, any port with annual average landings from the WTA of less than $2,500 were added to the combined confidential port landings. According to NMFS data, 76 different ports are included in the "All Other Ports" category shown in Table 7.4-11.

Table 7.4-11 Landed Value and Weight from the WTA, by Port (2014–2018)[1]

Port	Total, All Years		Annual Average	
	Weight (lb)	Value[2]	Weight (lb)	Value
WTA				
Atlantic City	2,140,732	$1,238,625	428,146	$247,725
Cape May	530,459	$308,085	106,092	$61,617
New Bedford	9,935	$85,724	1,987	$17,145
Barnegat	19,871	$70,009	3,974	$14,002
Newport News	3,701	$38,015	740	$7,603
All Other Ports	95,411	$230,390	19,082	$46,078
Total	**2,800,109**	**$1,970,848**	**560,022**	**$394,170**
Project 1 WTA[3]				
Atlantic City	1,472,824	$852,174	294,565	$170,435
Cape May	364,956	$211,962	72,991	$42,392
New Bedford	6,835	$58,978	1,367	$11,796
Barnegat	13,671	$48,166	2,734	$9,633
Newport News	2,546	$26,154	509	$5,231
All Other Ports	65,643	$158,508	13,129	$31,702
Total	**1,926,475**	**$1,355,944**	**385,295**	**$271,189**
Project 2 WTA[4]				
Atlantic City	1,006,144	$582,154	201,229	$116,431
Cape May	249,316	$144,800	49,863	$28,960
New Bedford	4,669	$40,290	934	$8,058
Barnegat	9,339	$32,904	1,868	$6,581
Newport News	1,739	$17,867	348	$3,573
All Other Ports	44,843	$108,283	8,969	$21,657
Total	**1,316,051**	**$926,299**	**263,210**	**$185,260**

[1]Source: VTR data provided by NMFS, 2020.

[2]Nominal values of landings provided by NMFS were updated to 2020 values using the Bureau of Labor Statistics, Producer Price Index for Commodity Code # 0223, Unprocessed, and Prepared seafood.

[3]Landings from the 54,175-acre (219.2 km^2) Project 1 WTA, which includes the 16,102-acre (65.2-km^2) Overlap Area.

[4]Landings from the 31,847-acre (128.9 km^2) Project 2 WTA, which includes the 16,102-acre (65.2-km^2) Overlap Area

Consistent with the findings in Kirkpatrick et al. (2017), Atlantic City is the highest revenue producing port in the Offshore Project Area, and accounts for approximately 56.9% of all revenue from the Offshore Project Area.

Table 7.4-12 identifies the commercial ports with landings from the Monmouth ECC. To meet confidentiality requirements, landings at certain ports were combined by NMFS and identified as “All Other Ports.” As part of this analysis, any port with annual average landings from the Monmouth ECC of less than $2,500 were added to the combined confidential port landings. According to NMFS data, 76 different ports are included in the “All Other Ports” category shown in Table 7.4-12

Table 7.4-12 Landed Value and Weight from the Monmouth ECC by Port (2014–2018)[1]

Port	Total, All Years		Annual Average	
	Weight (lb)	Value[2]	Weight (lb)	Value
Atlantic City	599,127	$362,796	119,825	$72,559
Point Pleasant	459,574	$265,277	91,915	$53,055
Barnegat	403,601	$205,011	80,720	$41,002
Cape May	238,321	$75,447	47,664	$15,089
New Bedford	10,020	$27,832	2,004	$5,566
All Other Ports	49,348	$72,252	9,870	$14,450
Total	**1,759,991**	**$1,008,615**	**351,998**	**$201,723**

[1]Source: VTR data provided by NMFS 2020.

[2]Nominal values of landings provided by NMFS were updated to 2020 values using the Bureau of Labor Statistics, Producer Price Index for Commodity Code #0223, Unprocessed, and Prepared seafood.

Table 7.4-13 identifies the commercial ports with landings from the Atlantic ECC. To meet confidentiality requirements, landings at certain ports were combined by NMFS and identified as “All Other Ports.” As part of this analysis, any port with annual average landings from the Atlantic ECC of less than $1,500 were added to the combined confidential port landings. According to NMFS data, 80 different ports are included in the “All Other Ports” category shown in Table 7.4-13.

Table 7.4-13 Landed Value and Weight from the Atlantic ECC by Port (2014–2018)[1]

Port	Total, All Years		Annual Average	
	Weight (lb)	Value[2]	Weight (lb)	Value
Atlantic City	6,660	$8,366	1,332	$1,673
All Others	20,505	$18,499	4,101	$3,700
Total	**27,165**	**$26,865**	**5,433**	**$5,373**

[1]Source: VTR data provided by NMFS, 2020.

[2]Nominal values of landings provided by NMFS were updated to 2020 values using the Bureau of Labor Statistics, Producer Price Index for Commodity Code # 0223, Unprocessed, and Prepared seafood.

Table 7.4-14 identifies species with landings from the WTA and the allocation of those landings to the Project 1 WTA and Project 2 WTA. To meet confidentiality requirements, certain species were combined by NMFS and are identified as "All Other Species." As part of this analysis, any species with annual average landings from the WTA of less than $1,000 were added to the combined confidential species landings. According to NMFS data, 115 different species are included in the "All Other Species" category shown in Table 7.4-14. To provide additional context for the relative significance of these species to commercial fishing in the New Jersey region, Table 7.4-14 also provides the average annual landed weight and value of each species landed in New Jersey. A comparison to New Jersey landings is provided because approximately 85.9% of the average annual value of all species harvested from the WTA are landed at New Jersey ports. Although vessels operating from other states may be active in the WTA, the comparison to state-wide landings in New Jersey provides a more conservative estimate of each species' exposure to the WTA because the average annual value of these landings in all New England and Mid-Atlantic states is much greater than New Jersey alone.

This comparison shows that the exposed annual average value of species harvested from the WTA and, consequently, the Project 1 and Project 2 WTA is quite small. The average annual value of the most exposed species in the WTA, channel whelk and surf clam, represent approximately 2% of those species' total average annual landings in New Jersey. The annual average value of most species harvested from the WTA is less than 0.4% of their annual average value in New Jersey.

Table 7.4-14 Landed Value and Weight from the WTA, by Species (2014–2018)[1]

Species	WTA Annual Average		Project 1 WTA Annual Average[3]		Project 2 WTA Annual Average[4]		New Jersey Annual Average	
	Weight (lb)	Value	Weight (lb)	Value	Weight (lb)	Value	Weight (lb)	Value
Surf Clam (*Spisula solidissima*)	427,917	$237,184	294,407	$163,183	201,121	$111,476	17,820,939	$11,629,605
Sea Scallop (*Placopecten magellanicus*)	8,776	$104,474	6,038	$71,878	4,12	$49,103	9,127,666	$104,477,556
American Lobster (*Homarus americanus*)	1,459	$7,154	1,004	$4,922	686	$3,362	414,983	$2,298,181
Longfin Squid (*Doryteuthis* [Amerigo] *pealeii*)	5,071	$6,300	3,489	$4,335	2,383	$2,961	3,080,904	$3,901,094
Black Sea Bass (*Centropristis striata*)	2,230	$5,900	1,534	$4,059	1,048	$2,773	617,293	$2,339,921
Summer Flounder (*Paralichthys dentatus*)	1,538	$5,098	1,058	$3,507	723	$2,396	1,362,378	$5,146,229
Channeled Whelk (*Busycotypus canaliculatus*)	527	$4,423	362	$3,043	248	$2,079	42,331	$208,899

Table 7.4-14 Landed Value and Weight from the WTA, by Species (2014–2018)[1] (continued)

Species	WTA Annual Average		Project 1 WTA Annual Average[3]		Project 2 WTA Annual Average[4]		New Jersey Annual Average	
	Weight (lb)	Value	Weight (lb)	Value	Weight (lb)	Value	Weight (lb)	Value
Illex Squid (*Illex illecebrosus*)	3,682	$2,039	2,533	$1,403	1,730	$958	18,668,926	$6,992,355
Smooth Dogfish (*Mustelus canis*)	1,276	$1,190	878	$819	600	$559	677,341	$350,844
Menhaden (*Brevoortia* spp.)	8,384	$1,169	5,768	$804	3,940	$549	70,450,141	$11,688,495
All Others	99,148	$19,080	68,214	$13,127	46,600	$8,967	-	-
Total	**560,008**	**$394,009**	**385,286**	**$271,078**	**263,204**	**$185,184**	**-**	**-**

[1]Source: VTR data provided by NMFS 2020.

[2]Nominal values of landings provided by NMFS were updated to 2020 values using the Bureau of Labor Statistics, Producer Price Index for Commodity Code #0223, Unprocessed, and Prepared seafood.

[3]Landings from the 54,175-acre (219.2 km^2) Project 1 WTA, which includes the 16,102-acre (65.2 km^2) Overlap Area.

[4]Landings from the 31,847-acre (128.9 km^2) Project 2 WTA, which includes the 16,102-acre (65.2 km^2) Overlap Area.

Table 7.4-15 identifies species with landings from the Monmouth ECC. To meet confidentiality requirements, certain species were combined by NMFS and are identified as "All Other Species." As part of this analysis, any species with annual average landings from the Monmouth ECC of less than $1,000 were added to the combined confidential species landings. To provide additional context for the relative significance of these species to commercial fishing in the New Jersey region, Table 7.4-15 also provides to average annual landed weight and value of each species landed in New Jersey. A comparison to New Jersey landings is provided because approximately 92.9% of the average annual value of all species harvested from the Monmouth ECC are landed at New Jersey ports. Although vessels operating from other states may be active in Monmouth ECC, the comparison to state-wide landings in New Jersey provides a more conservative estimate of each species' exposure to the Monmouth ECC because the average annual value of these landings in all New England and Mid-Atlantic states is much greater than New Jersey alone.

This comparison shows that the exposed annual average value of species harvested from the Monmouth ECC is small. The average annual value of the most exposed species in the Monmouth ECC, spiny dogfish and smooth dogfish, represent approximately 3.7% and 2.9%, respectively, of those species' total annual average landings in New Jersey. The annual average value of most species harvested from the Monmouth ECC is less than 0.7% of their annual average value in New Jersey.

Table 7.4-15 Landed Value and Weight from the Monmouth ECC, by Species (2014–2018)[1]

Species	Monmouth ECC Total, All Years		Monmouth ECC Annual Average		New Jersey Annual Average	
	Weight (lb)	Value[2]	Weight (lb)	Value	Weight (lb)	Value
Surf Clam (*Spisula solidissima*)	475,707	$301,568	95,141	$60,314	17,820,939	$11,629,605
Sea Scallop (*Placopecten magellanicus*)	11,234	$126,836	2,247	$25,367	9,127,666	$104,477,556
Summer Flounder (*Paralichthys dentatus*)	23,122	$101,312	4,624	$20,262	1,362,378	$5,146,229
Spiny Dogfish (*Squalus acanthias*)	460,560	$78,522	92,112	$15,704	2,343,347	$419,478
Monkfish (*Lophius americanus*)	44,662	$73,124	8,932	$14,625	1,813,485	$2,153,285
Skate Wings	101,045	$54,000	20,209	$10,800	2,590,189	$633,166

Table 7.4-15 Landed Value and Weight from the Monmouth ECC, by Species (2014–2018)[1] (Continued)

Species	Monmouth ECC Total, All Years		Monmouth ECC Annual Average		New Jersey Annual Average	
	Weight (lb)	Value[2]	Weight (lb)	Value	Weight (lb)	Value
Smooth Dogfish (*Mustelus canis*)	70,560	$50,999	14,112	$10,200	677,341	$350,844
Menhaden (*Brevoortia* spp.)	314,440	$37,838	62,888	$7,568	70,450,141	$11,688,495
American Lobster (*Homerus americanus*)	5,694	$30,577	1,139	$6,115	414,983	$2,298,181
Bluefish (*Pomatomus saltatrix*)	50,057	$30,912	10,011	$6,182	450,171	$290,954
Black Sea Bass (*Centropristis striata*)	5,522	$17,915	1,104	$3,583	617,293	$2,339,921
Longfin Squid (*Doryteuthis* [Amerigo] *pealeii*)	6,920	$8,454	1,384	$1,691	3,080,904	$3,901,094
Channeled Whelk (*Busycotypus canaliculatus*)	704	$5,863	141	$1,173	42,331	$208,899
All Others	189,563	$90,522	37,913	$18,104	-	-
Total	**1,759,790**	**$1,008,441**	**351,958**	**$201,688**	**-**	**-**

[1]Source: VTR data provided by NMFS 2020.
[2]Nominal values of landings provided by NMFS were updated to 2020 values using the Bureau of Labor Statistics, Producer Price Index for Commodity Code #0223, Unprocessed, and Prepared seafood.

Table 7.4-16 identifies species with landings from the Atlantic ECC. To meet confidentiality requirements, certain species were combined by NMFS and are identified as “All Other Species.” As part of this analysis, any species with annual average landings from the Atlantic ECC of less than $1,000 were added to the combined confidential species landings. In the case of the Atlantic ECC, only channeled whelk had average annual landings more than $1,000. To provide additional context for the relative significance of channeled whelk to commercial fishing in the New Jersey region, Table 7.4-16 also provides to average annual landed weight and value of channeled whelk landed in New Jersey. A comparison to New Jersey landings is provided because approximately 88.4% of the average annual value of all species harvested from the Atlantic ECC are landed at

New Jersey ports. Although vessels operating from other states may be active in the Atlantic ECC, the comparison to state-wide landings in New Jersey provides a more conservative estimate of channeled whelk's exposure to the Atlantic ECC because the average annual value of that species' landings in all New England and Mid-Atlantic states is much greater than New Jersey alone.

This comparison shows that the annual average value of channeled whelk harvested from the Monmouth ECC is small and represents approximately 1.1% of the annual average value of channeled whelk in New Jersey.

Table 7.4-16 Landed Value and Weight from the Atlantic ECC, by Species (2014–2018)[1]

Species	Atlantic ECC Total, All Years		Atlantic ECC Annual Average		New Jersey Annual Average	
	Weight (lb)	Value (USD)[2]	Weight (l)	Value (USD)	Weight (lb)	Value
Channeled Whelk (*Busycotypus canaliculatus*)	1,367	$11,586	273	$2,317	42,331	$208,899
All Others	25,762	$14,916	5,152	$2,983	-	-
Total	**27,129**	**$26,501**	**5,426**	**$5,300**	**-**	**-**

[1]Source: VTR data provided by NMFS 2020.

[2]Nominal values of landings provided by NMFS were updated to 2020 values using the Bureau of Labor Statistics, Producer Price Index for Commodity Code #0223, Unprocessed, and Prepared seafood.

Summary

The quantitative assessment of commercial fishing activity and value within the WTA, Project 1 WTA, Project 2 WTA, and ECCs described in Section 7.4.2.4 was conducted using VTR data provided by NMFS, including landings and values for trips that occurred with the WTA and ECCs; this quantitative assessment was also informed by assessments of fishing activity using VMS and AIS data. As described in Section 7.4.2.1, while VTR data used in this quantitative assessment represent the best available data, it is recognized that there are some limitations associated with VTR data and that they do not provide a complete picture of the value or intensity of any one fishery, particularly for lobster and Jonah crab because vessels that fish exclusively for these two species are not required to file VTRs. Available VTR and VMS data indicate that relatively little commercial fishing effort for lobster and Jonah crab occur in the WTA and ECCs. This suggests that the VTR data provide a reasonable estimate of economic exposure within the WTA, Project 1 WTA, Project 2 WTA, and ECCs.

As noted in Section 7.4.2, estimates of the economic value of commercial fishing activity in the WTA and ECCs represent the potential economic exposure, or maximum potential economic value, of commercial fisheries and do not represent actual or expected economic impacts. It is anticipated that most, if not all, historical fishing effort in the Offshore Project Area can be maintained throughout the construction, O&M, and decommissioning of the Projects.

Based on the preceding assessment of VTR data, approximately $3.0 million dollars of total landings (approximately $600,000 per year) were harvested from the WTA and ECCs from 2014 to 2018. This analysis indicates that:

- Approximately $395,000 of total landings per year were harvested from the WTA
    - Approximately $270,000 per year were harvested from the Project 1 WTA (which includes the Overlap Area)
    - Approximately $185,000 per year were harvested from the Project 2 WTA (which includes the Overlap Area)
- Approximately $202,000 per year were harvested from the Monmouth ECC
- Approximately $5,300 per year were harvested from the Atlantic ECC.

Surf clams are the highest revenue producing and most exposed species in the WTA, and account for approximately 60.2% of average annual revenue from the WTA (Kirkpatrick et al. 2017).

The sea scallop fishery, although not highly exposed within the WTA due, in part, to the high value of this fishery, is the second highest revenue species and accounts for 26.5% of average annual revenue in the Offshore Project Area. Based on ongoing communication between commercial scallop fishermen and the Atlantic Shores FLO, little scallop fishing activity is understood to occur within the WTA. Landings along the Monmouth ECC are also predominately surf clams and sea scallops.

The ports most affected as measured by total revenue are likely those that process surf clams in the region—Atlantic City and Cape May. In general, and over a two-decade period, surf clam landings have been declining in the Mid-Atlantic region, although this fishery is still active in the Offshore Project Area. Trends in the surf clam fishery show that warming waters of the Mid-Atlantic Bight have resulted in the commercial fishing effort for this fishery shifting northward and farther offshore into deeper waters (Hofmann et al. 2018). The fishery's response to this trend, primarily the relocation of fishing effort and processing capacity to the species more northerly range, has concentrated fishing pressure in the area immediately south of the Hudson Canyon resulting in decreased stock in the nearshore areas surrounding the WTA (Hofmann et al. 2018). A decline in landings per unit effort has resulted, meaning additional cost to the vessel operator and more fishing effort expended to land the same volume of surf clam. However, over the past decade, the total number of vessels participating in this fishery has remained relatively stable, as there has been very little change in the volume and value of landings and the numbers of vessels and dealers participating in this fishery. The shift of surf clams into deeper water has also contributed to mixing of surf clam within shellfish beds where the predominant species was ocean quahog, increasing the likelihood of co-occurrence during harvesting.

Landings, VTR, and VMS data do not fully explain the dynamic factors that influence landings and revenue. Although the effects of these factors may be reflected in the resulting reported revenue and landing, these data do not explain why catch may be high or low at any point in time, nor do they necessarily indicate either a high or low abundance of species. In addition, management of fisheries, including annual quotas for target and bycatch species, geographic and/or fisheries closures, and permit restrictions each influence fisheries landings and revenues, as do economic factors of market prices and supply, O&M costs, and quota and permit lease prices. Environmental conditions, such as water temperature, are also significant factors in the productivity of commercial fisheries. As a result, the locations of commercial fishing efforts are variable.

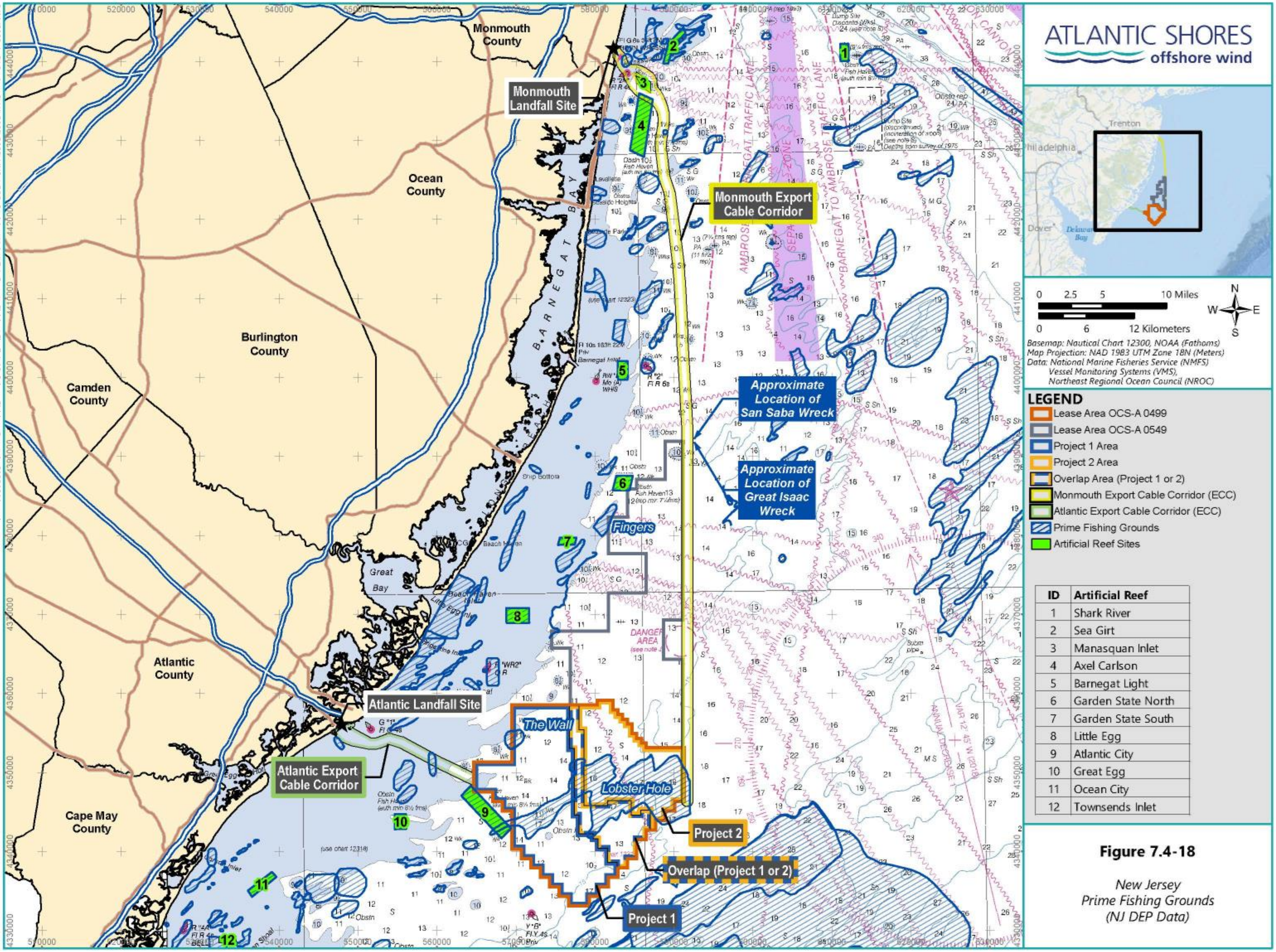
7.4.3 Assessment of For-Hire Recreational Fishing Effort

For-hire recreational fishing has important cultural and economic value in the Mid-Atlantic region and to the State of New Jersey, including within the Offshore Project Area. The entire near-coastal region and, more specifically, numerous locations off the coast of New Jersey host species targeted by for-hire recreational fishing operations.

Figure 7.4-18 identifies the "prime" fishing grounds of New Jersey and locations of artificial reefs constructed in proximity to the WTA and ECCs. Prime fishing grounds are known fishing target locations and areas frequented by recreational fishermen. An approximately 28,000 acre (113 km^2) recreational fishing area, known locally as the "Lobster Hole," intersects portions of the WTA.

Atlantic Shores has engaged with the recreational fishing industry to collect data directly from the fishing community on important recreational fishing areas. Atlantic Shores has hired a local, New Jersey fishermen to serve as its Recreational FIR. One of the first tasks completed by Atlantic Shores Recreational FIR during October of 2020 was to speak to a group of experienced recreational fishermen about their key fishing areas in the NJWEA. This initial map formed the basis of Atlantic Shores' understanding of important recreational fishing areas.

To further understand important areas for recreational fishermen, Atlantic Shores has held two meetings with recreational fishermen to gather information on important recreational fishing grounds. At the second meeting, the maps created in October were shared to all the attendees. Representatives of Atlantic Shores walked through each layer of the maps: NOAA base map, detailed bathymetry at 1 fathom increments, and the key fishing areas. No other feedback was given, other than to agree that the highlighted areas were correct. These data gathering efforts broadly corroborate the locations of prime fishing grounds shown on Figure 7.4-18.



ID	Artificial Reef
1	Shark River
2	Sea Girt
3	Manasquan Inlet
4	Axel Carlson
5	Barnegat Light
6	Garden State North
7	Garden State South
8	Little Egg
9	Atlantic City
10	Great Egg
11	Ocean City
12	Townsends Inlet

Figure 7.4-18

New Jersey Prime Fishing Grounds (NJ DEP Data)

Between 2015 and 2019, an annual average of 207,779 angler trips were estimated to occur on for-hire recreational vessels in State and Federal waters off the coast of New Jersey (NOAA MRIP 2020). NMFS (2021b) analysis of recreational party and charter vessel activity from 2008 to 2018 indicates that approximately 14,789 angler trips occurred within the Lease Area. In assessing for-hire recreational fishing effort in the larger NJWEA (which includes Lease Area OCS-A 0498 and the Atlantic Shores Lease Area OCS-A 0499), Kirkpatrick et al. (2017) identified three primary ports from which such vessel trips originate: Atlantic City, Barnegat, and Long Beach. The analysis by

NMFS (2021b) supports Kirkpatrick et al. (2017), indicating that approximately 85.5% of the 14,798 angler trips within the Lease Area between 2008 and 2018 originated at those three ports. All other ports in New Jersey account for approximately 12.9% of angler trips within the Lease Area during those same years.

According to MRIP data, between 2015 and 2019, the primary species landed by for-hire vessels in New Jersey waters were tunas/mackerels, striped bass, black sea bass, bluefish, and summer flounder. NMFS (2021b) analysis of recreational party and charter vessel activity from 2008 to 2018 indicates that, of all the species landed within the Lease Area, approximately 68.7% were black sea bass, 10.7% were summer flounder, and 5.4% were bluefish.

A regional assessment of the economic contribution of for-hire charter/headboat operators is available for the Atlantic and Gulf of Mexico coasts from Maine to Texas for the period of July to November 2013 (Hutt and Silva 2015). Along the stretch of Atlantic coast from Maine to Virginia (referred to as the Northeast), an estimated 4,936 charter trips that targeted Atlantic Highly Migratory Species (HMS) occurred from July to November 2013. Hutt and Silva (2015) estimated a total of $12.1 million in gross revenue in the Northeast from July to November 2013, of which $7.3 million was used for trip expenses (fuel, crew, bait, supplies, etc.) and $4.8 million was for owner net return and operation costs. Because these numbers represent the 2013 value of for-hire charter/headboat fishing along the Atlantic coast from Maine to Virginia, only a fraction of this revenue is likely generated in the Offshore Project Area.

The average fee in the Northeast per charter boat trip was $2,450; after accounting for expenditures, the average net return was estimated at $969 per charter boat trip. The average fee in the Northeast per headboat trip was $6,973; after accounting for expenditures, the average net return was estimated at $2,305 per headboat trip (Hutt and Silva 2015). NMFS (2021b) estimated the total revenue from recreational party and charter vessel trips per year by multiplying the annual mean combined charter and party for-hire fee for New Jersey by the total number of anglers for each year. In doing so, NMFS (2021b) estimated that average annual revenue from these vessel trips within the Lease Area is approximately $114,000.

New Jersey also hosts several offshore fishing tournaments each year. In 2020, for example, 20 such tournaments were held in New Jersey. These events primarily occur in the summer months and are geared toward anglers targeting HMS, which include federally regulated sharks, blue and white marlin, sailfish, roundscale spearfish, swordfish, and federally regulated tunas including bluefin, yellowfin, bigeye, skipjack, and albacore in the Atlantic, Gulf of Mexico, and Caribbean.

7.4.4 Potential Impacts and Proposed Environmental Protection Measures

Atlantic Shores recognizes the importance of commercial and for-hire recreational fisheries and is working to ensure co-existence and minimize potential effects. As part of those efforts, Atlantic Shores has developed a Gear Loss Avoidance Program to avoid fishing gear loss at all phases of the Projects. This Program includes direct outreach by the FLO and FIR to fishermen and use of scout boats operated by local fishermen to identify fishing gear located within areas of Project activity. Once the gear is identified, Atlantic Shores avoids identified fishing gear or works with fishermen to remove or relocate the gear. This plan also allows for agreements to temporarily delay Project activities until fishing is completed. Lastly, in the unlikely event that gear is lost or damaged, a gear loss form and policy is available on the "For Mariners" portion of the Projects' website. During 2 years of survey efforts (in 2019 and 2020), Atlantic Shores has successfully implemented its Gear Loss Avoidance Program to minimize interactions with fishing gear, by adjusting survey plans to avoid areas of active fishing, communicating with fishermen to remove gear prior to temporary survey activities in the area, and mitigating gear loss.

Atlantic Shores is also committed to finding ways to integrate fishermen into the Projects by planning and executing economic opportunities. Atlantic Shores is already employing local fishermen and their facilities for gear scouting in advance of survey vessels and for dock-side vessel support. Atlantic Shores is pursuing avenues to help fishermen meet Atlantic Shores' health, safety, security, and environmental protection (HSSE) standards for vessels and workforce, so that they can be eligible to apply as contractors to support environmental surveys as well as Project construction and O&M activities In September 2020, Atlantic Shores distributed a formal Request for Interest (RFI) to identify fishing businesses that had available docks and port real estate to support the Projects; Atlantic Shores received strong responses from four local fishing companies, indicating that the fishing industry does find valuable economic opportunities in the offshore wind industry. Atlantic Shores is continuing to advance opportunities for local fishermen to work on the Projects.

Atlantic Shores recognizes that Project activities may have an effect on commercial and for-hire recreational fisheries. The potential IPFs which may affect commercial fisheries and for-hire recreational fishing during Project construction, O&M, or decommissioning are presented in Table 7.4-17. This section focuses on those IPFs that may affect commercial and for-hire recreational fishing activity within the WTA and ECCs. Based on its ongoing outreach with commercial and for-hire recreational fishermen, Atlantic Shores also understands that commercial fishermen are concerned about potential biological effects to finfish and invertebrates, including potential effects from electromagnetic fields, noise, suspended sediment, and possible changes in prey abundance. An assessment of potential biological effects is presented in detail in Section 4.6 Finfish, Invertebrates, and Essential Fish Habitat, which concludes that most Project effects are localized, short-term, and unlikely to cause population level effects.

Table 7.4-17 Impact Producing Factors for Commercial Fisheries and For-Hire Recreational Fishing

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Vessel Traffic	•	•	•
Presence of Structures	•	•	•
Installation and Maintenance of New Structures and Cables	•	•	•

The maximum Project Design Envelope (PDE) analyzed for potential effects to commercial fisheries and for hire recreational fishing is the maximum offshore build-out of the Projects (as defined in Section 4.11 of Volume I), assuming the use of all piled foundations for the assessment of pile driving noise.

7.4.4.1 Vessel Traffic

Commercial and for-hire fishing vessels active in the Offshore Project Area, either engaged in fishing (i.e., fishing gear deployed) or transiting between ports and fishing grounds, may be affected by the presence of Project vessels. As described in detail in Section 7.6 Navigation and Vessel Traffic, a minor increase in vessel traffic will occur during construction, O&M, and decommissioning. Approximately two to six vessel round trips per day are expected during construction and O&M. As described in Sections 4.10.3 and 5.5 of Volume I, vessels used for construction and O&M will operate primarily from ports with little commercial fishing activity. Consequently, competition for dock- and shore-side services within these ports is not expected to affect commercial fishing activities. Further, the Projects' use of vessels may present additional economic opportunities for commercial fishermen. Through an RFI in September 2020, Atlantic Shore identified multiple ports that would like to support O&M with fuel, repairs, storage, and meeting space. Atlantic Shores has already begun using local commercial fishing facilities for docking and shore-side services and will continue to seek further opportunities to do so.

To minimize the Projects' potential effects to commercial and for-hire recreational fishing from increased vessel traffic, Atlantic Shores will establish a Marine Coordinator who will be charged with monitoring daily vessel movements, implementing communication protocols with external vessels both in port and offshore to avoid conflicts, and monitoring safety zones. Communications will begin prior to construction and will continue throughout the construction process. Daily coordination meetings between contractors are expected to be held to avoid conflicting operations at port facilities and transit routes to the Offshore Project Area. To provide construction zone control, the Marine Coordinator will employ radio communications and safety vessels to address any vessels entering the construction zone.

The Marine Coordinator will be responsible for coordinating with the U.S. Coast Guard (USCG) for any required Notices to Mariners (NTMs), and during construction will be the primary point of contact with the USCG, port authorities, State and local law enforcement, marine patrol, port operators, and commercial and for-hire fishing vessel operators. Mariners will be informed of construction activities, including the anticipated locations of those activities by the Marine Coordinator, allowing vessels to alter their navigation routes if needed to avoid affected areas.

Atlantic Shores is committed to maintaining communication, coordination, and involvement with commercial and for-hire recreational fishermen to keep them informed of Project activities and associated vessel traffic. Atlantic Shores has developed a Fisheries Communication Plan (see Appendix II-R) that defines outreach and engagement with commercial and for-hire recreational fishermen during all phases of the Projects, from development through decommissioning. This plan promotes the safety of those working and fishing in the Offshore Project Area, obtains community input to address existing data gaps on fisheries in the Lease Area, identifies effects to fishermen and ways these can be avoided and mitigated, resolves conflicts, and builds relationships with local fisheries to inform responsible design and operation of the Projects.

To support the execution of the Fisheries Communication Plan, Atlantic Shores utilizes its FLO and its Recreational FIR. Captain Kevin Wark, a commercial New Jersey fisherman, has been hired by Atlantic Shores to serve as the FLO. The FLO acts as a representative of Atlantic Shores and a liaison to the fishing community to help reconcile potential issues and facilitate the exchange of information. Captain Adam Nowalski, a licensed fishing captain, has been hired by Atlantic Shores as the Recreational FIR and represents the recreational fishing industry.

Atlantic Shores' FIR is conducting extensive outreach to recreational fishing stakeholders to better understand how recreational fishing is pursued in the Offshore Project Area. During the winter of 2021, Atlantic Shores held two open houses with members of the recreational fishing industry to present details of the Project, gather input on key concerns, and to identify potential collaborative research efforts. Atlantic Shores' outreach efforts continue with one-on-one meetings with stakeholders to better understand fishermen's concerns and to familiarize New Jersey fishermen with the Project.

The FLO also works to implement the Gear Loss Avoidance Program developed by Atlantic Shores. Prior to and throughout any marine operations, Atlantic Shores works with our FLO to canvas the Offshore Project Area for fixed fishing gear that could interact with Project-related activites, including the scouting of survey vessel routes to avoid negative gear interactions with fishermen. All gear is either catalogued for avoidance, or, if the gear owner can be positively identified, the FLO will engage with the fishermen to establish the procedures for avoidance, and if possible, temporary relocation of the gear. The fishermen are also informed of the process for filing claims associated with lost or damaged gear should an interaction inadvertently occur.

In addition to supporting the Gear Loss Avoidance Program, Atlantic Shores, its FLO, and its FIR employ an array of strategies to engage the fishing community including, but not limited to:

- **A "For Mariners" Project Webpage:** Atlantic Shores established a webpage specifically for commercial and recreational fishermen and boaters containing Project information, real-time buoy data (wind, wave, pressure, and temperature), live vessel schedules and tracking charts, and relevant contact information. This website offers opportunities to submit feedback as well (www.atlanticshoreswind.com/mariners/).

- **Communication and Distribution of Project Updates:** Throughout each stage of the projects, a NTM is published on the Project website and distributed to local docks to show the development area on local nautical charts and a description of active activities, timelines, and relevant contact information. Additionally, announcements and updates will be shared with print, online, and local news outlets, as well as through an email distribution list. A 24-hour phone line has been established to address real-time conflicts and safety concerns.

- **USCG Communication:** A Marine Coordinator will be employed as Atlantic Shores' primary point of contact with the USCG, port authorities, State and local law enforcement, marine patrol, port operators, and commercial operators. An emergency response plan will be developed in coordination with the USCG and communication protocols will be established. The Marine Coordinator will monitor daily vessel movements and will enforce temporary safety zones demarcated around working areas.

- **Meetings and Community Involvement:** Atlantic Shores has held meetings, open houses, and webinars with local fishermen, gear representatives, professional fisheries organizations, and fishing clubs as a means of introducing the Projects to a wide audience and soliciting feedback. Atlantic Shores will establish "Port Hours" with an open-door policy in local ports to encourage local engagement starting later in 2021 after the initial open houses. Atlantic Shores and its representatives are also actively attending industry-sponsored meetings (e.g., RODA [Responsible Offshore Development Alliance] and ROSA) and meetings with Federal agencies (e.g., BOEM, NMFS), regional fisheries management councils (e.g., MAFMC, NEFMC) and NJDEP to stay well-informed of the industry status, needs, and concerns at the Project and regional levels.

- **Fishing Tournaments:** Atlantic Shores will participate in commercial and recreational fishing conferences and trade shoes and will identify tournaments and dates, engage with organizers, share operational plans, and contact information, and identify and monitor the VHF channel used by the tournament to minimize Project traffic in these locations and raise awareness of project vessel activity.

The methods outlined in the Atlantic Shores Fisheries Communication Plan have been implemented since early 2019 in support of the Project site assessment and site characterization activities in the Offshore Project Area. Proactive communication, supported by both the FLO and

Recreational FIR, has allowed Atlantic Shores to work with the fishing community to temporarily relocate gear to avoid interactions, appropriately site and route Atlantic Shores facilities to avoid areas of concentrated fishing activity to the maximum extent practicable, and schedule Project activities to avoid interactions with local fishing operations.

7.4.4.2 Installation and Maintenance of New Structures and Cables

Installation and maintenance of new structures and cables within the WTAs and ECCs (the area of seafloor disturbance during construction is described in Section 4.5.10 of Volume I) may cause temporary disruptions to commercial and for-hire recreational fishing activities. During all Projects' phases, Atlantic Shores will adhere to its Fisheries Communication Plan (see Section 7.4.4.1 and Appendix II-R) and the Gear Loss Avoidance Program and will reach out to its fishing industry contacts to avoid and minimize interactions with fishing vessels and gear via the outreach and coordination mechanisms described in Section 7.4.4.1.

Construction and support vessels will be present within the WTA and ECCs during pre-installation and installation activities for WTGs, offshore substation (OSS) positions, offshore cables (export, inter-array, and inter-link), and other Project components. It is anticipated that temporary safety zones will be established around Project construction vessels and installation activities, which may temporarily disrupt transit and access to fishing grounds that are within or in proximity to temporary safety zones. Installation of the offshore cables may temporarily restrict deployment of fishing gear within the WTA and along the ECCs. The duration of any such effects depends, in part, on the installation method selected but, regardless of installation method, only a limited area surrounding the immediate installation activity will be affected at any given time, leaving surrounding areas available for commercial and for-hire recreational fishing activities. Installation methods and timeframes are described in Sections 4.1 and 4.5 of Volume I. For the ECCs, it is anticipated that the duration of construction will be on the order of several months. These areas of restricted activity will be clearly communicated to the fishing community via the outreach and coordination methods described in Section 7.4.4.1. During any marine operation, Atlantic Shores will follow its Gear Loss Avoidance Program to identify and minimize interactions with fishing gear.

As a result of pre-installation and installation activities, some fishing vessels may temporarily elect to fish in other locations. Electing to fish in other locations may incur additional operating costs if those locations are more distant and/or some vessels may experience lower revenue if those locations are less productive, though available data suggest productive fishing areas are available in the area immediately surrounding the WTA, as evidenced by mapping of VMS data for those fishing shown in Figure 7.4-10 and Figure 7.4-16. Any such effects are anticipated to be temporary. It is expected that commercial fishing vessels transiting the Offshore Project Area will be able to avoid cable installation vessels and safety zones though routine adjustments to planned navigation routes.

During O&M, routine (e.g., annual surveys) and non-routine (e.g., cable reburial) maintenance procedures will occur (see Section 5.0 of Volume I). Many maintenance activities will be based on the WTGs or OSSs and will not require in-water work other than vessels transporting technicians.

More significant and less frequent maintenance procedures may require in-water work and vessels to support those procedures. When necessary, temporary safety zones will be established around maintenance vessels and activities; however, O&M activities will be on a much smaller scale than during construction. Like construction, commercial fishing vessels transiting the Offshore Project Area would be expected to avoid any limited vessels and safety zones though routine adjustments to planned navigation routes.

Installation and maintenance of new structures and cables may also have the potential to affect commercially significant species through temporary increases in suspended sediments and habitat alteration. These potential effects are described in Section 4.6 Finfish, Invertebrates, and Essential Fish Habitat.

During decommissioning, the Projects' WTGs and OSSs will be removed. The offshore cables may be retired in place or removed. If offshore cable removal is required, the cables will be removed from their embedded position in the seabed and reeled up onto barges or vessels. Effects from Project decommissioning are expected to be like those experienced during construction.

7.4.4.3 Presence of Structures

The presence of structures (including WTGs, OSSs, offshore cables, scour protection, and cable protection) may affect navigation within the WTA by commercial and for-hire recreational fisheries; however, the layout has been developed to accommodate vessel transit to local fishing ports and offshore fishing grounds. Additionally, the WTA and ECCs will be open to marine traffic during O&M, and no permanent restrictions to commercial or for-hire recreational fishing are proposed. As stated, limited restrictions may occur during some maintenance activities where temporary safety zones may be established around maintenance vessels and activities.

Atlantic Shores is siting Project infrastructure to avoid concentrated areas of fishing activity to the maximum extent practicable. An independent study of VMS data within the Lease Area produced by New Jersey surf clam industry representatives (Azavea 2020) found that fishing density is low within the WTA (Figure 7.4-19).

Atlantic Shores has minimized effects to commercial and for-hire recreational fishing by selecting a layout that will facilitate ongoing transit and fishing activities by these vessels. The layout has been developed in coordination with the surf clam/quahog dredging fleet, which is the predominant commercial fishery within the WTA. As described in Section 3.1 of Volume I, the independent study of VMS data produced by New Jersey surf clam industry representatives (Azavea 2020) found that a significant majority of fishing vessel traffic (towing and transiting) had headings between east-west and east-northeast to west-southwest (Figures 7.4-20 and 7.4-21).

The findings of Azavea (2020) were corroborated by the analysis of three years (2017–2019) of AIS data included in the Projects' NSRA (see Appendix II-S) which showed that approximately half (46%) of fishing vessels transit the Lease Area along tracks that range in orientation from east to west and northeast-southwest. While the primary direction of fishing vessel traffic varies somewhat across the Lease Area (a northeast to southwest heading is more frequent in the northern portion of the Lease Area whereas a southeast to northwest heading is more common farther south), commercial fishermen have indicated a preference for a uniform layout across the WTA.

Based upon consultations with commercial fishermen and analyses of VMS and AIS data, including Azavea (2020), the WTGs will be aligned in a uniform grid with rows in an east-northeast to west-southwest direction spaced 1.0 nm (1.9 km) apart and rows in an approximately north to south direction spaced 0.6 nm (1.1 km) apart (see Figure 1.1-2 of Volume I). The OSS positions will also be located along the same east-northeast rows as the proposed WTGs, preserving 1.0 nm-wide (1.9 km-wide) corridors between structures. The WTG grid will create diagonal corridors oriented approximately northwest-southwest that are 0.54 nm (1.0 km) wide and diagonal corridors oriented approximately north-northeast that are 0.49 nm (0.9 km) wide (see Figure 7.6-11).

As explained in Section 8.1 of the NSRA (see Appendix II-S), USCG recommended guidelines for corridor spacing to allow two-way transit (USCG 2020) include two navigation paths that are each four vessel lengths wide, two collision avoidance zones that are each 1.5 vessel lengths wide, two safety margins that are each six vessel lengths wide, and a 164 ft (50 m) or 820 ft (250 m) safety zone around each WTG (Figure 7.4-22). Under these guidelines, the 1 nm (1.9 km) east-northeast corridors are sufficiently sized to accommodate all sizes of fishing vessels currently transiting through the WTA. The 0.6 nm (1.1 km) and 0.54 nm (1.0 km) corridors are sufficiently sized to accommodate between 25% and 98% of the fishing vessels currently transiting through the WTA, depending on whether the additional safety buffer is assumed to be 164 ft (50 m) or 820 ft (250 m). Therefore, although vessel maneuverability within the WTA depends on many factors (including vessel size, fishing gear or method used, and weather conditions), the proposed layout is expected to accommodate fishing patterns observed in the WTA as shared with Atlantic Shores by the surf clam industry. While it is expected that fishing vessels can transit through the WTA, if fishing vessels choose to transit around the WTA, minor increases in transit time (typically 15 to 20 minutes or less) may occur (see Section 8.2 of Appendix II-S). Additional detail regarding commercial fishing vessel traffic in the Offshore Project Area is provided in Appendix II-S.

As explained in Section 8.2 of the NSRA (see Appendix II-S), the presence of structures in the WTA is anticipated to have only a minor impact on recreational fishing vessels transit routes. With input from the FIR, the potential rerouting of recreational fishing vessels through and around the WTA was analyzed. Based on this analysis, there would be very little change in overall distance traveled if vessels elected to navigate through the WTA, routing around turbines where and if necessary, though it is assumed vessels may operate at slower speeds when traveling within the WTA. If vessels elect to transit around the WTA, it is anticipated that rerouting will have a small effect on travel distance and time, at most, increasing travel distance by up to 1.6 nm (3.0 km) and increasing travel time by up to approximately 3.8 minutes. Several routes would not be impacted by the WTA

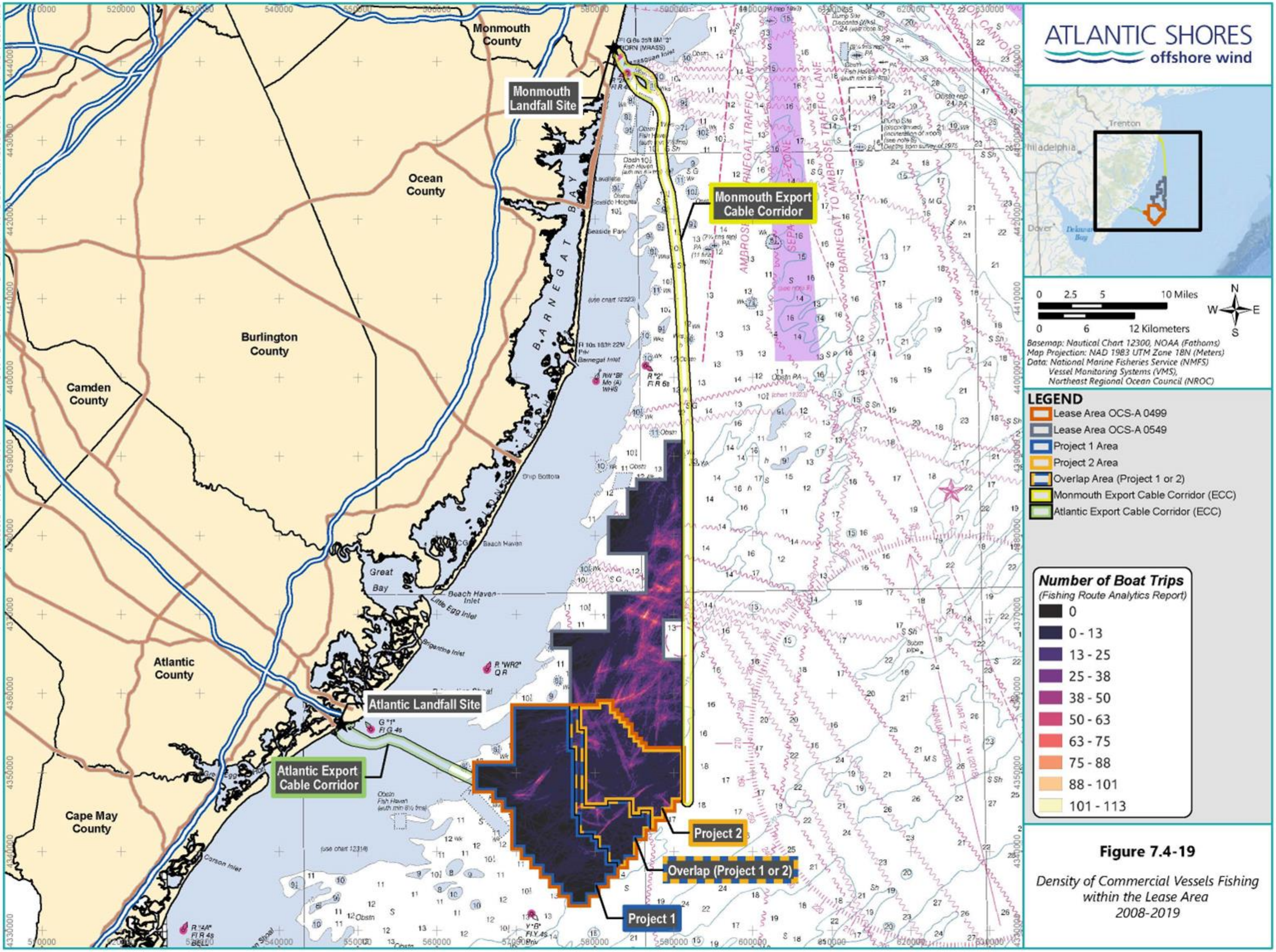


Figure 7.4-19

Density of Commercial Vessels Fishing within the Lease Area 2008-2019

8/11/2022 | G:\Projects2\NJ\5665\2022\MXDs\COP_Revision\Vol_III\7.4_Comm_Fishing\Fig 7.4-19_Density_Commercial_Vessels_Fishing_20220811.mxd

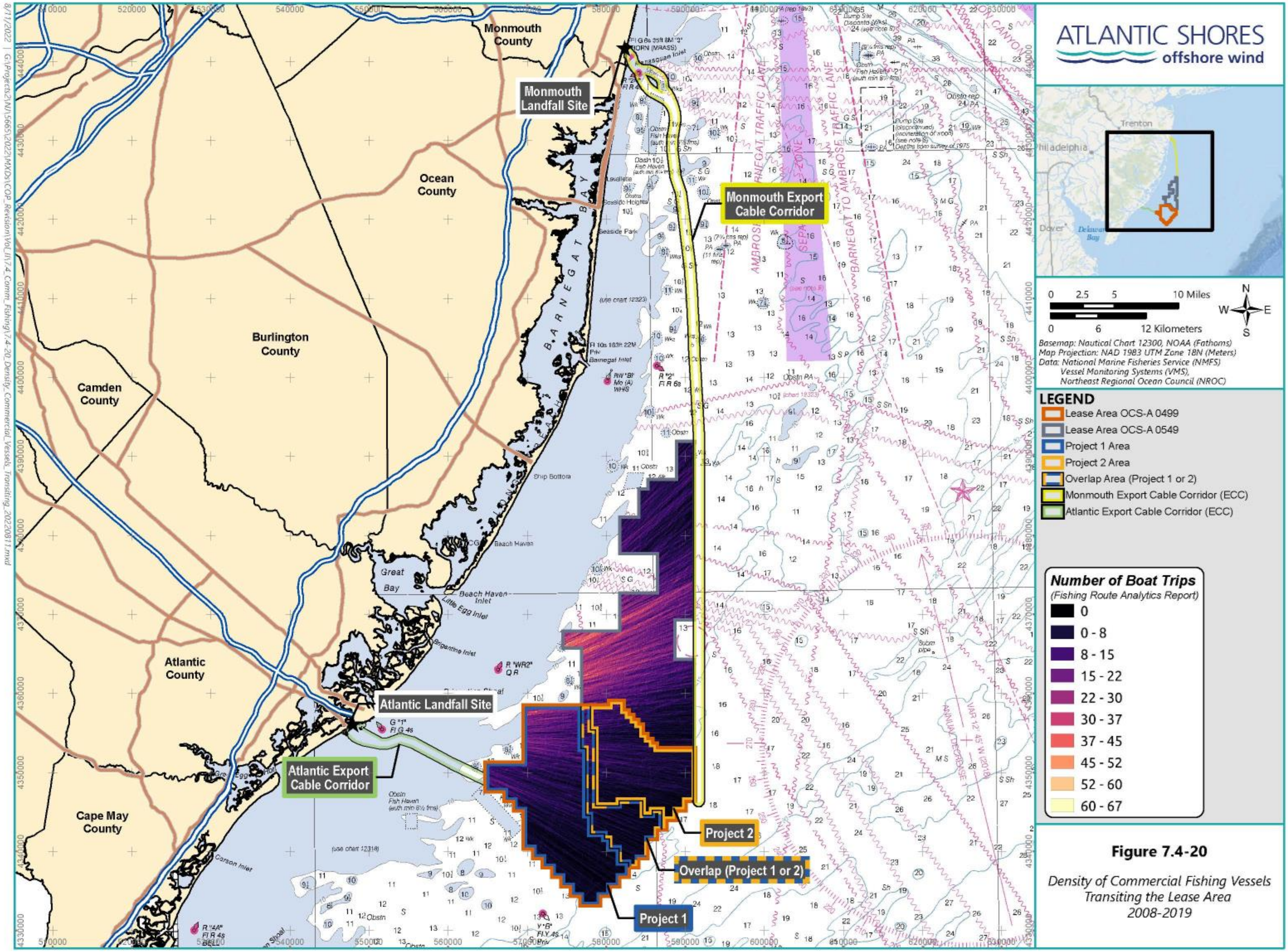
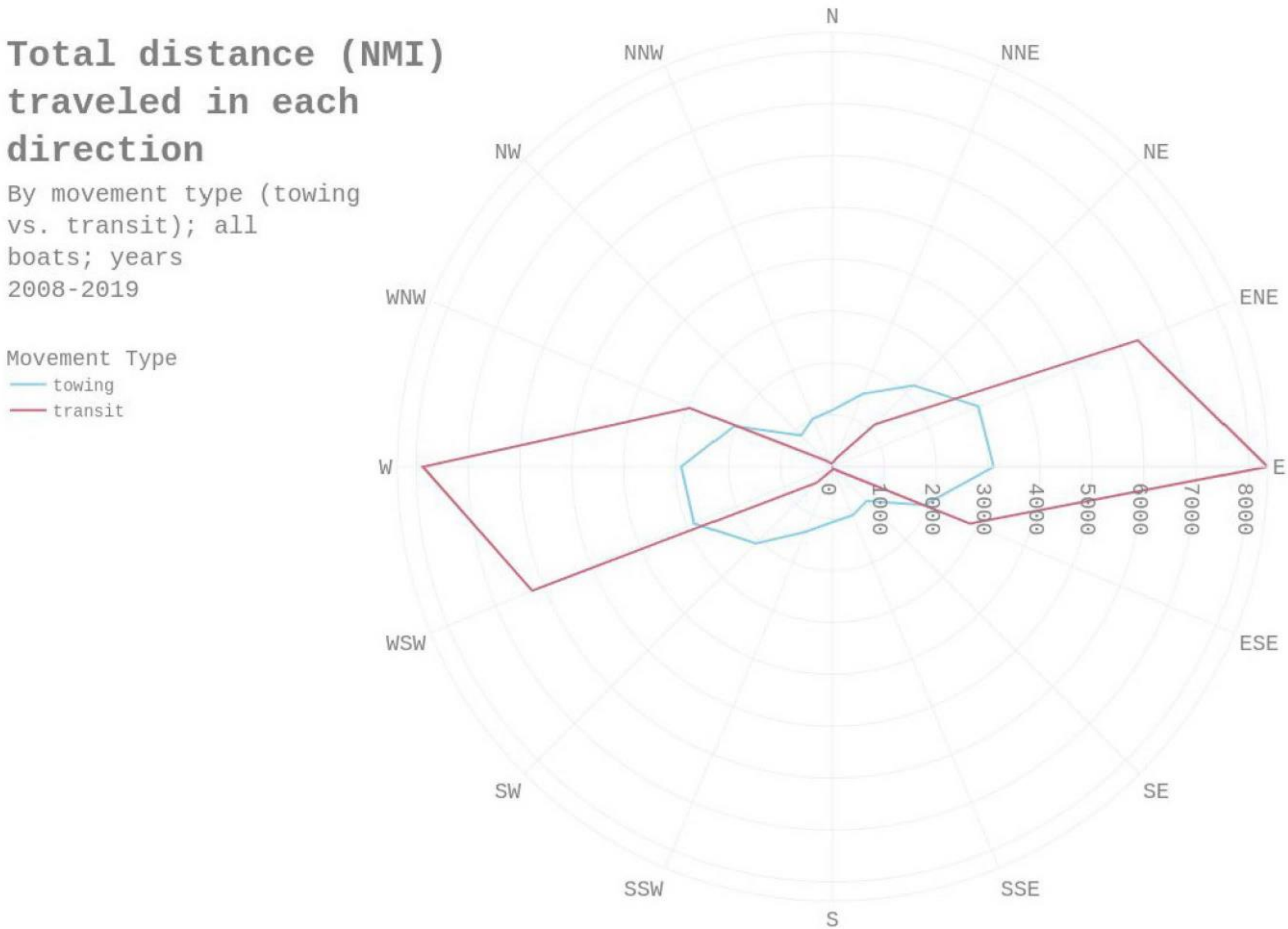


Figure 7.4-20

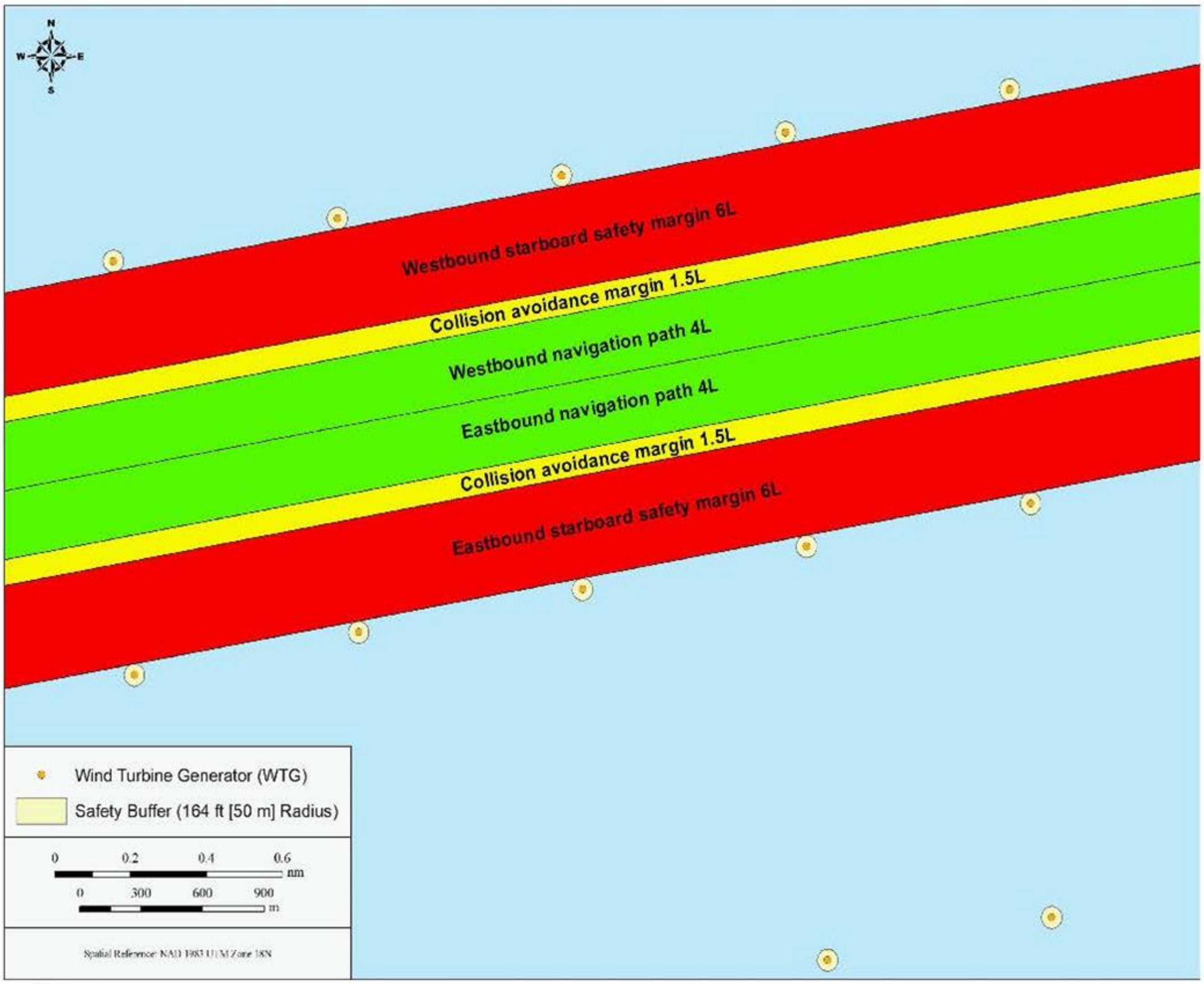
Density of Commercial Fishing Vessels Transiting the Lease Area 2008-2019



ATLANTIC SHORES offshore wind

Figure 7.4-21

Travel Directions for Commercial Fishing Vessels within the Lease Area



Notes:

1. Recommended corridor width is based on the US Coast Guard Massachusetts/Rhode Island Port Access Route Study.
2. A safety zone with a 164 feet (50 meter) radius is shown.

and for most routes, transiting around the WTA would result in less than 0.7 nm (1.3 km) of additional distance traveled. Atlantic Shores also has minimized effects to commercial and for-hire recreational fishing from the presence of offshore cables. All offshore cables will have a target minimum burial depth of 5 to 6.6 ft (1.5 to 2 m). The cable burial depth is based upon a cable burial risk assessment that considers activities such as commercial fishing practices and anchor use to develop a safe target burial depth for the cables. This risk assessment will be included in the 2021 Construction and Operations Plan (COP) supplement. Atlantic Shores has determined that the target burial depth is sufficient to protect the cables from expected commercial fishing practices including hydraulic dredging, so the presence of these cables is not anticipated to interfere with any typical fishing practices except in limited locations where cable protection may be required.

Additionally, while fiber optic cables are present in the northern portion of the Lease Area (see Figure 4.5-10 of Volume I) and there is evidence that fishing activities regularly occur in the vicinity of these cables, Atlantic Shores is not aware of any cable faults or fishing gear snags that have occurred. As a further point of reference, the Tata Global Network Atlantic (TGN-A) North cable, located to the north of the WTA, has not experienced any faults (inclusive of fishing gear snags) within the U.S. EEZ during its operational lifespan (SUBCOM 2019).

As described in Section 4.5 of Volume I, cable protection may be necessary if the target burial depth cannot be achieved for any reason (e.g., due to sediment properties or a cable joint). Cable protection may also be required to support the crossing of existing marine infrastructure such as submarine cables or pipelines (see Section 4.5.8 of Volume I). While Atlantic Shores will minimize the amount of cable protection required, up to 10% of the export cables, inter-array cables, and inter-link cables are conservatively estimated to require cable protection where sufficient burial depth is not achieved. Cable protection will be designed to minimize effects to fishing gear to the maximum extent practicable, and fishermen will be informed of the areas where cable protection is installed.

As described more fully in Sections 4.5 Benthic Resources and 4.6 Finfish, Invertebrates, and Essential Fish Habitat, the presence of structures and cable protection will alter existing habitats. The creation of structured habitat is expected to benefit species such as American lobster, striped bass, black sea bass, and Atlantic cod and potentially increase their habitat. Similarly, the presence of foundations may increase habitat and provide forage and refuge for some migratory finfish and invertebrate species.

For-hire recreational fishermen may see some benefits (i.e., potential for increases in localized fish abundance) as a result of the Projects. By providing additional structure for species that prefer hard, complex bottoms the WTG and OSS foundations may function as fish aggregating devices (BOEM 2012) and provide a potential benefit to for-hire recreational fishermen. Additionally, interest in visiting the WTA may result in an increased number of fishing trips originating from New Jersey ports. These additional vessel trips could support an increase in angler expenditures at shoreside facilities servicing for-hire recreational fishermen (Kirkpatrick et al. 2017).

To facilitate safe navigation in the Offshore Project Area, all foundations will contain marine navigation lighting and marking in accordance with USCG and BOEM guidance. To aid mariners navigating within and near the WTA, each WTG position will be maintained with a Private Aid to Navigation (PATON). Atlantic Shores will work with the USCG and BOEM to determine the appropriate marine lighting and marking schemes for the proposed offshore facilities. Based on USCG District 5 Local Notice to Mariner (LNM) 45/20, Atlantic Shores expects that each permanent structure (including WTGs, OSSs, and the met tower) will include unique alphanumeric identification and lights that are visible in all directions. Sound signals will be installed on select foundations in accordance with the Marking and Lighting Plan that will be developed in consultation with the USCG. Atlantic Shores will have the capability to mark each permanent structure including WTG, OSS, and meteorological position (virtually or using physical transponders) with AIS; however, the number, location, and type of AIS transponders will be determined in consultation with USCG. . Additional information on marine navigation lighting and marking on the foundations can be found in the NSRA (see Appendix II-S). Additionally, WTG and OSS foundations will be equipped with access ladders to allow distressed mariners access to an open refuge area. The presence of a person on the offshore structure will be detected, for example, by cameras or intrusion detectors.

Some survey work by Federal or State fisheries agencies to inform stock assessments and fishing quotas and otherwise support a variety of marine research may occur within the WTA. NEFSC seasonal trawl surveys, as well as surf clam and ocean quahog survey dredging for NEFSC Resource Survey Reports, are conducted offshore New Jersey, and may be conducted occasionally within the WTA. In 2016, for example, a single trawl during the NEFSC Spring Multispecies Bottom Trawl Survey and no dredges for the NEFSC Resource Survey Report were conducted within the WTA. Depending on the size of the vessels used for survey work, modifications to existing survey protocols may be required. Such modifications may include using smaller vessels or relocating survey transects outside of the WTA. Such modifications, if necessary, would be expected to allow for sufficient data collection. Atlantic Shores will continue to consult with appropriate Federal and State fisheries agencies on expected effects to fisheries survey work, if any. Atlantic Shores is also proposing to conduct its own fisheries surveys; this effort is described in Appendix II-K.

7.4.4.4 Summary of Proposed Environmental Protection Measures

Atlantic Shores understands the socioeconomic importance of commercial and for-hire recreational fishing to the State of New Jersey and is committed to achieving coexistence with those who fish within Atlantic Shores Offshore Project Area. Atlantic Shores has developed the following proposed environmental protection measures:

- A desktop assessment of commercial fishing activity in the Offshore Project Area was conducted using publicly available data (AIS, VTR, and VMS), reports, academic studies, information from fishermen, and consultations with government agency representatives and stakeholders to select a layout that will facilitate ongoing transit and fishing activities.

- Atlantic Shores is a founding member of the ROSA, which advances regional research and monitoring of fishery and offshore wind interactions. Findings from these efforts will inform the Project design and will help to build data and communication tools for fishermen that support accurate, real-time information on offshore wind projects.
- Atlantic Shores signed a Memorandum of Understanding (MOU) with Stockton University to sponsor research to investigate technology development related to the development of offshore wind energy and to investigate potential fisheries benefits resulting from offshore wind structures. Findings from this research will be used to support the design and implementation of pre-, during, and post-construction fisheries monitoring.
- Information from industry conversations, direct data gathering exercises with fishermen, consultations with government agency representatives, and analysis of public data have been compiled and used to guide the siting, design, O&M, and decommissioning of the Projects.
- The proposed layout was developed in close coordination with commercial fishermen to align with the predominant flow of vessel traffic.
- Project infrastructure is being sited and oriented to avoid concentrated areas of fishing activity to the maximum extent practicable.
- The amount of cable protection will be limited. Cable protection will be designed to minimize effects to fishing gear to the maximum extent practicable, and fishermen will be informed of the areas where cable protection is installed.
- Offshore cables will be buried at a sufficient depth of 5 to 6.6 ft (1.5 to 2 m) to avoid interaction with fishing gear.
- To facilitate safe navigation, all offshore structures will include marine navigation lighting and marking in accordance with USCG and BOEM guidance. Atlantic Shores will continue to work with the USCG and BOEM to determine the appropriate marine lighting and marking schemes for the proposed offshore facilities.
- Each permanent structure (including WTGs, OSSs, and the met tower) will include unique alphanumeric identification and lights that are visible in all directions. Sound signals will be installed on select foundations in accordance with the Marking and Lighting Plan that will be developed in consultation with the USCG.
- WTG, OSS, meteorological (met) tower, and met buoy positions will be maintained with PATONs.
- WTG and OSS foundations will be equipped with access ladders to allow distressed mariners access to an open refuge area above the splash zone. The presence of a person on the offshore structure will be detected, for example, by cameras or intrusion detectors.
- Atlantic Shores will have the capability to mark each WTG, OSS, and met tower position (virtually or using physical transponders) with AIS. The number, location, and type of AIS transponders will be determined in consultation with USCG.

- A Fisheries Communication Plan has been developed that defines outreach and engagement with fishing interests during all phases of the Projects, from development through decommissioning.
- Atlantic Shores employs an active commercial fisherman, Captain Kevin Wark, as the FLO and an active recreational fisherman, Captain Adam Nowalski, as the Recreational FIR.
- A Gear Loss Avoidance Program has been developed to identify gear located within the Project area and to develop a cooperative plan with fishermen to avoid, remove, or relocate fishing gear within areas of Project activity. This plan includes direct outreach to fishermen and a scout boat plan to identify fishing gear located within areas of Project activity. A gear loss form and policy has been made accessible on the Projects' website.
- A "For Mariners" project webpage (www.atlanticshoreswind.com/mariners/) has been developed that contains the latest news and events, real-time Project buoy data display and Project vessel tracking chart, Project vessel schedules, and FLO and FIR contact information.
- Specific methods for communicating with offshore fishermen while they are at sea are being established, including a 24-hour phone line to address any real-time operational conflicts and/or safety issues.
- Updated asset and operational awareness bulletins will be regularly distributed showing the development area, depicted on local nautical charts, with a description of the assets in the area, the activities taking place, timelines and relevant contact information. Atlantic Shores will also publish announcements and share updates with print and online industry publications and local news outlets.
- Atlantic Shores distributed a formal RFI to identify fishing businesses that had available docks and port real estate to support the Projects.
- A Marine Coordinator will be employed to monitor daily vessel movements, implement communication protocols with external vessels both in port and offshore to avoid conflicts, and monitor safety zones. Daily coordination meetings between contractors are expected to be held to avoid conflicting operations at port facilities and transit routes to the Offshore Project Area. The Marine Coordinator will be responsible for coordinating with the USCG for any required NTMs.
- Since June 2021, NJDEP has led a multi-state compensatory mitigation initiative that includes the States of New Jersey, New York, Massachusetts, Connecticut, Rhode Island, New Hampshire, Maine, Delaware, Maryland, Virginia, and North Carolina to encourage the Bureau of Ocean Energy Management (BOEM) to develop a standardized fisheries compensation framework, which guidance is near final, and the states have partnered to establish a regional administrator to manage the future mitigation funds. In contributing to the Compensatory Mitigation Fund, Atlantic Shores has agreed to:
    - Utilize the regional fund administrator for purposes as outlined under item 6 above that is currently being established by the 11 coastal states initiative

as outlined in item 7 above; or utilize another method of administration as directed by the State of New Jersey.

- o Establish a Navigational Safety Adaptation Fund and a Gear Loss and Damage Compensation program to address fisheries mitigation.

7.5 Land Use and Coastal Infrastructure

This section describes land use and coastal infrastructure present in the Onshore Project Area, associated impact producing factors (IPFs), and measures to avoid, minimize, or mitigate potential effects to these resources during construction, operations and maintenance (O&M), and decommissioning.

Atlantic Shores has worked to design the Projects to be compatible with surrounding land use and communities, and to safeguard environmentally and culturally sensitive areas. Atlantic Shores has located onshore interconnection cable routes and infrastructure primarily along existing roadways, utility rights-of-way (ROWs), and/or along bike paths. All proposed development is compatible with the existing zoned use.

Potential visual effects of the Projects are discussed in Section 5.0 Visual Resources and Appendix II-M.

7.5.1 Affected Environment

Atlantic Shores has identified two counties in New Jersey where onshore facilities may be located: Atlantic County and Monmouth County. Atlantic Shores has also identified potential port facilities that may be used in New Jersey, New York, the Mid-Atlantic, New England, the U.S. Gulf Coast, and/or overseas to support Project construction and O&M. This section describes the affected environment within those portions of Atlantic and Monmouth Counties where onshore Project components may be located, followed by a description of potential port facilities.

7.5.2 Atlantic County, New Jersey

Onshore Project components in Atlantic County include the Atlantic Landfall Site, Cardiff onshore interconnection cables, a new onshore substation and/or converter station at Fire Road Substation Site, and potential upgrades to the existing Cardiff Substation point of interconnection (POI). Land uses at these locations are shown on Figure 7.5-1. Atlantic Shores is also proposing to establish an O&M facility in Atlantic City, New Jersey. This O&M facility will be the primary location for O&M activities including material storage, day-to-day management of inspection and maintenance, vehicle parking, marine coordination, vessel docking, and dispatching of technicians.

To establish the O&M facility, Atlantic Shores intends to develop a shoreside parcel in Atlantic City that was formerly used for vessel docking or other port activities. Construction of the O&M

facility is expected to involve the construction of a new building and associated potential adjacent parking structure (see Figure 7.5-2), repairs to the existing bulkheads/docks, installation of new dock facilities, and maintenance dredging in coordination with the City's dredging of the adjacent basins. The O&M facility developed at the shoreside parcel in Atlantic City may also be supported with the use of existing surface parking lots and warehouse or office space within an industrial, commercial, and/or waterfront area.

The offshore-to-onshore transition between export cables within the export cable corridors (ECCs) to onshore interconnection cables will occur at two landfall sites.

The Atlantic Landfall Site will be located on a parcel of land that is currently used as a public parking lot bounded by Pacific, South Belmont, and South California Avenues and California Avenue within Atlantic City in Atlantic County, New Jersey (see Figure 4.8-1). This landfall site will include underground transition vaults associated with the Atlantic export cables (one per export cable). The Cardiff Onshore Interconnection Cable Route is an approximately 12-14 mi (23 km) underground transmission route that largely uses existing linear infrastructure corridors to connect the Atlantic Landfall Site to the existing Cardiff Substation POI (see Figure 7.5-1). From the Atlantic Landfall Site, the PDE includes three independent routes through Atlantic City to a common point at the southeast corner of Pete Pallitto Field, which is located at the intersection of N. Sovereign Ave and Fairmont Avenue in Atlantic City.

From the convergence point at the southeast corner of Pete Pallitto Field, the Cardiff Onshore Interconnection Cable Route continues northwest to the existing Cardiff Substation POI, primarily following existing roadways, utility ROWs, and/or bike paths. Near Pete Pallitto Field, HDD is expected to be used to cross under the waterway (Chelsea Harbor) to Bader Airfield. From Bader Airfield two options have been identified to cross Great Thoroughfare to the mainland:

1. From Bader Airfield 1 mi (1.6 km) HDD under Great Thoroughfare to an open area behind a marina. From this point the route continues along US Route 40 for approximately 2.3 miles (3.8 km) to Palermo Avenue.
2. From Bader Airfield 0.2 mi (0.25 km) HDD under Great Thoroughfare to a vacant lot. From this point the route continues along US Route 40 for approximately 0.34 mile (0.5 km) to the Atlantic City Highschool Campus. From the western edge of the campus 0.30 mi (0.50 km) HDD under Great Thoroughfare to a second vacant lot adjacent to US Route 40. From this lot another 0.65 mi (1.0 km) HDD to a third vacant lot adjacent to US Route 40. From this point the route enters a railroad and Atlantic City Electric (ACE) ROW for approximately 1.5 mi (2.4 km) to Palermo Avenue.

From Palmero Avenue, both options continue along US Route 40 or the railroad and ACE ROW to a common point at the intersection of Devins Lane and US Route 40. The route then follows Delancy Avenue, Old Egg Harbor Road, and Hingston Ave for approximately 0.8 mile (1.3 km) to the potential substation/converter station site at Fire Road Site. The route then exits the substation converter station site and follows Fire Road for approximately 0.34 mile (0.5 km) to the ACE ROW.

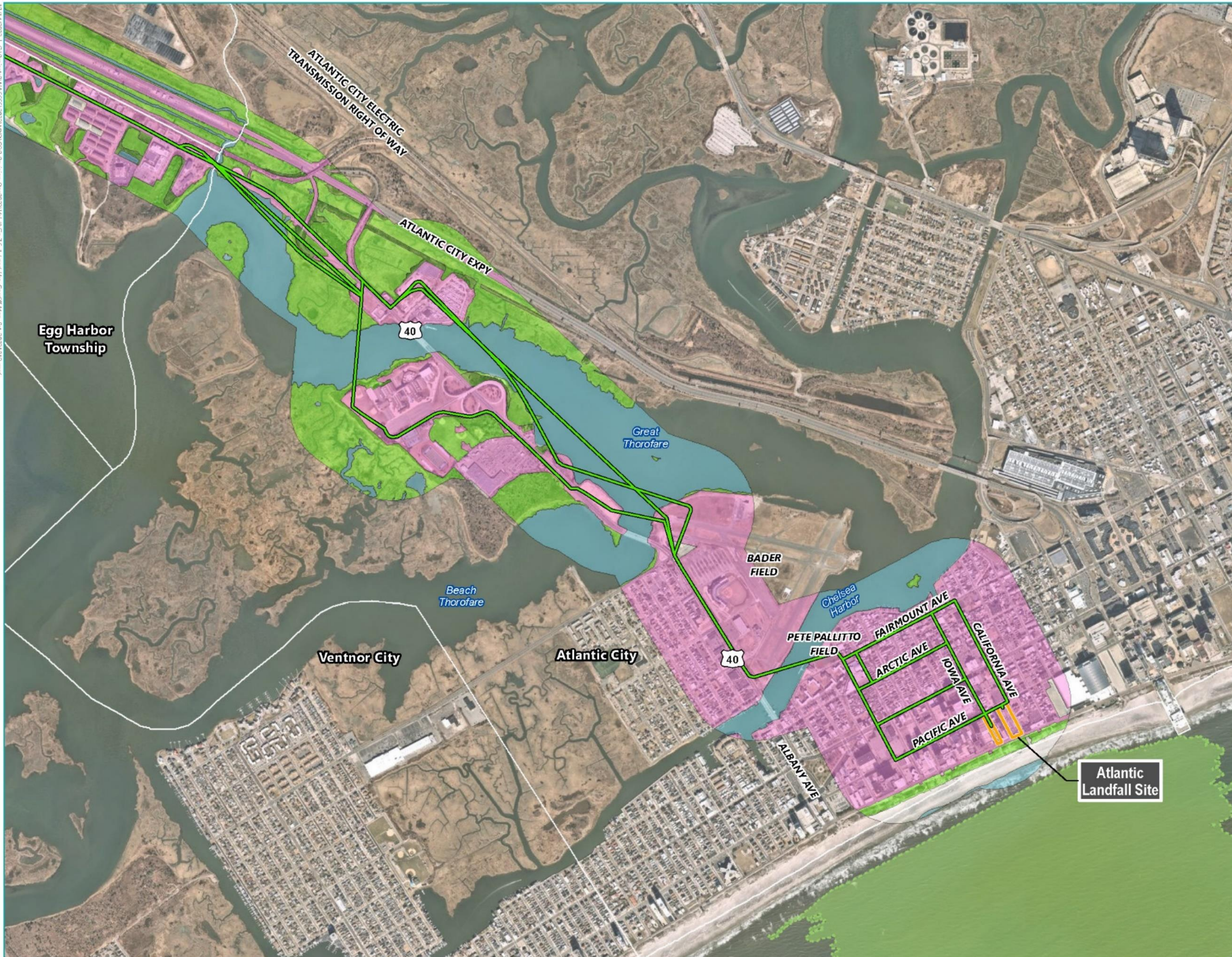
The route follows this ROW for approximately 0.6 mile (0.9 km) crossing the Garden State Parkway and US Route 40. Northwest of the intersection of the Garden State Parkway and Route 40, the railroad ROW transitions to the Atlantic County Bikeway East and the route follows this for approximately 3.2 mi (5 km) to English Creek Road. The route then turns north along a 0.5 mi (0.8 km) segment on English Creek Avenue and an additional 0.5 mi (0.8 km) along the bike path to a 0.3 mi (0.5 km) segment on Roberta Avenue to reach the existing ACE 230 kV transmission ROW. The route then follows the existing ACE 230 kV transmission ROW to the Cardiff Substation POI.

The Cardiff Substation POI is owned by ACE and is operated at 230 kV. Modifications to the POI will be required to accommodate the interconnection of the Projects. The scope of the required modifications will be determined upon completion of the Facilities Study Report by ACE and the Pennsylvania-New Jersey-Maryland Interconnection (PJM), which is expected to be available in spring 2022. The scope of modifications at the POI may range from expanding the existing substation by adding additional breaker bay(s) to upgrading the existing high voltage section of the substation to a breaker and a half configuration. ACE will be responsible for the design and construction of the required upgrades on the existing electrical grid, including the upgrades at Cardiff Substation. The Cardiff Onshore Interconnection Cable route will also include an additional substation and/or converter station option at Fire Road Site, located in Egg Harbor Township. The site is approximately 20 acres and bordered by Fire Road (County Road 651) and Hingston Avenue.

7.5.3 Monmouth County, New Jersey

Onshore Project components in Monmouth County include the Monmouth Landfall Site and the Larrabee Onshore Interconnection Cable Route. The Larrabee Onshore Interconnection Cable route will include a new substation and/or converter station at the Lanes Pond Road Site or the Randolph Road Site or the interconnection to a substation and/or converter station at the Brook Road Site developed under the New Jersey Board of Public Utilities (NJBPU) State Agreement Approach (SAA). Land uses at these locations are shown on Figure 7.5-4.

The Monmouth Landfall Site is located within the Borough of Sea Girt at the Army National Guard Training Center (NGTC). The landfall will occur on the southeast corner of the NGTC in a previously disturbed area. The Larrabee Onshore Interconnection Cable Route begins at the Monmouth Landfall Site and is an approximately 12 mi (19.5 km) underground transmission route that largely uses existing linear infrastructure corridors and ROWs to connect the Monmouth Landfall Site to the existing Larrabee Substation POI (see Figure 7.5-5). The Larrabee Onshore Interconnection Cable Route is described in detail in Section 4.8.2 of Volume I. As shown on Figure 7.5-4, the route passes through various land uses, including urban and forested areas.



ATLANTIC SHORES offshore wind

0 0.2 0.4 Miles

0 0.25 0.5 Kilometers

N W E S

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, February 2021

LEGEND

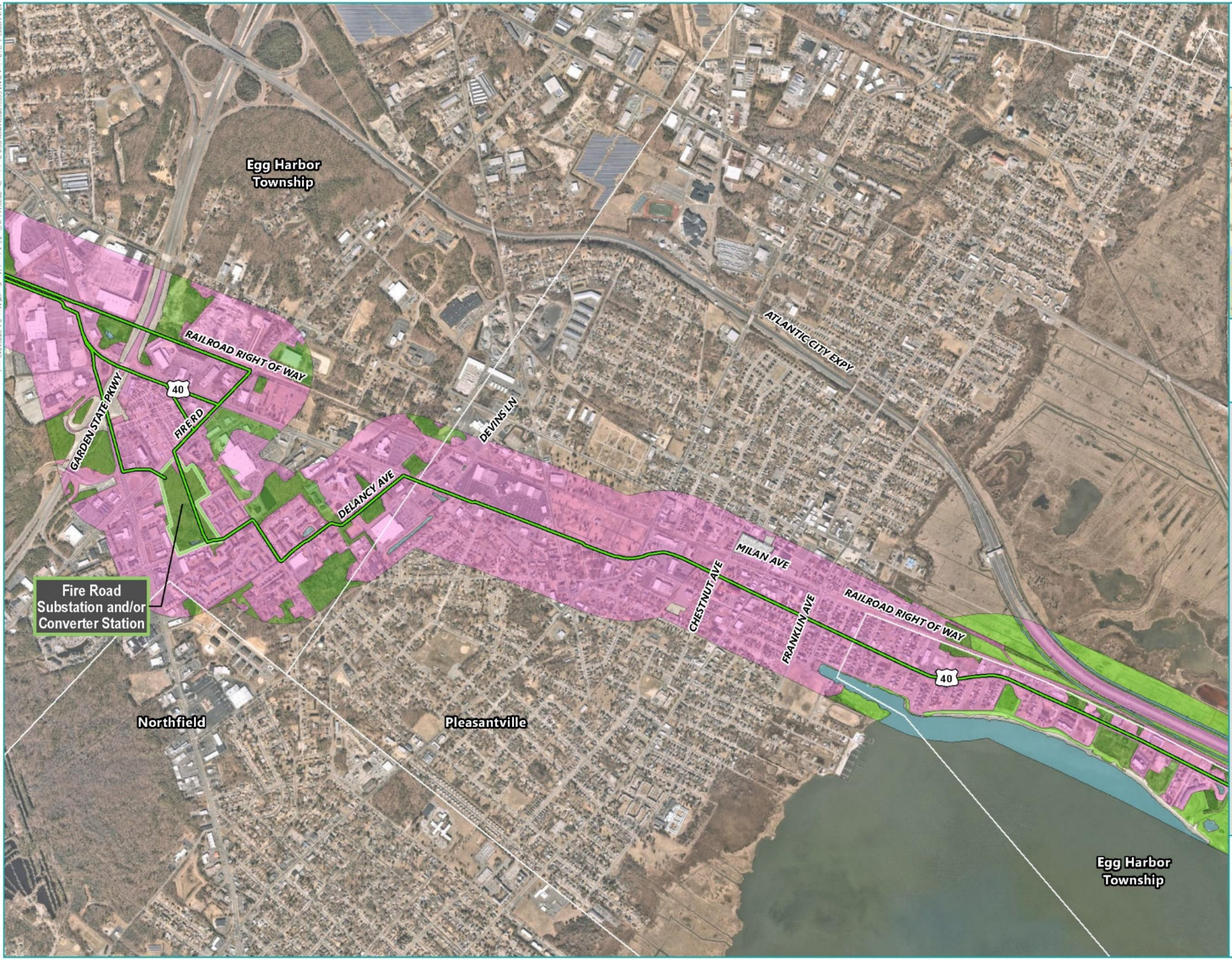
- Cardiff Onshore Interconnection Cable Route Options
- Substation and/or Converter Station
- Existing Cardiff Substation (POI)
- Atlantic Landfall Site
- Atlantic Export Cable Corridor
- Municipal Boundaries

NJDEP Land Use/Land Cover (2015)

- Agriculture
- Urban
- Barren Land
- Water
- Forest
- Wetlands

Figure 7.5-1
Sheet 1 of 3

Land Use/Land Cover - Cardiff Onshore Interconnection Cable Routes, and Onshore Substation and/or Converter Station Sites Atlantic County, New Jersey



ATLANTIC SHORES offshore wind

0 0.2 0.4 Miles
0 0.25 0.5 Kilometers
N W E S

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, February 2021

LEGEND

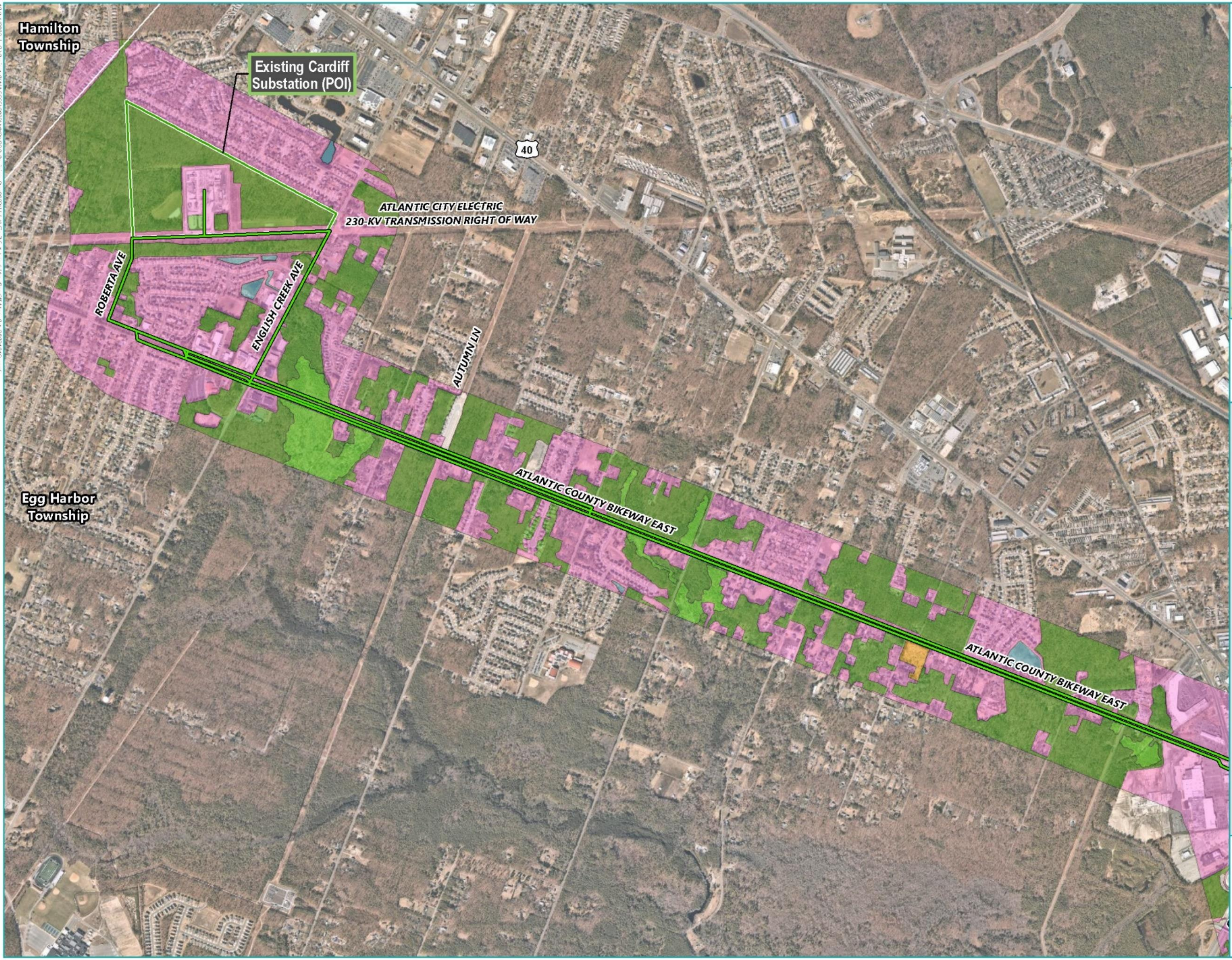
- Cardiff Onshore Interconnection Cable Route Options
- Substation and/or Converter Station
- Existing Cardiff Substation (POI)
- Atlantic Landfall Site
- Atlantic Export Cable Corridor
- Municipal Boundaries

NJDEP Land Use/Land Cover (2015)

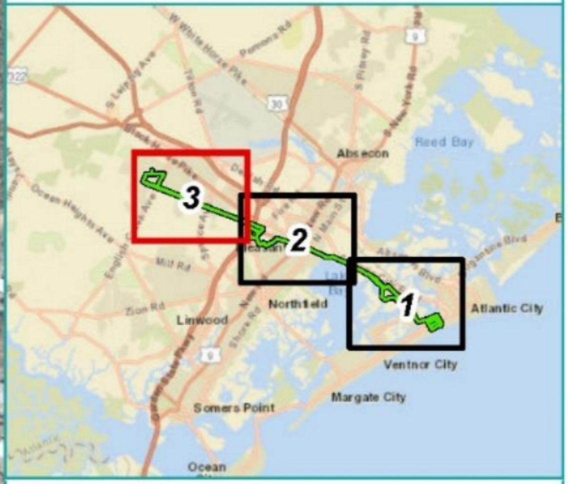
- Agriculture
- Urban
- Barren Land
- Water
- Forest
- Wetlands

Figure 7.5-1
Sheet 2 of 3

Land Use/Land Cover - Cardiff Onshore Interconnection Cable Routes, and Onshore Substation and/or Converter Station Sites Atlantic County, New Jersey



ATLANTIC SHORES offshore wind



0 0.2 0.4 Miles

0 0.25 0.5 Kilometers

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, February 2021

LEGEND

- Cardiff Onshore Interconnection Cable Route Options
- Substation and/or Converter Station
- Existing Cardiff Substation (POI)
- Atlantic Landfall Site
- Atlantic Export Cable Corridor
- Municipal Boundaries

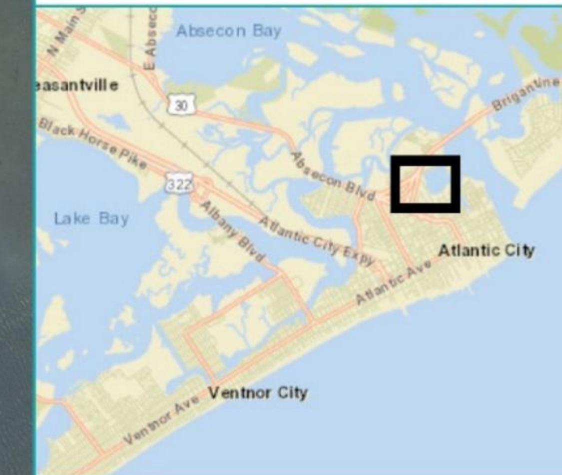
NJDEP Land Use/Land Cover (2015)

- Agriculture
- Urban
- Barren Land
- Water
- Forest
- Wetlands

Figure 7.5-1
Sheet 3 of 3

Land Use/Land Cover - Cardiff Onshore Interconnection Cable Routes, and Onshore Substation and/or Converter Station Sites Atlantic County, New Jersey

ATLANTIC SHORES offshore wind



0 75 150 300 Feet

0 40 80 Meters

N W E S

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

LEGEND

Proposed Operations and Maintenance Facility and Potential Adjacent Parking Structure

NJDEP Land Use/Land Cover (2015)

Agriculture
Urban
Barren Land
Water
Forest
Wetlands

Figure 7.5-2

Land Use/Land Cover
Proposed Operations and Maintenance Facility and Potential Adjacent Parking Structure

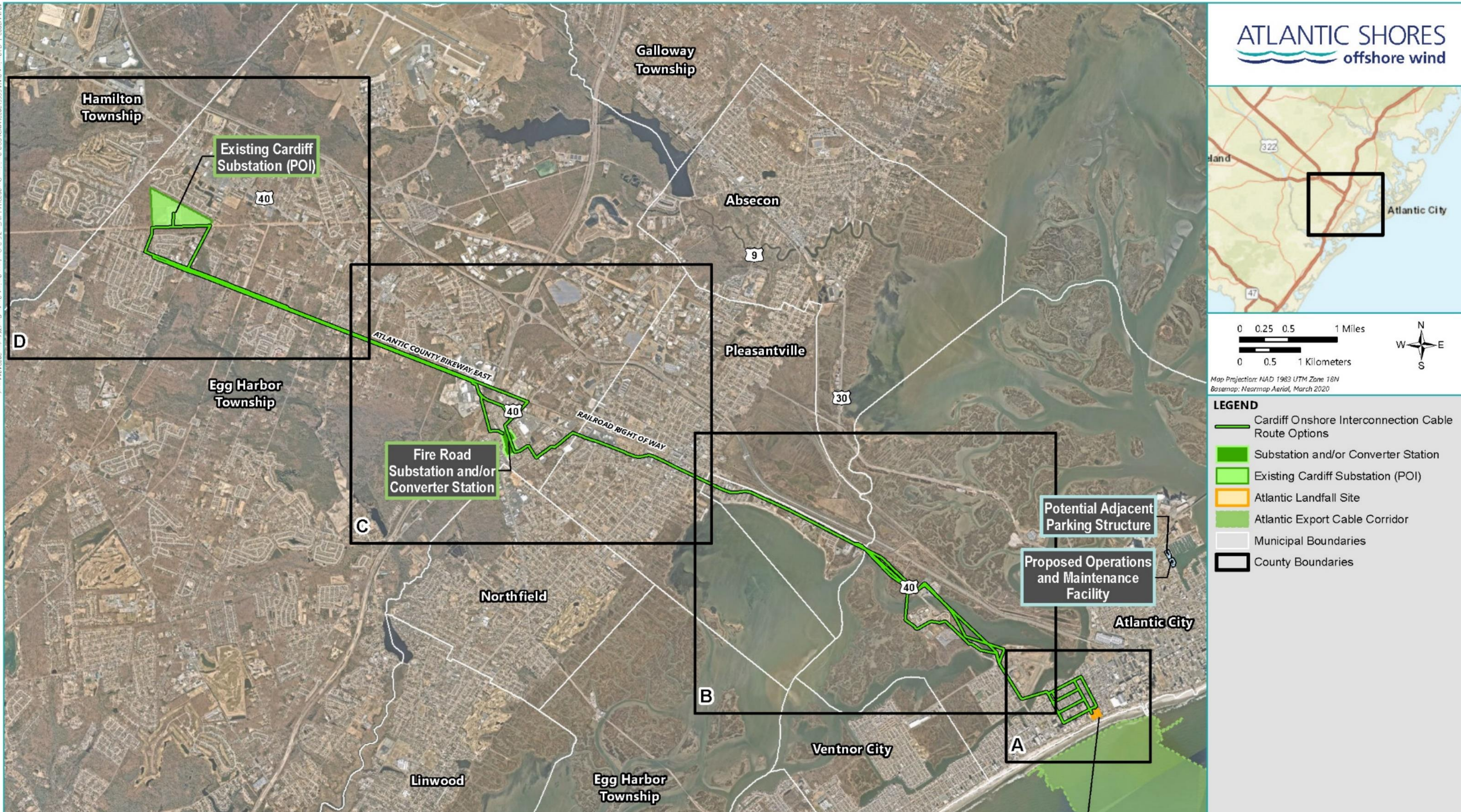
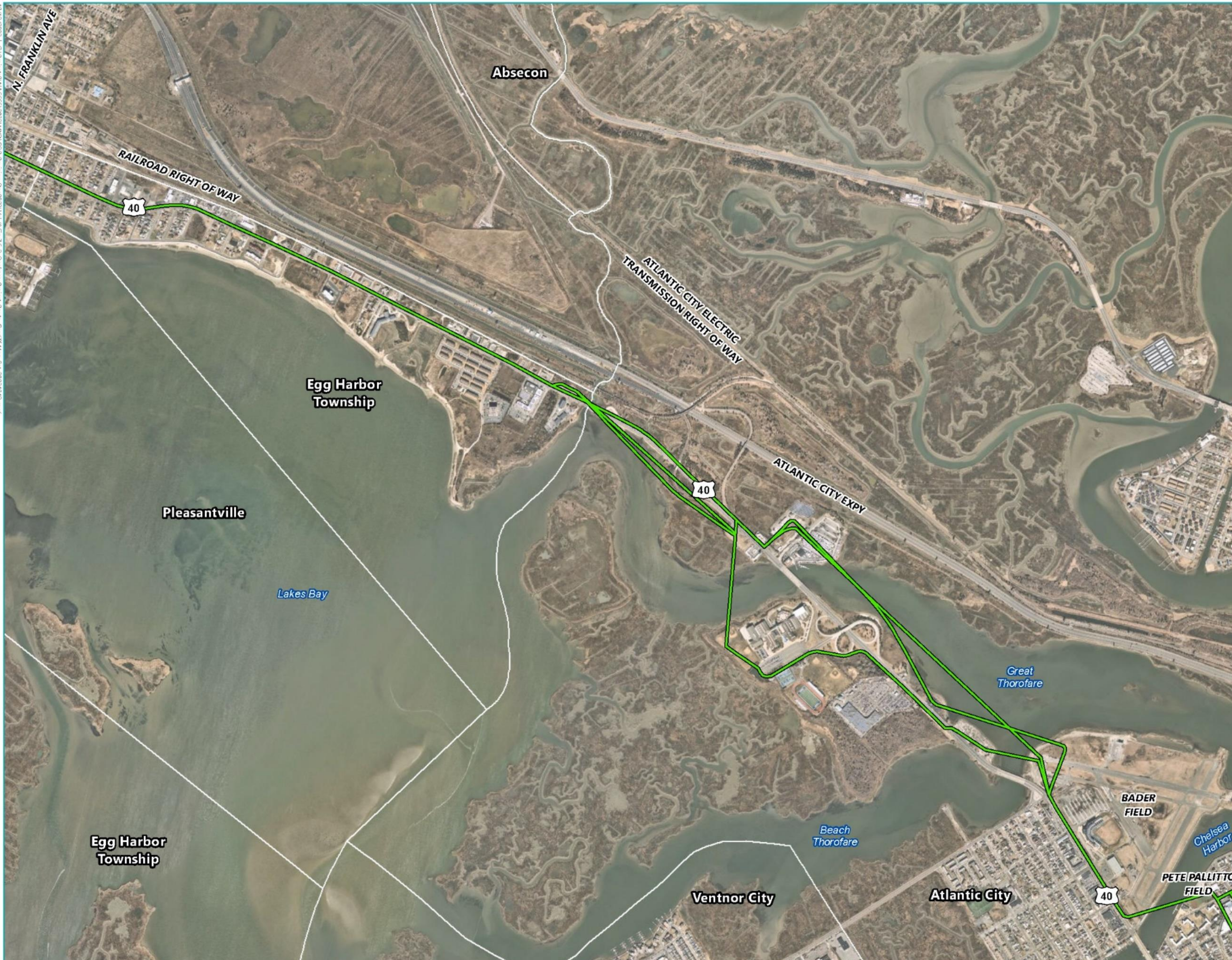


Figure 7.5-3 Index

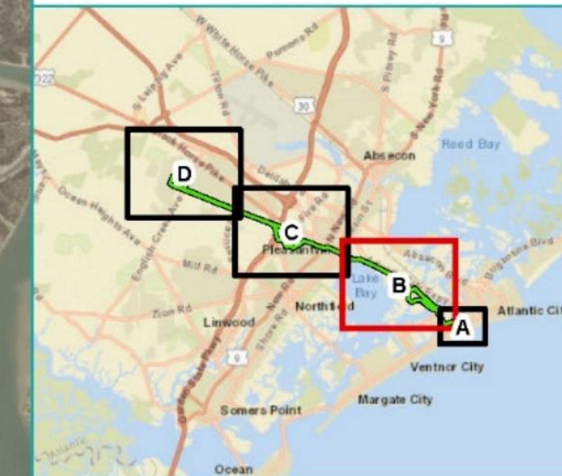
Atlantic Landfall Site, Cardiff Onshore Interconnection Cable Route, and Onshore Substation Site Atlantic County, New Jersey

Figure 7.5-3A

Atlantic Landfall Site, Cardiff Onshore Interconnection Cable Route, and Onshore Substation Site Atlantic County, New Jersey



ATLANTIC SHORES offshore wind



0 0.2 0.4 Miles

0 0.25 0.5 Kilometers

N W E S

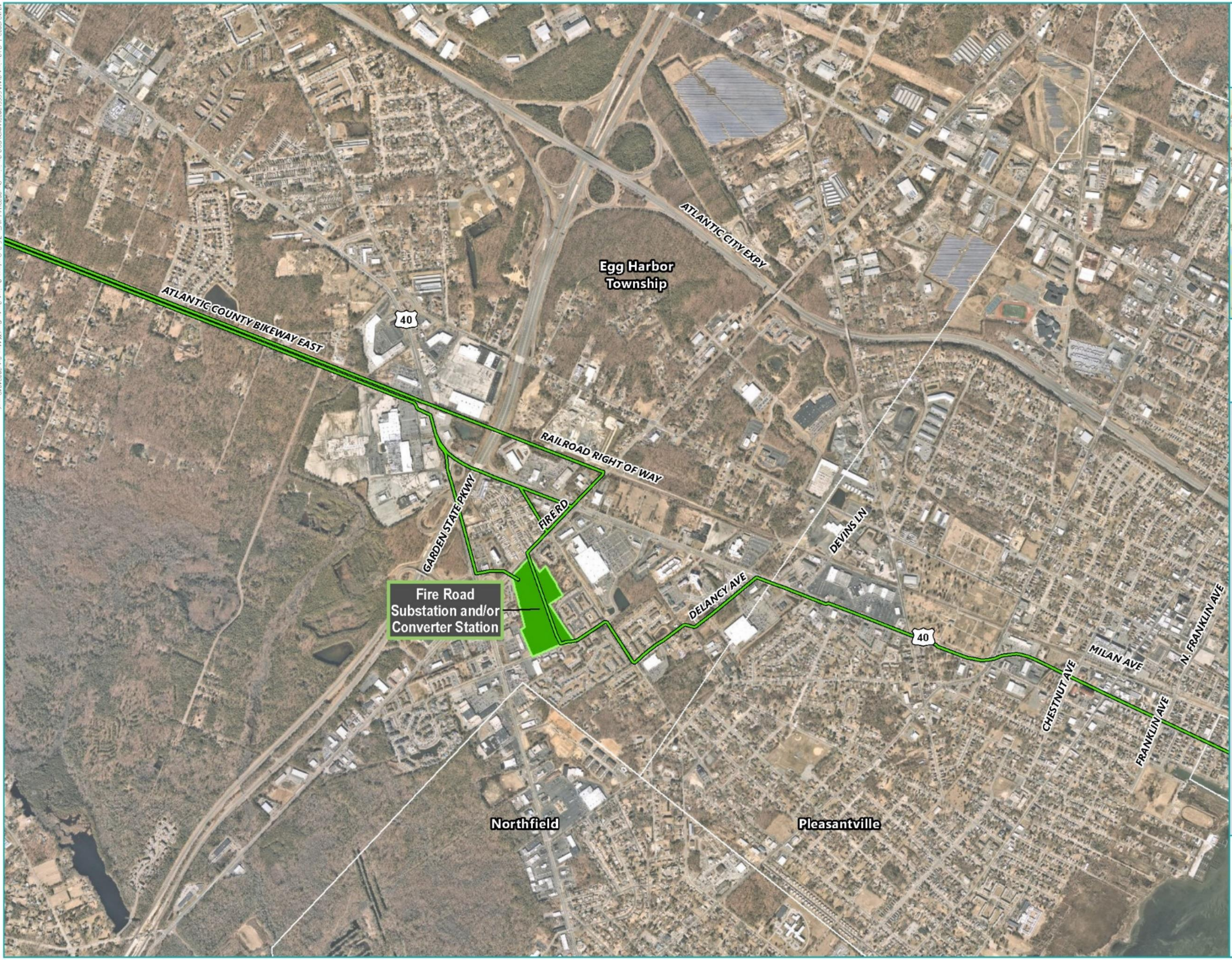
Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

LEGEND

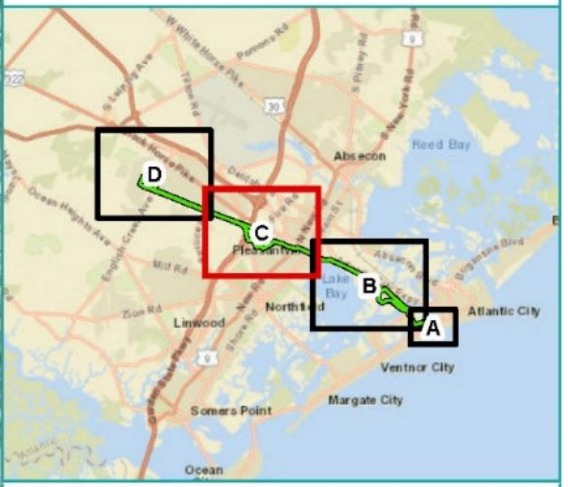
- Cardiff Onshore Interconnection Cable Route Options
- Substation and/or Converter Station
- Existing Cardiff Substation (POI)
- Atlantic Landfall Site
- Atlantic Export Cable Corridor
- Municipal Boundaries
- County Boundaries

Figure 7.5-3B

Atlantic Landfall Site, Cardiff Onshore Interconnection Cable Route, and Onshore Substation Site Atlantic County, New Jersey



ATLANTIC SHORES offshore wind



0 0.2 0.4 Miles

0 0.25 0.5 Kilometers

N S E W

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

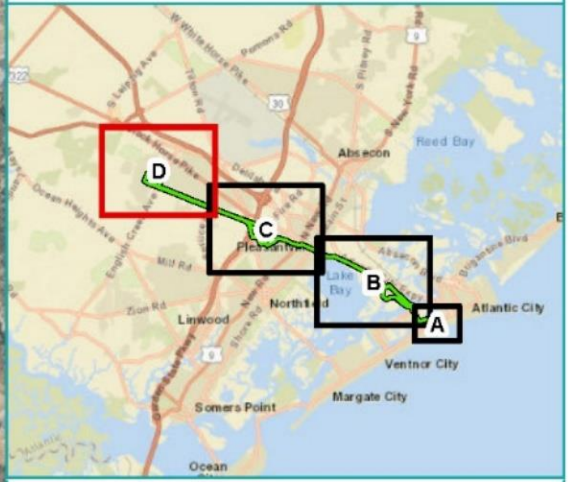
LEGEND

- Cardiff Onshore Interconnection Cable Route Options
- Substation and/or Converter Station
- Existing Cardiff Substation (POI)
- Atlantic Landfall Site
- Atlantic Export Cable Corridor
- Municipal Boundaries
- County Boundaries

Figure 7.5-3C

Atlantic Landfall Site, Cardiff Onshore Interconnection Cable Route, and Onshore Substation Site
Atlantic County, New Jersey

ATLANTIC SHORES offshore wind



0 0.2 0.4 Miles

0 0.25 0.5 Kilometers

N S E W

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

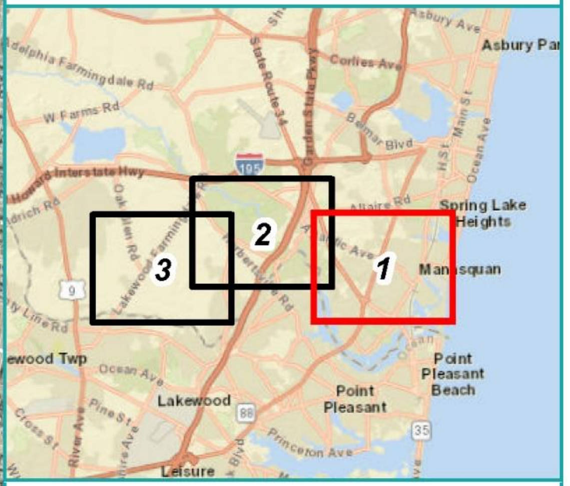
LEGEND

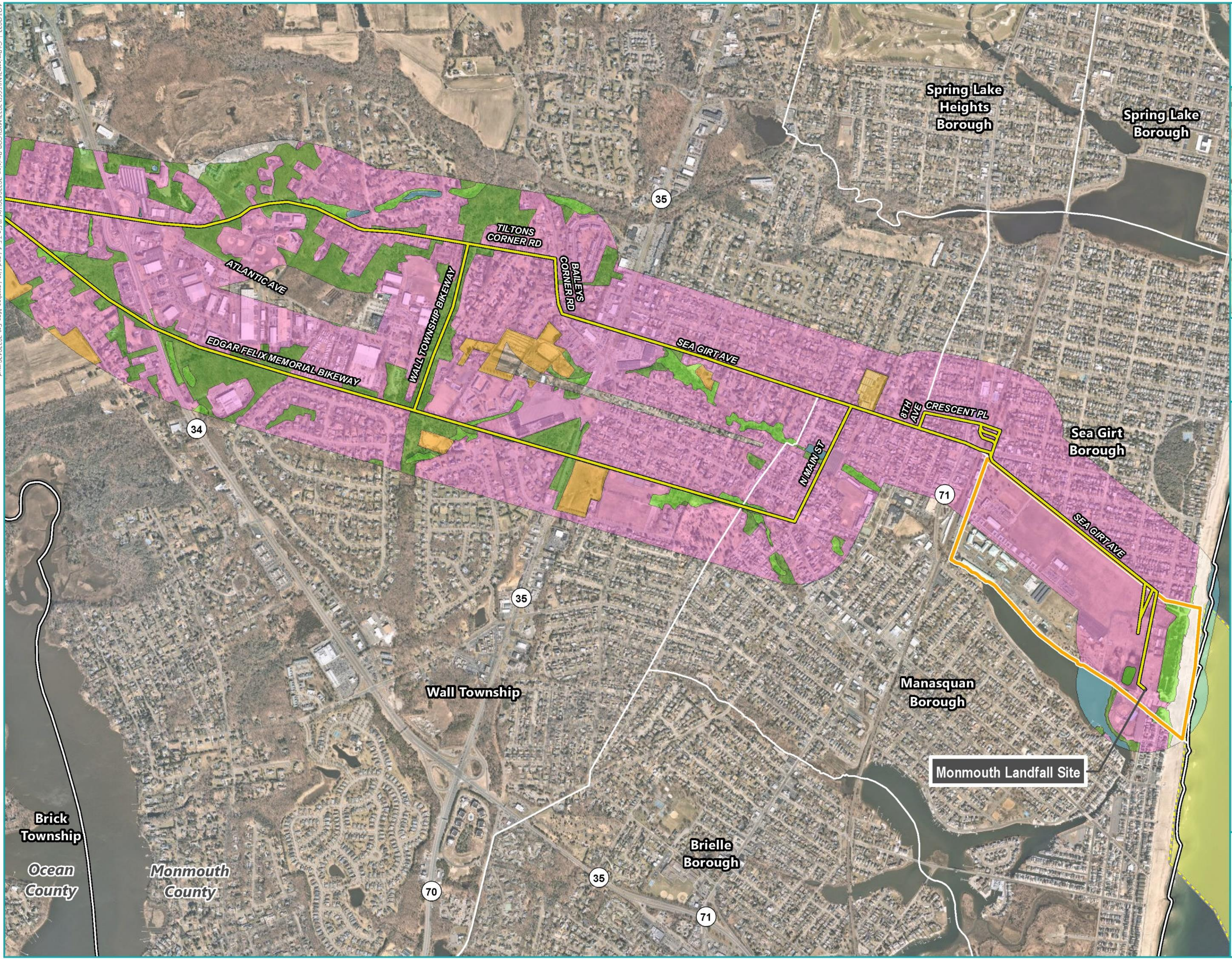
- Cardiff Onshore Interconnection Cable Route Options
- Substation and/or Converter Station
- Existing Cardiff Substation (POI)
- Atlantic Landfall Site
- Atlantic Export Cable Corridor
- Municipal Boundaries
- County Boundaries

Figure 7.5-3D

Atlantic Landfall Site, Cardiff Onshore Interconnection Cable Route, and Onshore Substation Site
Atlantic County, New Jersey

ATLANTIC SHORES
offshore wind





0 0.1 0.2 0.4 Miles

0 0.25 0.5 Kilometers

N E S W

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2021

LEGEND

- Larrabee Onshore Interconnection Cable Route Options
- Substation and/or Converter Station Option
- Larrabee Onshore Substation (POI)
- Monmouth Landfall Site
- Monmouth Export Cable Corridor
- Municipal Boundaries
- County Boundaries

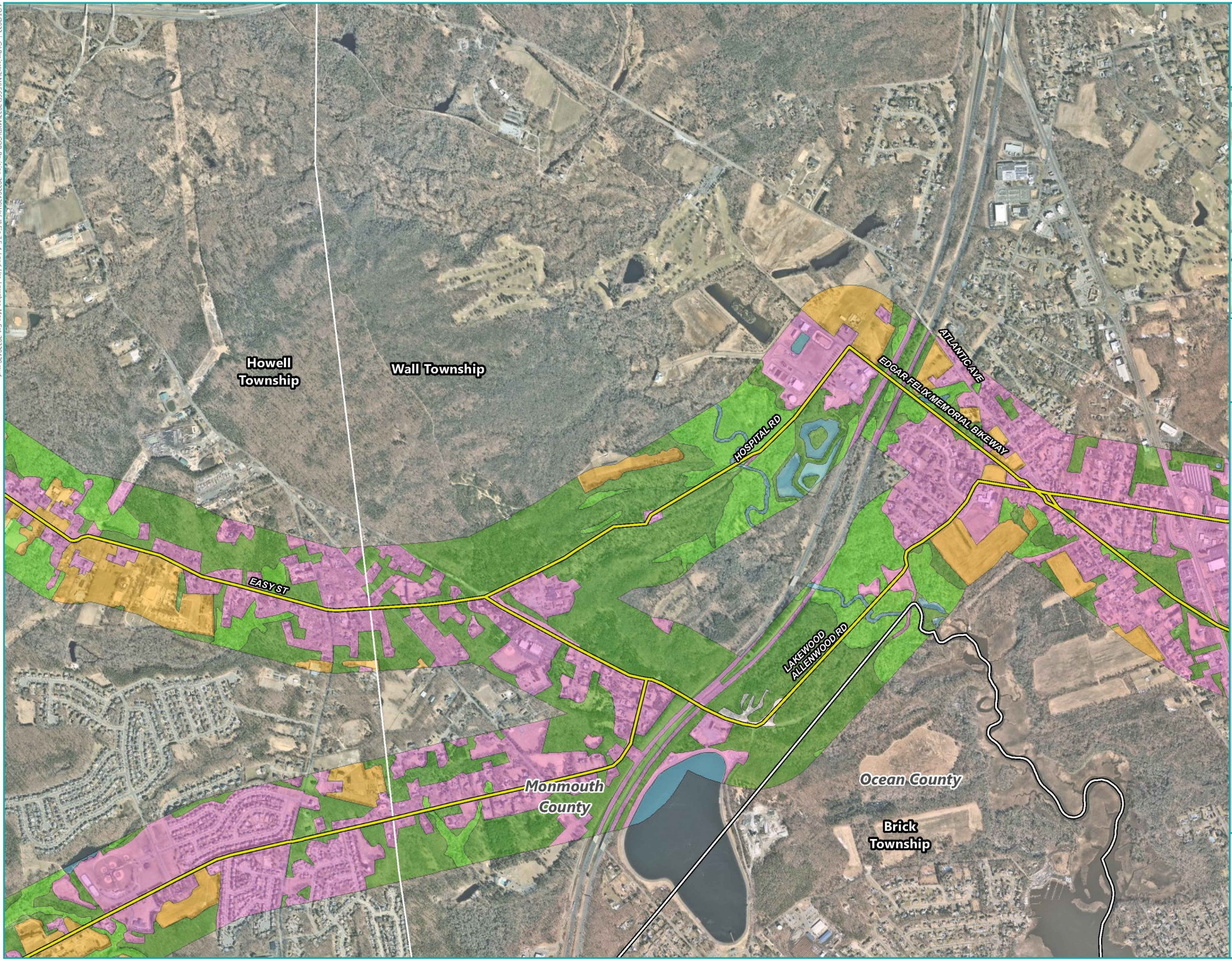
NJDEP Land Use/Land Cover (2015)

- Agriculture
- Urban
- Barren Land
- Water
- Forest
- Wetlands

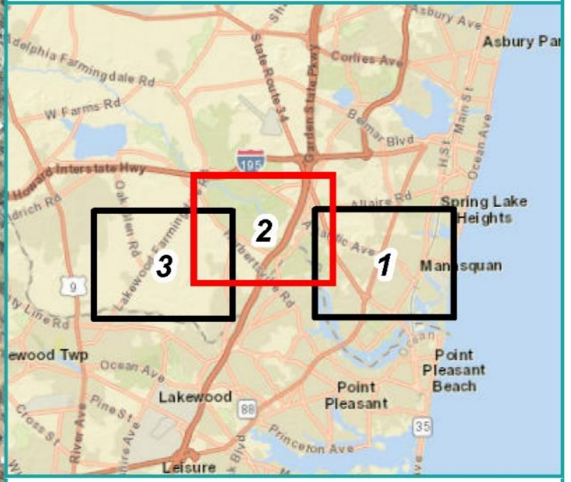
Figure 7.5-4
Sheet 1 of 3

Land Use/Land Cover - Larrabee Onshore Interconnection Cable Routes
Monmouth County, New Jersey

4/21/2023 | G:\Projects2\NJ\5665\2023\MXD\COP_Revision_20230420\Vol_II\Fig 7.5-4_Land_Use_Larrabee_Map_Set_20230420.mxd



ATLANTIC SHORES offshore wind



0 0.1 0.2 0.4 Miles
0 0.25 0.5 Kilometers

N W E S

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2021

LEGEND

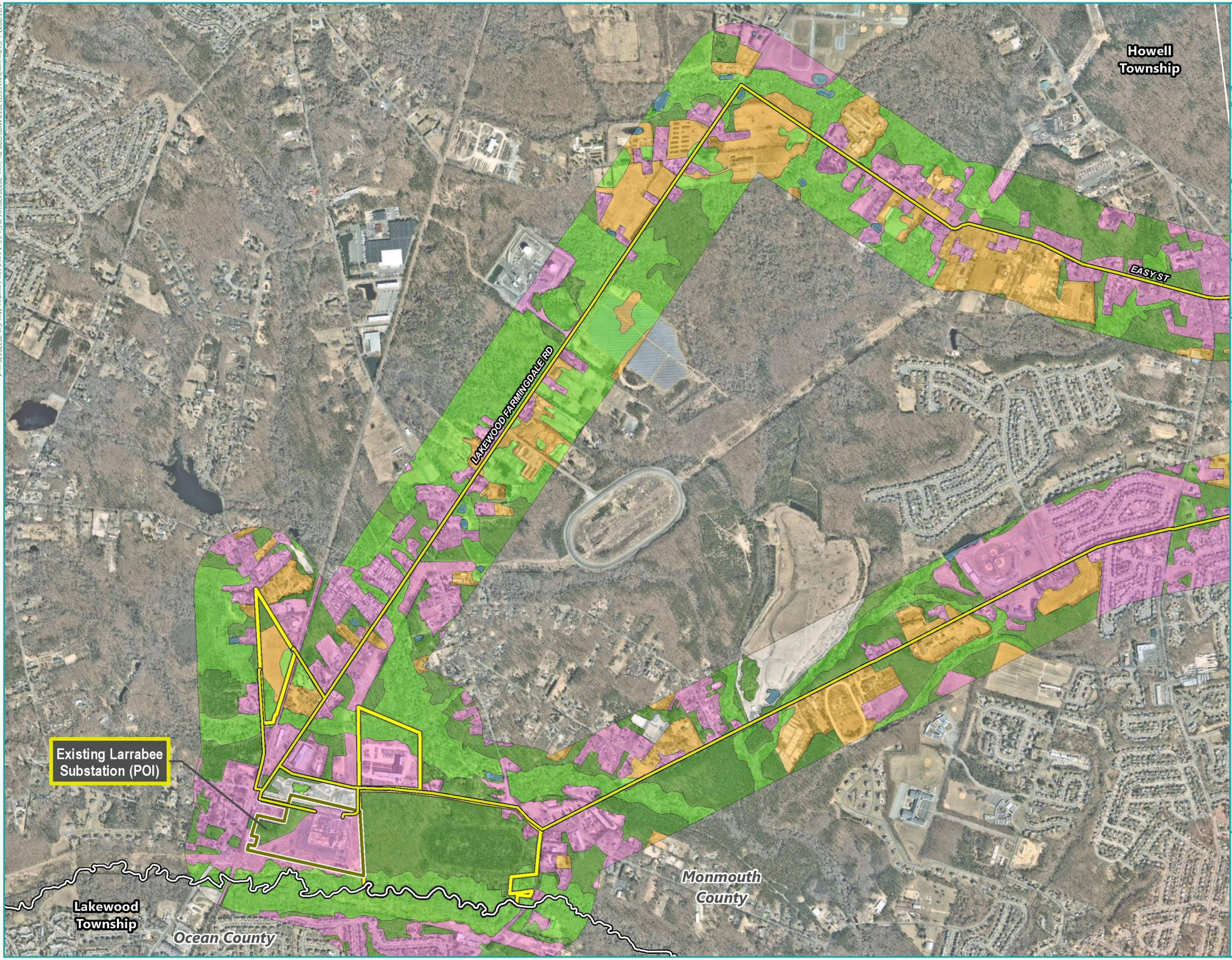
- Larrabee Onshore Interconnection Cable Route Options
- Substation and/or Converter Station Option
- Larrabee Onshore Substation (POI)
- Monmouth Landfall Site
- Monmouth Export Cable Corridor
- Municipal Boundaries
- County Boundaries

NJDEP Land Use/Land Cover (2015)

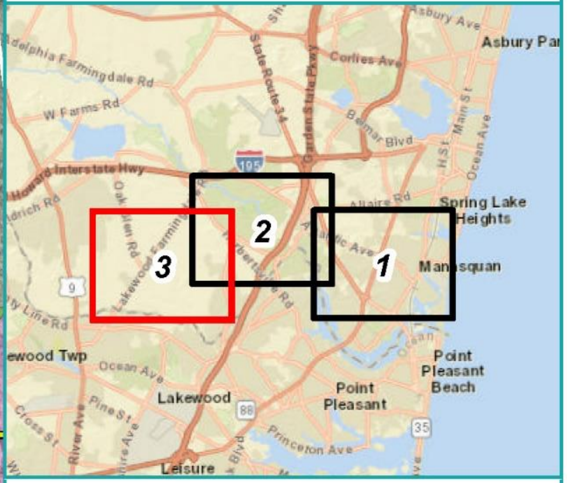
- Agriculture
- Urban
- Barren Land
- Water
- Forest
- Wetlands

Figure 7.5-4
Sheet 2 of 3

Land Use/Land Cover - Larrabee Onshore Interconnection Cable Routes Monmouth County, New Jersey



ATLANTIC SHORES offshore wind



0 0.1 0.2 0.4 Miles

0 0.25 0.5 Kilometers

N W E S

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2021

LEGEND

- Larrabee Onshore Interconnection Cable Route Options
- Substation and/or Converter Station Option
- Larrabee Onshore Substation (POI)
- Monmouth Landfall Site
- Monmouth Export Cable Corridor
- Municipal Boundaries
- County Boundaries

NJDEP Land Use/Land Cover (2015)

- Agriculture
- Urban
- Barren Land
- Water
- Forest
- Wetlands

Figure 7.5-4
Sheet 3 of 3

Land Use/Land Cover - Larrabee Onshore Interconnection Cable Routes Monmouth County, New Jersey

The Larrabee Substation POI is owned by Jersey Central Power & Light (JCP&L) and has a maximum voltage of 230 kV. Modifications to the existing POI will be required to accommodate the interconnection of the Projects. The scope of the required modifications will be determined upon completion of the Facilities Study Report by JCP&L and PJM, which is expected to be available in fall 2021. The scope of modifications is expected to include upgrading the existing substation by adding additional breaker bay(s). JCP&L will be responsible for the permitting, design, and construction of the required upgrades on the existing electrical grid, including the upgrades at Larrabee Substation; therefore, this upgrade is not addressed further in this section.

The Larrabee Onshore Interconnection Cable route will include a new substation and/or converter station at the Lanes Pond Road Site or the Randolph Road Site or the interconnection to a substation and/or converter station at the Brook Road Site developed under the NJBPU's SAA.

7.5.4 Port Utilization

Atlantic Shores has identified several port facilities in New Jersey, New York, the Mid-Atlantic, and New England that may be used for major construction staging activities for the Projects. In addition, some components, materials, and vessels could come from U.S. Gulf Coast, Canadian, and European ports.

Potential construction ports are listed in Table 7.5-1. All ports that may be used are either existing facilities or planned facilities that are expected to be developed by others to support the burgeoning offshore wind industry; none of the potential facilities are proposed for development by Atlantic Shores. Atlantic Shores has identified several construction ports to maintain flexibility. It is likely that only some of the ports identified in Table 7.5-1 will be utilized for Project construction; the ports ultimately selected for use will depend on the status of port upgrades and final construction logistics planning. Activities such as refueling, restocking supplies, sourcing parts for repairs, and potentially some crew transfer, may occur out of ports other than those identified.

Figure 7.5-5

Monmouth Landfall Site, Larrabee Onshore Interconnection Cable Route, and Onshore Substation Sites Monmouth County, New Jersey

Table 7.5-1 Ports that May be Used During Project Construction

Location	Port
New Jersey	Lower Alloways Creek (future New Jersey Wind Port)
	Port of Paulsboro
	Repauno Port & Rail Terminal (formerly Dupont)
Virginia	Portsmouth Marine Terminal
U.S. Specialty Ports	Ingleside, Texas

Atlantic Shores will likely establish a long-term crew transfer vessel (CTV) base at the O&M facility in Atlantic City during O&M. If Atlantic Shores employs a service operation vessel (SOV)-based O&M strategy, those SOVs would likely be operated out of existing ports such as Lower Alloways Creek Township, the Port of New Jersey/New York, or another industrial port identified in Table 7.5-1 that has suitable water depths to support an SOV. Atlantic Shores may also use the other ports listed in Table 7.5-1 to support O&M activities.

While it is anticipated that ports listed in Table 7.5-1 can support the Projects' needs, use of another U.S. or international port may be possible if significant non-routine maintenance is needed for the Projects.

7.5.5 Potential Impacts and Proposed Environmental Protection Measures

The potential IPFs which may affect land use and coastal infrastructure during Project construction, O&M, or decommissioning are presented in Table 7.5-2.

Table 7.5-2 Impact Producing Factors for Land Use and Coastal Infrastructure

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Land Disturbance	•	•	•
Port Utilization	•	•	•
Presence of Structures		•	

The maximum Project Design Envelope (PDE) analyzed for potential effects to land use and coastal infrastructure is the maximum onshore and offshore build-out of the Projects as defined in Section 4.11 of Volume I.

7.5.6 Land Disturbance

Short-term and localized land disturbance will occur from construction, O&M, and decommissioning of the landfall sites, onshore interconnection cables, and new substations and/or converter station sites, as well as potential upgrades to the POIs. To minimize land disturbance, Atlantic Shores has located onshore interconnection cable routes primarily along existing roadways, utility ROWs, and/or along bike paths. Land disturbance associated with the Projects is temporary and disturbed areas along the onshore interconnection cable routes and at the landfall sites will be returned to their original conditions, except for manholes that are installed for maintenance access. Construction will be conducted in accordance with soil erosion and sedimentation control plans.

Landfall Sites and Onshore Interconnection Cable Routes

As further described in Section 4.7.1 of Volume I, the offshore-to-onshore transition at the landfall sites will be accomplished using horizontal directional drilling (HDD). The HDD activity will involve establishing a staging area at the landfall site, where drilling will be initiated within an excavated pit. Drilling will then proceed from the staging area and under the beach to the offshore HDD exit location. Land disturbances during construction will be temporary and limited to the localized HDD staging area. Atlantic Shores will work with municipal officials to develop the construction schedule and hours in accordance with municipal noise ordinances. Certain activities, such as conduit pull-in, cannot stop once they are started, so work may need to continue or extended hours on rare occasions. All disturbed areas will be restored to their previous condition following completion of HDD.

From the landfall site to the POI, the onshore interconnection cables will be contained within a buried concrete duct bank. As described in Section 4.8 of Volume I, installation of the concrete duct bank for onshore interconnection cables will typically be accomplished via open trenching with a temporary trench up to 15 ft (4.5 m) wide and 12 ft (3.5 m) deep. These dimensions are also sufficient for the installation of splice vaults where necessary. Specialty techniques (e.g., HDD, pipe jacking, and jack-and-bore) are anticipated at unique features such as busy roadways and wetlands and are further described in Section 4.8.3 of Volume I.

The onshore interconnection cable routes were selected to primarily use existing roadway ROWs, utility ROWs, and/or bike paths to minimize effects to land use. At any given time, construction and the associated land disturbance will be limited to discrete areas and will therefore, only affect a specific area for a short period of time. Atlantic Shores is proposing to adhere to voluntary seasonal construction restrictions for appropriate portions of the onshore interconnection cable routes where seasonal use is most concentrated. For the Cardiff Onshore Interconnection Cable Route, no summer construction (generally from Memorial Day to Labor Day) will occur from the Atlantic Landfall Site to Pleasantville, on the mainland. For the Larrabee Onshore Interconnection Cable Route, no summer construction will occur from the Monmouth Landfall Site, past the Garden State Parkway, to where the route exits the bike path near Allaire State Park.

Construction laydown areas have not yet been identified, but Atlantic Shores anticipates they will either be paved areas or will be locations already utilized for similar activities. As such, construction laydown is not expected to require new land disturbance.

Mitigation measures such as erosion and sedimentation controls will be utilized during construction at the landfall sites and along the onshore interconnection cable routes. No permanent effects to land use are expected upon completion of construction because all temporarily disturbed areas will be fully restored and all Project infrastructures will be entirely underground except for at-grade manhole covers. Effects during decommissioning are expected to be similar to effects during construction and will be temporary in nature.

During O&M, periodic maintenance of the onshore facilities may be required. Any necessary maintenance will be accessed through manholes, thereby avoiding and minimizing land disturbance.

New Substations and Points of Interconnection

Potential substation and/or converter station sites were / will be selected to minimize effects to surrounding land uses. As described further in Section 4.9 of Volume I, temporary land disturbance will occur within the footprint of the proposed substation and/or converter station sites and will include land clearing, grading, trenching, and installation of equipment and equipment foundations. Appropriate erosion/sedimentation controls will be used during construction and a job-site safety program will be implemented to prevent public access to the construction site.

Once the onshore substation and/or converter station is operational, a security plan will control site access by employing fencing (with earth grounding), screening barriers, camera systems, signage, and physical barriers. Existing vegetative buffers will be enhanced (only native vegetative species will be used) and setback, landscaping, buffering, screening, and/or lighting will be provided along exposed sides of the site. Atlantic Shores expects to coordinate with local authorities regarding the use of vegetative buffers at the onshore substations.

Once the substation and/or converter station is operational, periodic maintenance activities will likely occur within the substation and/or converter station site and appropriate environmental protection measures, such as erosion and sedimentation control, will be used. During decommissioning, effects are expected to be similar to construction.

The scope of modifications at either the Cardiff or Larrabee POIs is not yet known but may include expanding the existing substation and/or converter station by adding additional breaker bay(s) to upgrading the existing high voltage section of the substation to a breaker and a half configuration. Such activities, if required, are anticipated to occur within the footprint of the existing POI or in the immediate vicinity.

7.5.7 Port Utilization

Project construction, O&M, and decommissioning will require the use of existing ports. Atlantic Shores has identified several ports to be utilized for Project construction and O&M (Table 7.5-1). Potential ports for the Projects have been chosen that have existing adequate infrastructure (including high load-bearing ground and deck capacity, adequate vessel berthing parameters, and suitable laydown and fabrication space), or where such infrastructure is proposed for development by other entities within the Projects' timeframe. Atlantic Shores has identified several ports for potential use because many port entities have plans to upgrade or further develop port facilities in support of the burgeoning offshore wind industry. It is essential for the Projects to have the ability to utilize the most appropriate port facilities for construction given uncertainties regarding which planned port upgrades will be completed within the Projects' development schedule and projected demand for the port facilities by other offshore wind developers.

As described above in Section 7.5.1.3, vessel operations and frequency, as well as onshore traffic, may increase near the port facilities during construction, O&M, and decommissioning. Section 7.6 Navigation and Vessel Traffic, as well as the Navigation Safety Risk Assessment (NSRA) in Appendix II-S, describe vessel navigation in detail and Section 7.9 Onshore Transportation and Traffic describes potential onshore traffic. Vessel use during O&M is not anticipated to affect or interfere with normal port operations. The potential ports and surrounding waterways are expected to have the necessary capacity for the potential vessel traffic. Atlantic Shores will employ a Marine Coordinator to manage vessel movements and will also utilize additional mitigation measures as described in Section 7.6 Navigation and Vessel Traffic to avoid or minimize effects.

7.5.8 Presence of Structures

The Projects include the presence of transmission cable infrastructure, specifically, underground onshore cables and vaults at the landfall sites and along the onshore interconnection cable routes. The cable infrastructure will be located underground and is not anticipated to interfere with land uses or coastal infrastructure. The facilities will be regularly monitored, and repairs and maintenance will be conducted promptly. Any necessary repairs on the interconnection cables will be accessed through manholes and repairs will be completed within the installed transmission infrastructure. Atlantic Shores is selecting onshore substation and/or converter station sites to minimize effects to surrounding land uses to the extent practicable. Therefore, the Projects are not expected to result in permanent effects to land uses or coastal infrastructure.

7.5.9 Summary of Proposed Environmental Protection Measures

Atlantic Shores understands the importance of land use and coastal infrastructure and has worked to design the Projects to be compatible with surrounding land use and communities and to safeguard environmentally and culturally sensitive areas. Project construction, O&M, and decommissioning activities are designed to minimize effects to land use and coastal infrastructure.

Offshore

- A Marine Coordinator will be used to manage any increase in vessel movements during Project construction, O&M, and decommissioning.

Onshore

- A desktop assessment has been conducted of the relevant land uses and coastal infrastructure to avoid and minimize effects.

- HDD cable installation will be used at the landfall sites to minimize land disturbance. Land disturbance will be temporary and disturbed areas will be restored to their previous condition, except for the proposed manholes that will be used for access to maintain the cables.

- Onshore interconnection cable routes have been routed primarily along previously disturbed ROWs.

- Onshore substations and/or converter stations will be sited on previously disturbed lands to the extent practicable to minimize effects to surrounding land uses and to be compatible with the existing zoned use.

- Design elements will be implemented (e.g., certified enclosures, natural barriers, and landscaping around the onshore substations and/or converter stations) to minimize effects to surrounding land uses and communities.

- Access for repairs on the interconnection cables will take place through manholes and repairs will be completed within the installed transmission infrastructure, thus minimizing land disturbance.

- Voluntary seasonal construction restrictions for onshore interconnection cable installation will be followed.

- Erosion and sedimentation control measures will be utilized during construction at the landfall sites and along the onshore interconnection cable routes.

- A job-site safety program will be implemented to prevent public access to the Projects' construction site.

7.6 Navigation and Vessel Traffic

This section describes maritime navigation and vessel traffic in the Offshore Project Areas, associated impact-producing factors (IPFs), and measures to avoid, minimize, or mitigate potential effects to these resources during construction, operation and maintenance (O&M), and decommissioning. The marine and coastal waters of the Mid-Atlantic have a rich maritime history, and the waters off the New Jersey coast have and continue to support maritime activities and commerce including commercial (non-fishing) and military traffic, recreational traffic, and fishing vessels. The Projects Wind Turbine Area (WTA) is in the southern portion of Lease Area OCS-A 0499 (Lease Area), which was sited by the Bureau of Ocean and Energy Management (BOEM) to avoid high marine traffic areas and minimize effects to existing marine users (see Section 1.3.1 of Volume I). The overall traffic density within the WTA is relatively low, with two or more Automatic Identification System (AIS)-equipped vessels present in the 102,124-acre (413.3 square kilometer [km^2]) WTA for only 15.6% of the time (1,362 hours per year on average).

Atlantic Shores supports the appropriate mixed use of ocean waterways and has actively considered existing marine traffic patterns during all phases of the Projects' development. Atlantic Shores has also engaged in extensive and proactive coordination with the U.S. Coast Guard (USCG), mariners, fishermen, and other stakeholders using multiple communication channels to better understand both navigation and vessel traffic within the WTA and mariner concerns.

This navigation risk assessment considered the proposed development for the Projects within the WTA in its entirety and thus evaluated the installation of up to 200 wind turbine generators (WTG), up to 10 offshore substations (OSS), and one permanent meteorological tower (met tower) to be situated on the western perimeter of the WTA. Given the vessel traffic patterns in this region and the proposed layout of the Projects, Baird believes that the risks associated the entire WTA would not differ substantially from consideration of risks in the individual projects. Construction of either of the projects will result in modifications to vessel traffic patterns and in a change to the overall risk profile. Construction of the second project following the first does not introduce significantly greater risk as the total risk is not directly proportional to the number of WTGs.

7.6.1 Affected Environment

The maritime navigation and vessel traffic information contained in this section is supported by the following study:

- **The Navigation Safety Risk Assessment** (NSRA, Appendix II-S) identifies existing navigation patterns and potential effects of the Projects during the construction, O&M, and decommissioning phases. Information in the NSRA is based on the USCG Navigation and Vessel Inspection Circular No. 01-19 (NVIC 01-19), which provides guidance on the information and factors to be considered when reviewing an application for a permit to build and operate an Offshore Renewable Energy Installation (OREI), such as the proposed Projects. Key considerations evaluated in the NSRA include: (1) safety of navigation, (2) the effect on traditional uses of the waterway, and (3) the impact on maritime search and rescue activities by the USCG and others.

The Offshore Project Area considered for the purposes of assessing marine navigation and vessel traffic is the broader geographic region offshore from the New Jersey coast surrounding the Monmouth and Atlantic Export Cable Corridors (ECCs) and the WTA. The following sections provide an overview of current maritime navigation in the Offshore Project Area (see Section 7.6.1.1), followed by a detailed discussion of existing vessel traffic patterns (see Section 7.6.1.2).

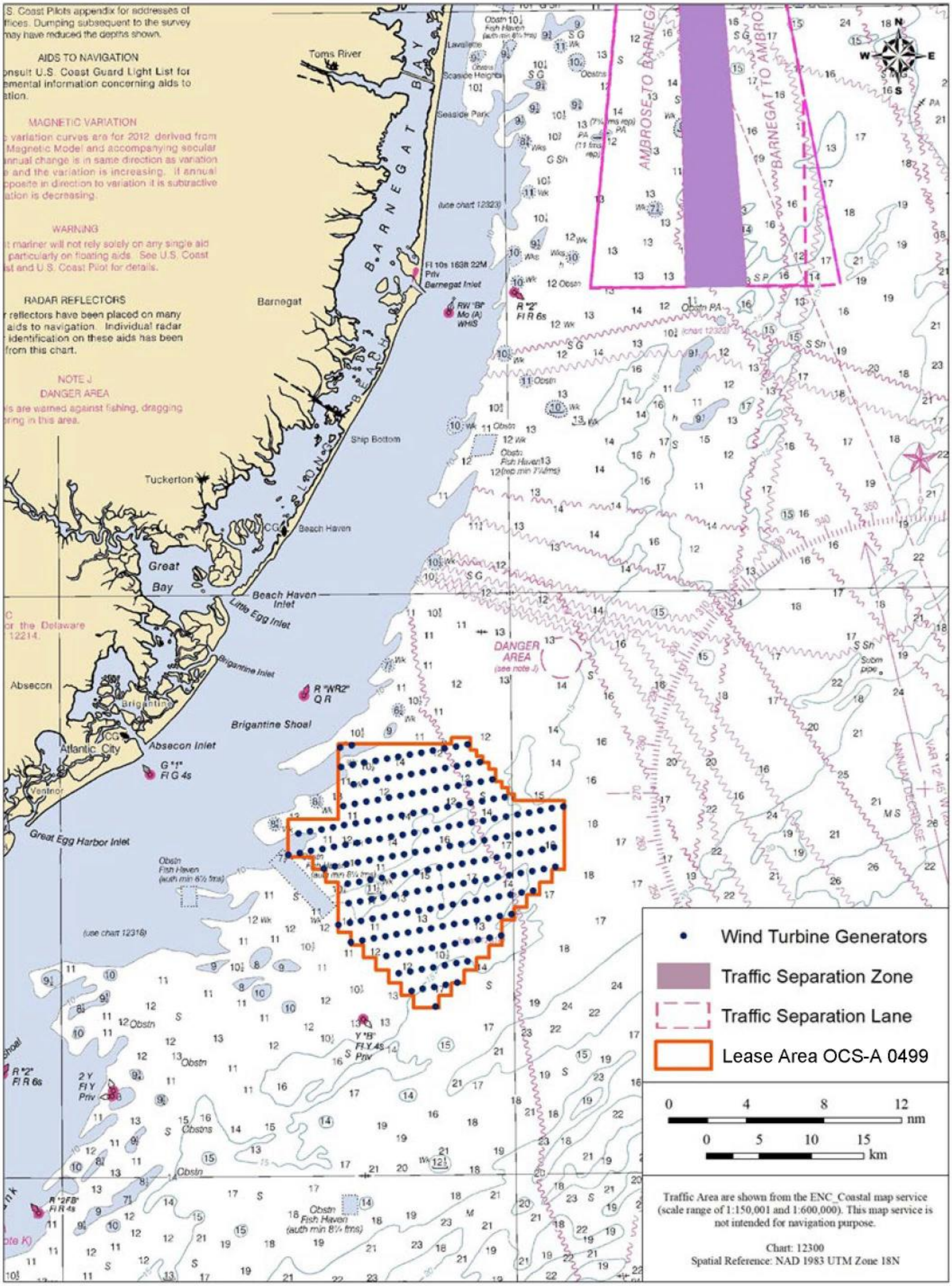
7.6.1.1 Navigation

Private Aids to Navigation (PATONs), Federal Aids to Navigation (ATONs), and radar transponders are located throughout the Offshore Project Area (Figure 7.6-1). These aids to navigation consist of lights, sound horns, buoys, and onshore lighthouses. They are intended to serve as visual and audible references to support safe maritime navigation.

ATONs are developed, operated and maintained or regulated by the USCG to assist mariners in determining their position, identify safe courses, and warn of dangers and obstructions. ATONs are marked on the National Oceanic and Atmospheric Administration (NOAA) nautical charts.

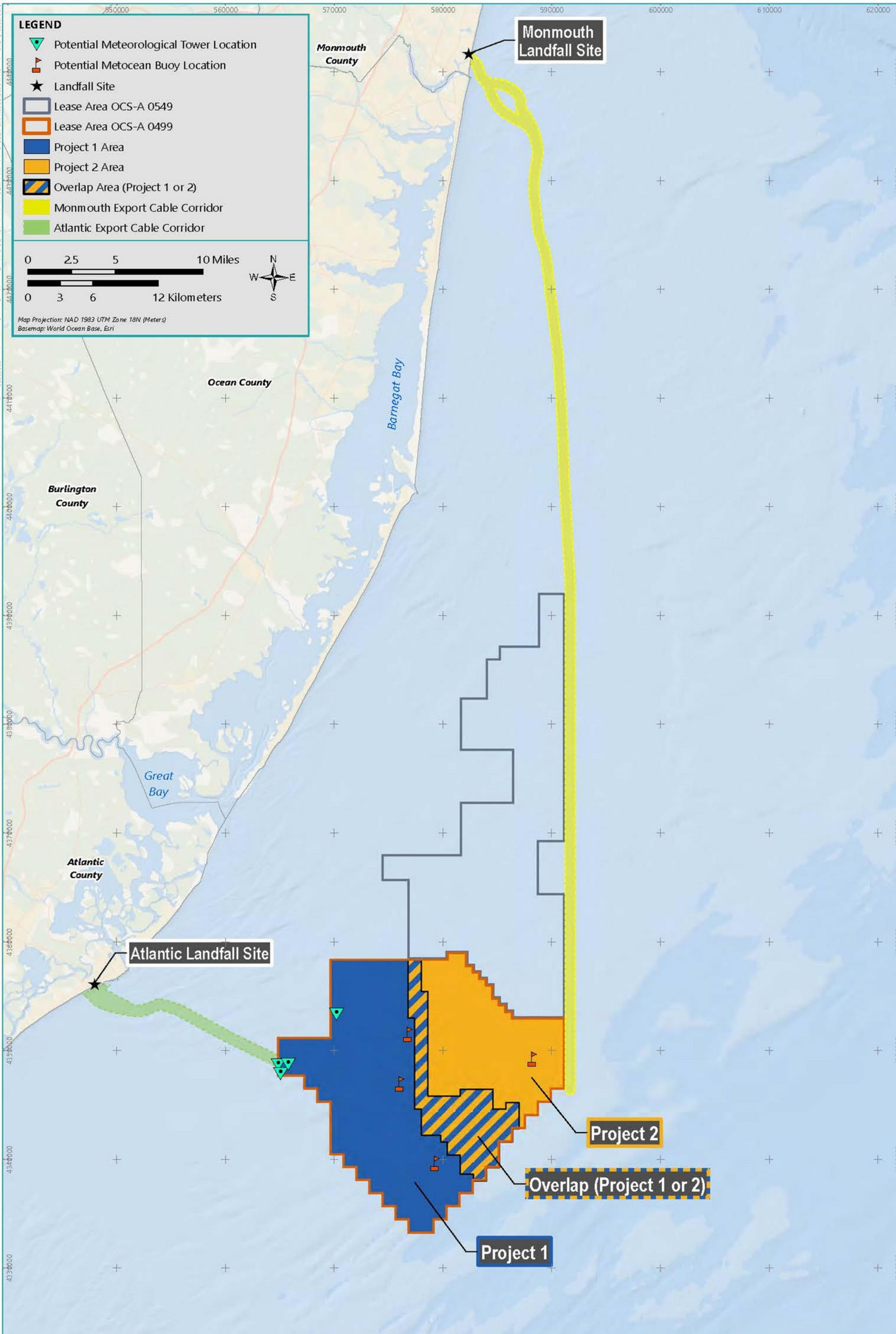
Most private and Federal ATONs in the Offshore Project Area, including a historic lighthouse demarcating Barnegat Inlet, are located inshore relative to the WTA. There are no ATONs or PATONs in the WTA. The closest PATON relative to the WTA is a buoy located approximately 1 nautical mile (nm) (1.85 kilometer [km]) south of the southeast corner of the WTA. A temporary Light Detection and Ranging (lidar) buoy managed and operated by Atlantic Shores is currently located within the WTA in accordance with a Site Assessment Plan approved by BOEM in April 2021. Also, a single permanent met tower may be constructed within the WTA and, during construction, up to four meteorological and oceanographic (metocean) buoys may be temporarily located within the WTA (see Section 4.6 of Volume I). Figure 7.6-2 shows potential met tower and metocean buoy locations for the Projects.

The WTA is in relatively deep water 62 to 121 feet (ft) (19 to 37 meters [m]), and there are no impediments to navigation through this area presently. There are no demarcated waterways adjacent to or within the WTA; however, there is the Ambrose-Barnegat Traffic Separation Scheme (TSS) leading to and from New York City. This TSS is located approximately 25 nm (46 km) north of the WTA. A TSS separates opposing streams of vessel traffic by creating separated, unidirectional traffic lanes and is typically designed to safely guide commercial vessels transiting to and from major ports. Because the WTA is located so far south of the Ambrose-Barnegat TSS area, it is not expected to impede commercial traffic in or out of that TSS.



ATLANTIC SHORES offshore wind

Figure 7.6-1
Lease Area Overlaid on Navigational Chart 12300



ATLANTIC SHORES offshore wind

Figure 7.6-2

Potential Met Tower and Metocean Buoy Locations

7.6.1.2 Vessel Traffic

Vessel traffic in the Offshore Project Area makes use of waterways, ports, and other coastal infrastructure to move goods and passengers and is essential for the region's economy and security. Vessel traffic includes a variety of types including dry cargo and tanker vessels, recreational vessels, fishing vessels, and tug-barge vessels. Each of the specific vessel types operate differently and may have operational and navigational requirements that present unique needs based on other uses and activities within the Offshore Project Area.

The NSRA presents an assessment of vessel traffic within the Offshore Project Area based on AIS data from 2017 through and including 2019. AIS is not required for vessels fewer than 65 ft long, so not all vessels, particularly smaller fishing and recreational vessels, are equipped with AIS. For the NSRA, estimates were made of percentage of AIS and non-AIS equipped fishing and recreational vessels expected to transit the WTA. To address the fact that not all fishing and recreational vessels may have AIS, the AIS traffic volumes assumed in the risk modeling (see Section 7.6.2.4) were increased by 100% to account for fishing and recreational vessels. In addition, BOEM provided polar histograms (plots of the frequency of vessel tracks by track heading) developed from six years of VMS fishing vessel data (2014 to 2019, inclusive) that were considered.

Based on the NSRA, unique vessel types identified by AIS in the WTA include recreational fishing, dry cargo, fishing (in-transit), tug-barge, tanker, fishing (while fishing versus in-transit), other, and passenger, in ascending order. There were two tall ships during the 3-year AIS data record, and no military vessels that transited directly through the WTA; however, there were a few military vessel transits in the wider region. The AIS data indicated that most unique vessels entering the WTA were recreational craft (34%) and cargo (27%); however, most unique vessel tracks that traversed the WTA were by commercial fishing vessels (41%) and cargo (26%). Table 7.6-1 shows vessel types within the WTA based on the 2017–2019 AIS data (see also Table 6.2 of Appendix II-S).

Table 7.6-1 Vessel Types within the WTA Based on 2017–2019 AIS Data

	UNIQUE VESSELS		UNIQUE TRACKS	
	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE
Dry Cargo Vessels	780	27%	3,169	26%
Tankers	186	6%	302	2%
Passenger Vessels	84	3%	304	2%
Tug-barge Vessels	177	6%	861	7%
Military Vessels[2]	0	0%	0	0%
Recreational Vessels	998	34%	1,713	14%
Fishing Vessels (all)	329	11%	5,101	41%
Other Vessels	113	4%	376	3%
Unspecified AIS Type	248	9%	489	4%
Total (2017–2019)	2,915	100%	12,315	100%
Annual Average Vessel Tracks	-	-	4,105	-

[1]No military vessels had transits through the WTA, but there were a small number of transits in the wider region.

AIS data were used to determine vessel traffic densities in the Offshore Project Area, and the results of this analysis are plotted and presented graphically in the NSRA (see Section 6.3 of Appendix II-S). The traffic density for all vessels is concentrated in the nearshore and harbor areas west of the WTA and moderately heavy on north-south routes to the east of the WTA, as shown in Figure 7.6-3. The WTA itself is in a less traveled area between the nearshore areas to the west and the north-south routes to the east. The overall traffic density within the WTA was found to be relatively low, with two or more vessels present in the 102,124-acre (413.3 km^2) WTA for only 15.6% of the time (1,362 hours per year on average).

Larger ships, specifically cargo vessels, are the predominant users of the north-south routes to the east of the WTA, as shown in Figure 7.6-4. Some of this larger ship traffic has historically transited more densely through the far eastern part of the WTA. As shown in Figure 7.6-5, the primary tug-barge north-south route is closer to shore to the west of the WTA.

Smaller vessels, including recreational and fishing vessels (when transiting), tend to concentrate their traffic in the nearshore areas west of the WTA, with significantly less traffic within the WTA. Traffic densities for recreational vessels are shown in Figure 7.6-6; traffic densities for fishing vessels (when transiting) are shown in Figure 7.6-7. Traffic densities for fishing vessels (when transiting) are noticeably high in the vicinity of three major New Jersey commercial fishing ports: Long Beach-Barnegat, Atlantic City, and Cape May-Wildwood.

Fishing vessels (when fishing) tend to concentrate their activity to the northeast of the WTA, with some increased activity occurring within the northeast and east sectors of the WTA, as shown in Figure 7.6-8.

Vessel densities relative to the ECC locations are shown in Figure 7.6-9 for the Monmouth ECC and Figure 7.6 10 for the Atlantic ECC. Vessel crossings occur across the length of the Monmouth ECC, but overall vessel traffic density along the Monmouth ECC is relatively low, with the highest concentration of traffic offshore of Barnegat. Similarly, vessel crossings also occur across the length of the Atlantic ECC, with the highest concentration of traffic closer to Atlantic City.

AIS data were also queried within the WTA to establish a representative profile of seasonal and year-round activity. There is strong seasonality as to the number of vessels collectively transiting the WTA, varying from three transits per day on average in the winter to 6.4 transits per day in the summer. This seasonality is primarily driven by the fishing and recreational vessels as the transits of commercial (non-fishing) vessels were relatively consistent from month to month. Detailed descriptions of vessel traffic within the Offshore Project Area are provided in Appendix II-S (Section 6.0). The USCG has undertaken two recent planning efforts for the reduction of navigational risk that are pertinent to the Offshore Project Area. An Atlantic Coast Port Access Route Study (ACPARS) was completed in July 2015 (USCG 2015). The ACPARS reviewed the entire eastern seaboard from Maine to Florida.

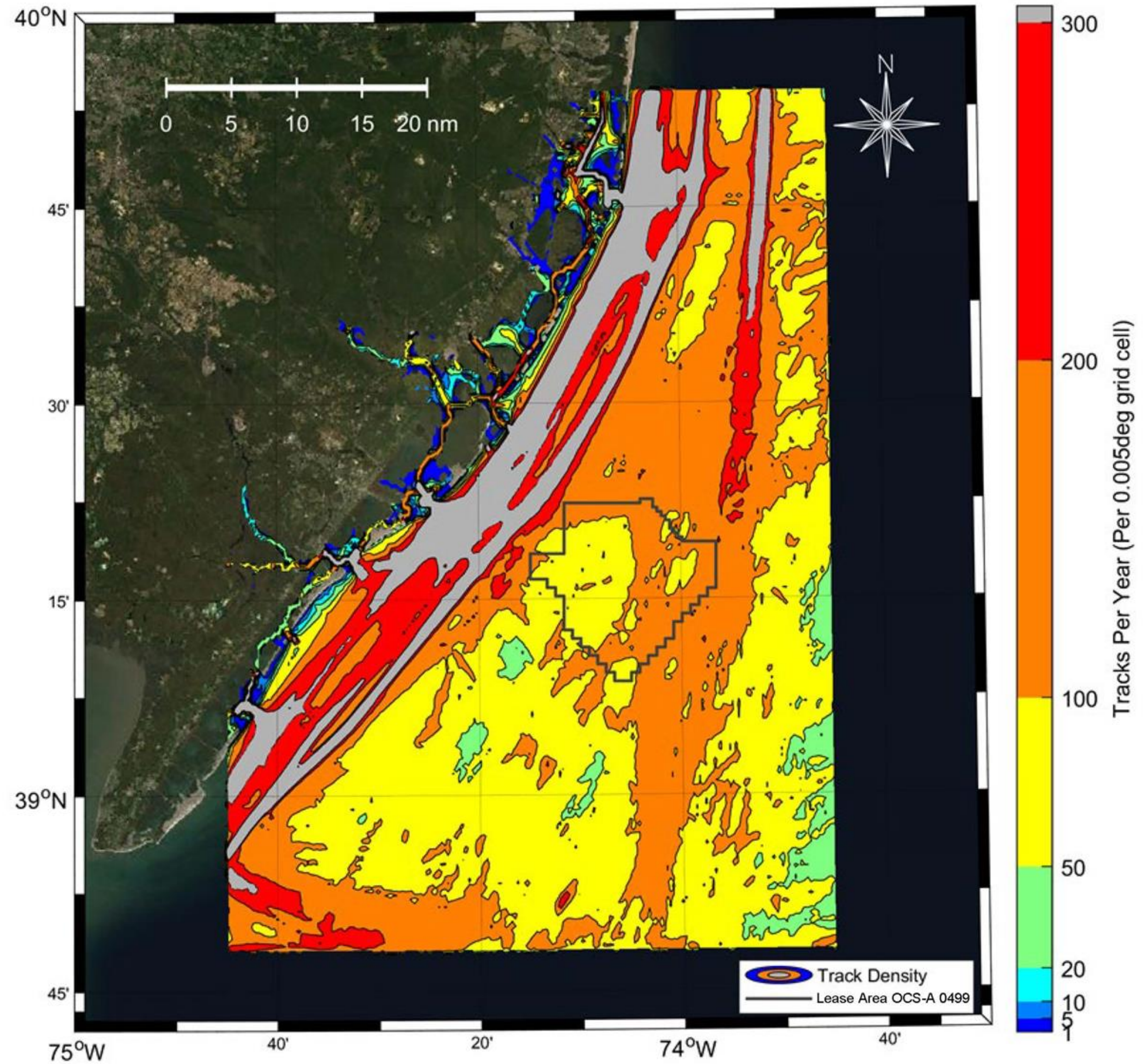
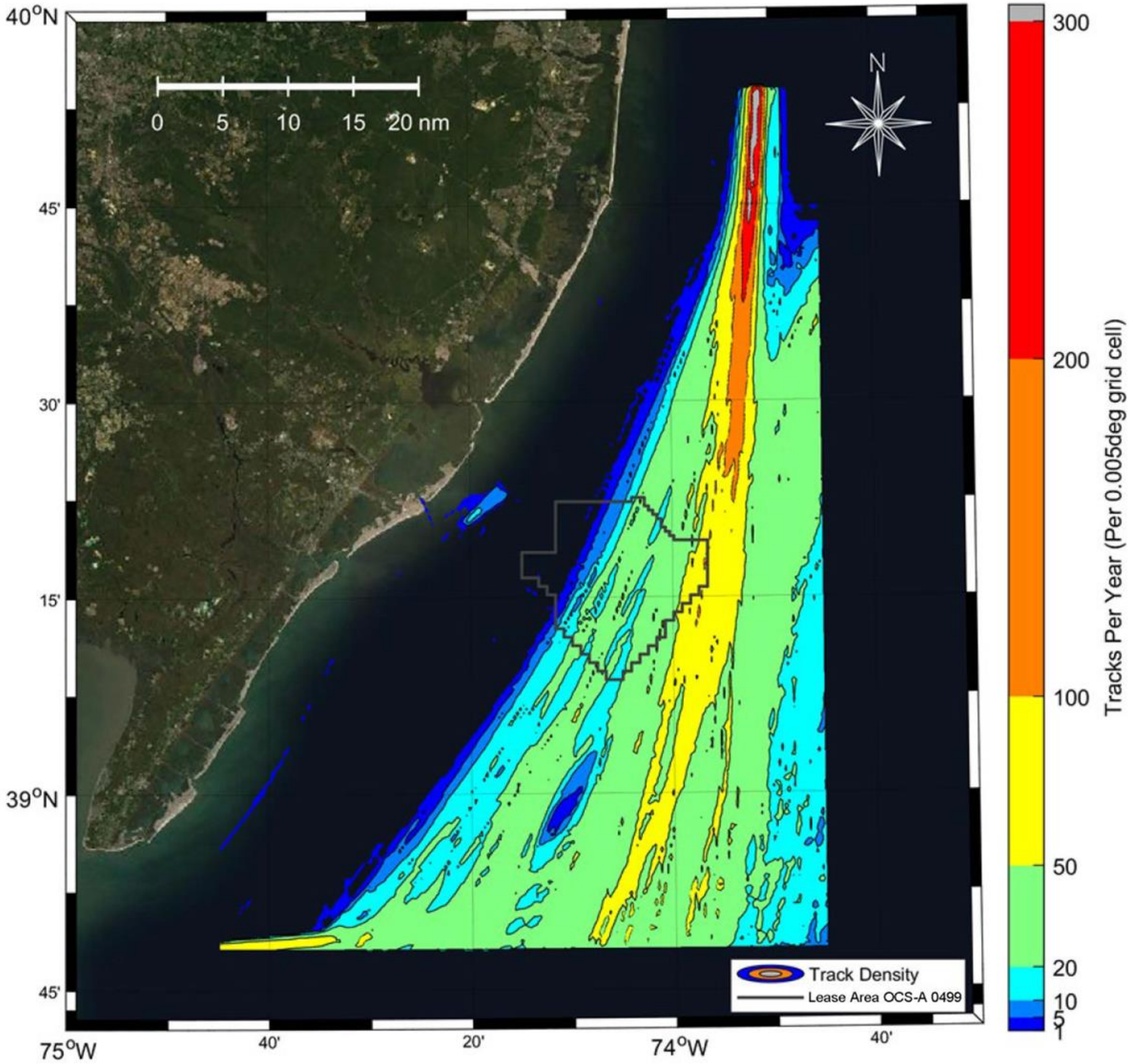


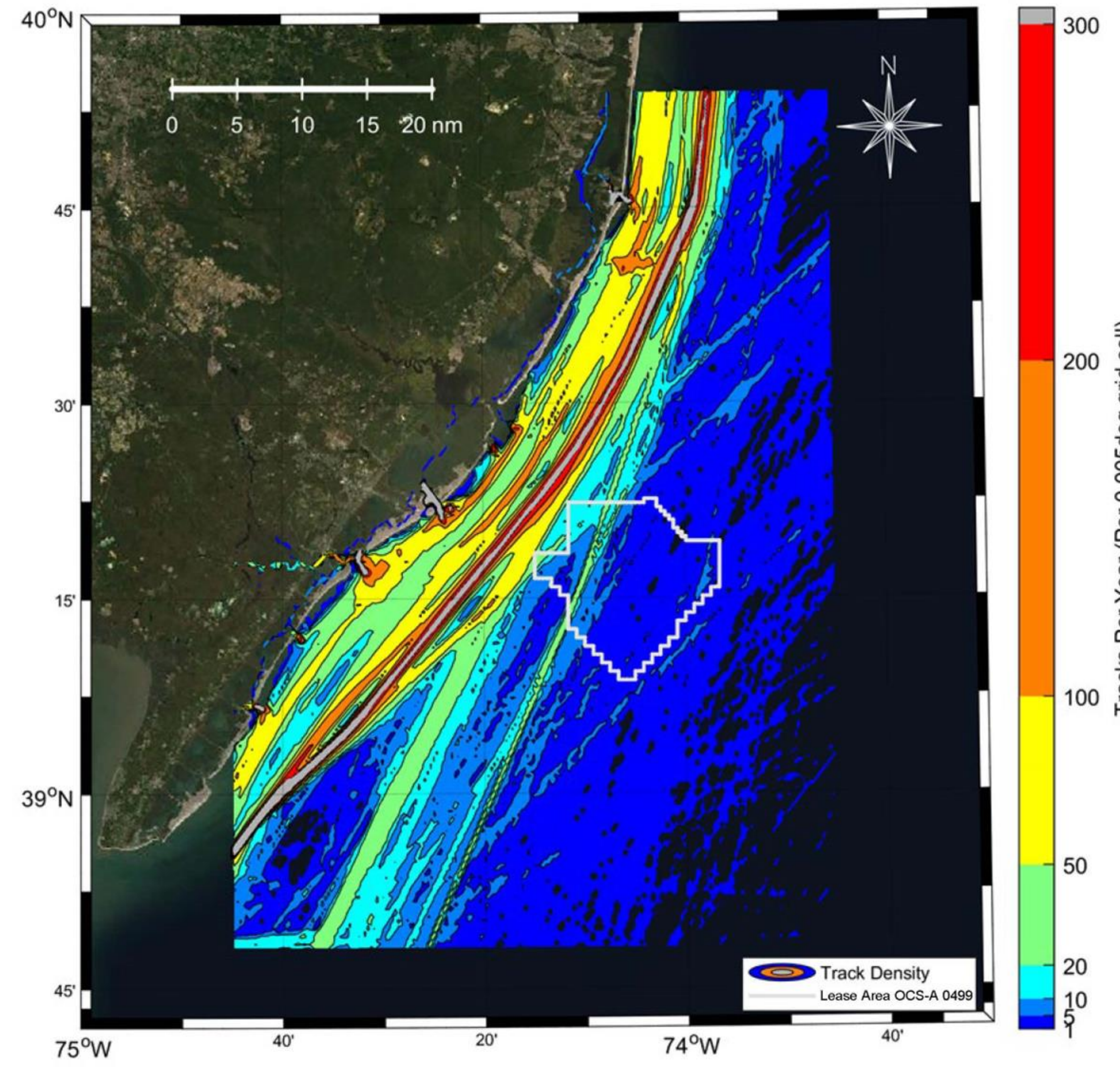
Figure 7.6-3

AIS Vessel Traffic Density for All Vessels in the AIS Coverage Area



ATLANTIC SHORES offshore wind

Figure 7.6-4
AIS Vessel Traffic Density for Cargo Vessels in the AIS Coverage Area



ATLANTIC SHORES offshore wind

Figure 7.6-5
AIS Vessel Traffic Density for Tug Tows

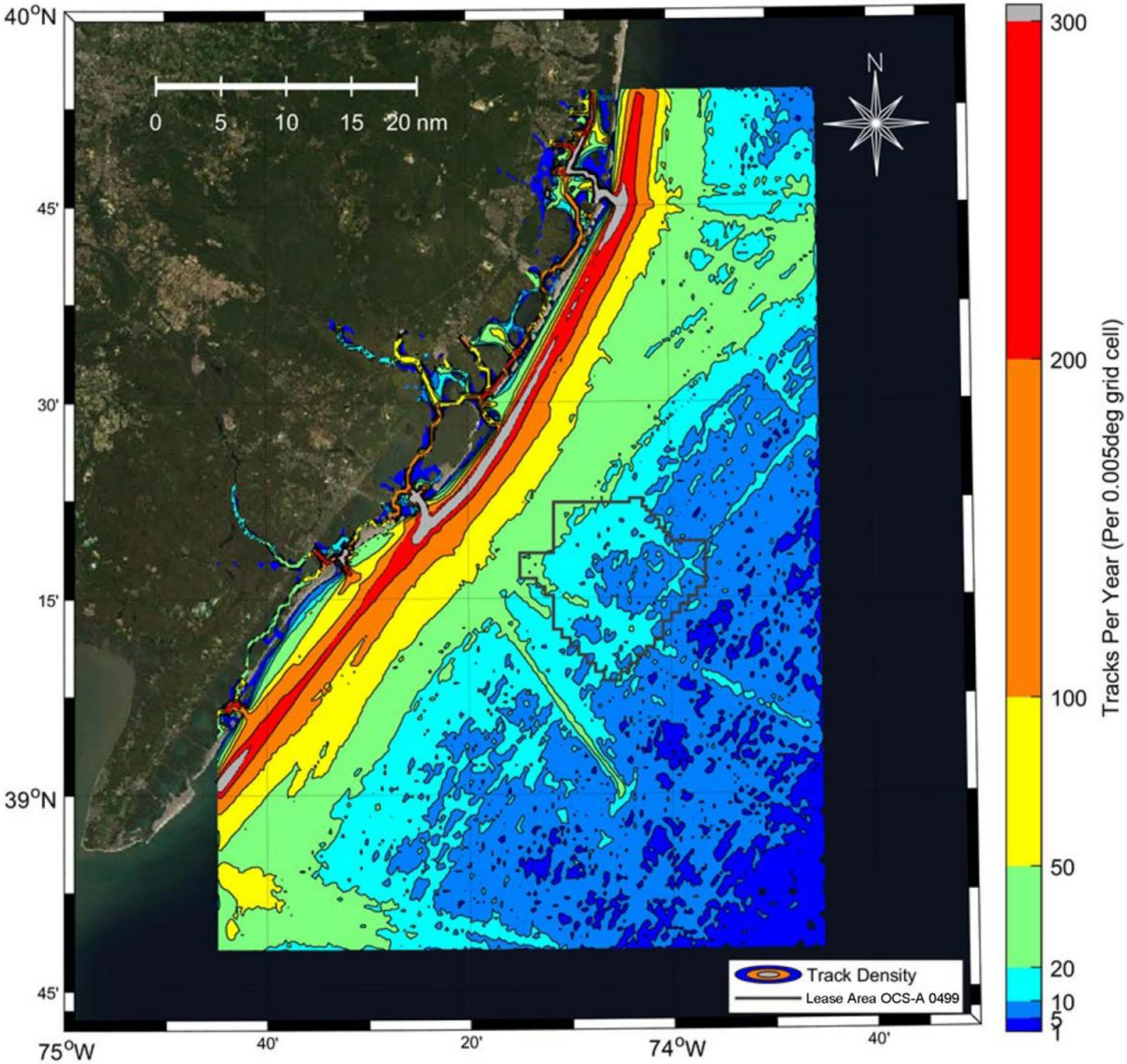


Figure 7.6-6
AIS Vessel Traffic Density for Recreational Vessels

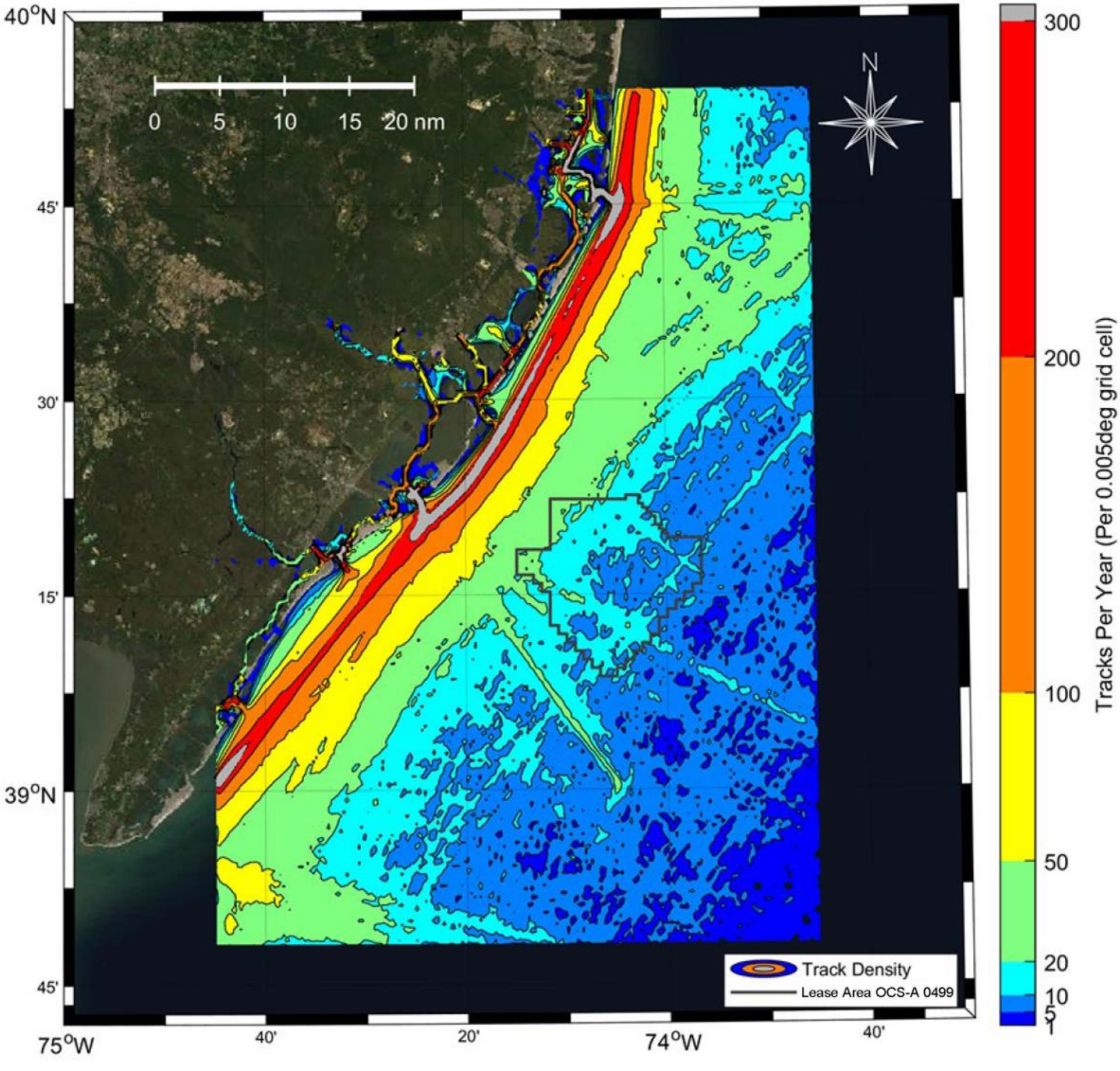


Figure 7.6-6
AIS Vessel Traffic Density for Recreational Vessels

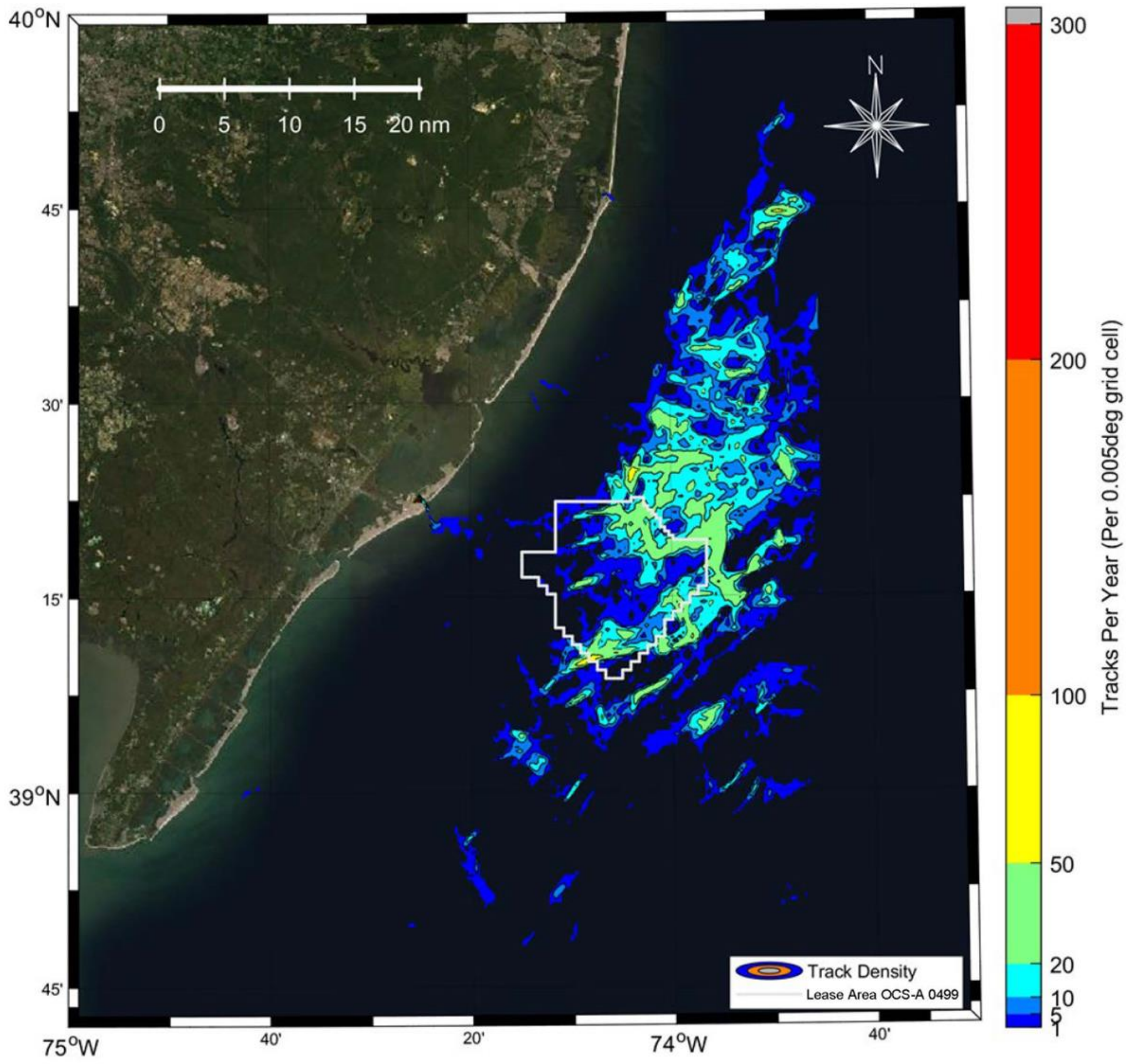


Figure 7.6-8

AIS Vessel Traffic Density for Fishing Vessels (Less Than 4 Knots) in the AIS Coverage Area

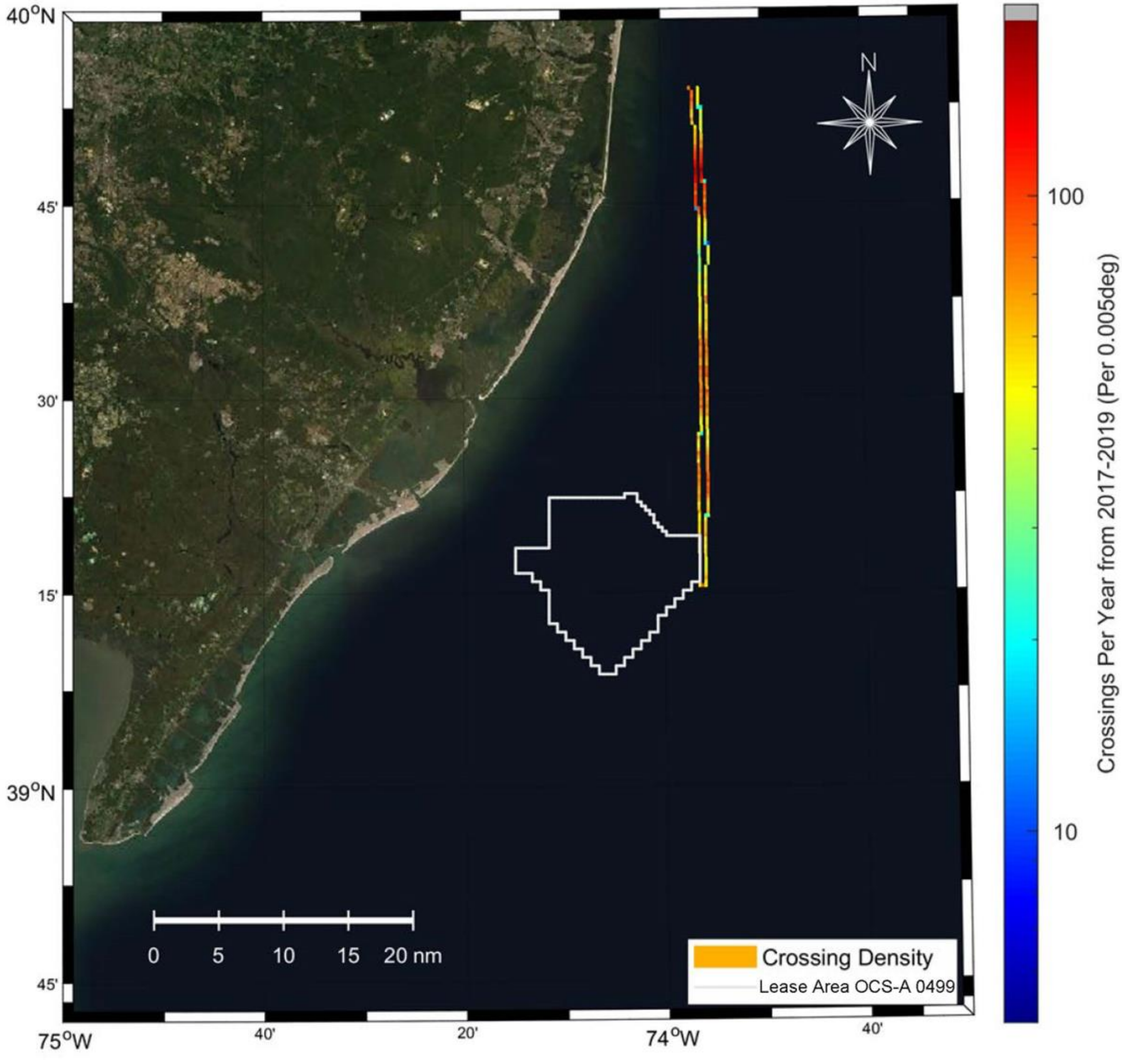


Figure 7.6-9

Track Density for Vessels Crossing the Monmouth ECC

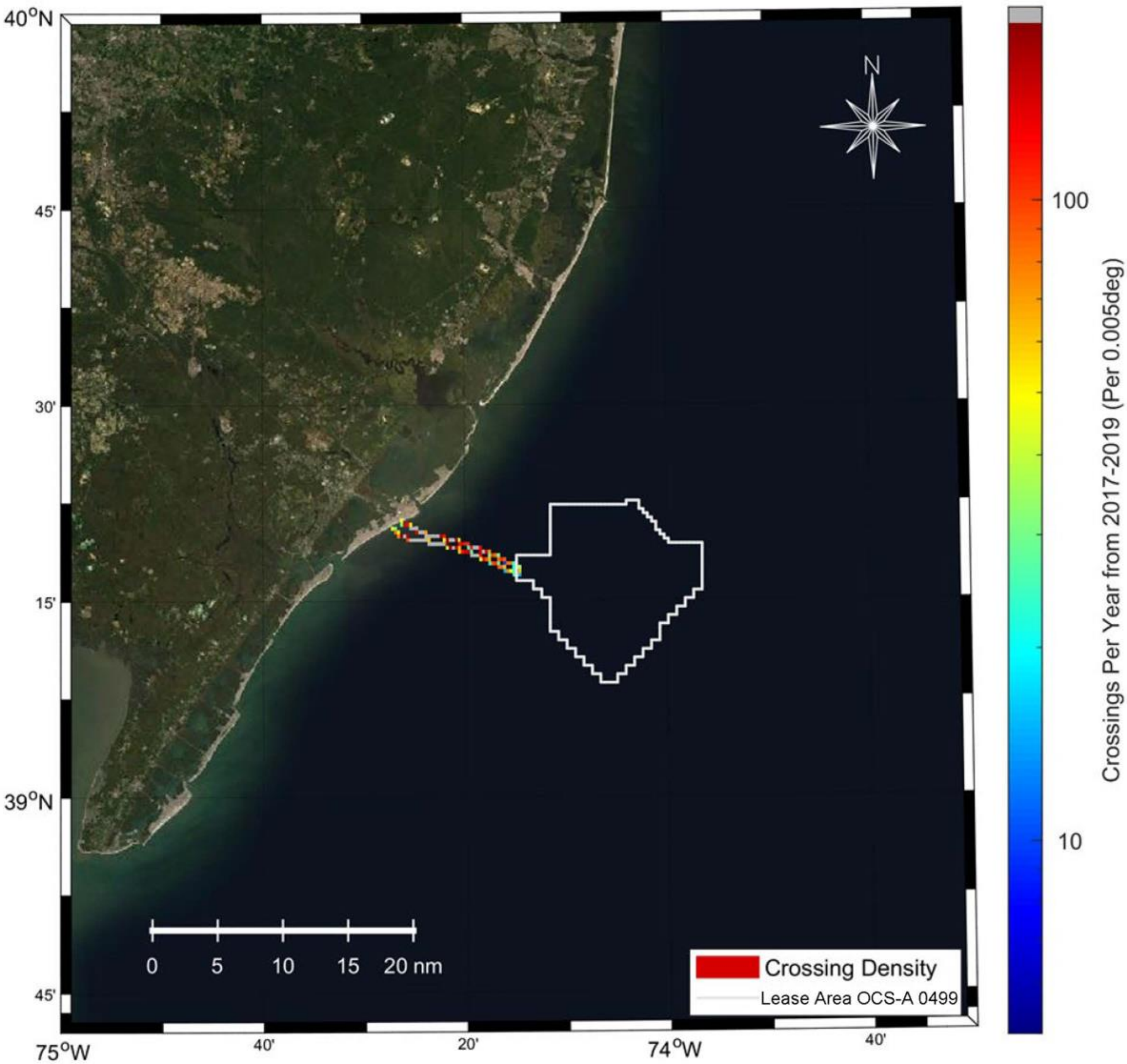


Figure 7.6-10
Track Density for Vessels Crossing the Atlantic ECC

As part of the ACPARS study, a set of planning guidelines were developed to assist in the development of future recommendations with respect to the navigation of vessels near OREIs. The ACPARS is further described in Section 3.2.2 of Appendix II-S. Additionally, the USCG is presently undertaking a Port Access Route Study (PARS) for the New Jersey coastal area, and this may influence the location of future commercial traffic waterways. The PARS will consider planned and potential offshore development (expected to include the Atlantic Shores WTAs and ECCs), existing and future port capabilities, future traffic increases, existing and potential anchorage areas, changing vessel traffic patterns, weather conditions, and general navigational difficulty. The geographic scope of this study is the New Jersey coastline and approaches to Delaware Bay. The study will determine whether existing or additional vessel routing measures are necessary to improve navigational safety in the area.

In September 2021, the USCG released a draft report, "*Port Access Route Study for the Seacoast of New Jersey Including Offshore Approaches to the Delaware Bay, Delaware*." The study included extensive outreach to other government agencies and stakeholders, review of 10 years of search and rescue and marine data, analyses of AIS and VMS data, navigational risk modelling, and consideration of present vessel routing measures as well as shipping safety fairways. The PARS underwent public review and comment in September and October 2021, and Atlantic Shores will continue active coordination with USGS through issuance of the final report which is anticipated in the first or second quarter of 2022.

7.6.2 Potential Impacts and Proposed Environmental Protection Measures

The potential IPFs which may affect navigation and vessel traffic during Project construction, O&M, or decommissioning are presented in Table 7.6-2.

Table 7.6-2 Impact Producing Factors for Navigation and Vessel Traffic

IMPACT PRODUCING FACTORS	CONSTRUCTION & INSTALLATION	OPERATIONS & MAINTENANCE	DECOMMISSIONING
Vessel and Aircraft Traffic	●	●	●
Installation and Maintenance of New Structures and Cables	●	●	●
Presence of Structures	●	●	●
Collisions and Allisions	●	●	●

The maximum Project Design Envelope (PDE) analyzed for potential effects to navigation and vessel traffic is the maximum offshore build-out of the Projects (see Section 4.11 of Volume I).

7.6.2.1 Vessel and Aircraft Traffic

Project construction, O&M, and decommissioning will require use of vessels and aircraft that will affect navigation in the Offshore Project Area including transiting vessels and vessels that are actively fishing. During construction, a variety of vessels will be needed to support the installation of major Project components including foundations, offshore substations (OSSs), wind turbine generators (WTGs), scour protection, and offshore cables. Vessels to support fuel bunkering may also be used. Representative vessel types that may be used for each of these activities are provided in Table 4.10-1 of Volume I and include jack-up vessels, heavy lift vessels, tugs, barges, cable laying vessels, dredgers, feeder vessels, fall pipe vessels, crew transfer vessels (CTVs), service operations vessels (SOVs), and others. Helicopters may also be used for crew transfer or visual inspection of equipment.

The actual level of vessel activity within the WTA and ECCs during construction will depend on the final design of the offshore facilities and on selection of specific vessel types and logistics approaches. Currently, maximum estimates for the total number of vessels required for any single offshore construction activity range from two vessels for scour protection installation to up to 16 vessels for offshore substation installation. For the export cable installation, it is currently estimated that up to six vessels could be operating at once. In the unlikely event that all Project 1 and Project 2 construction activities were to occur simultaneously, a total of 51 vessels could be present at any one time. These estimated counts do not reflect vessel movement, as some constructions vessels will work stationary for longer periods of time. The Projects will collectively require a total of approximately four to 12 daily transits (equivalent to two to six daily round trips) between construction staging port facilities under consideration and the offshore construction areas.

Because many of the construction activities are sequential both within and across the Projects, not all vessels involved in a given activity will operate simultaneously. Additionally, many of the construction vessels will remain in the WTA or ECCs for days or weeks at a time and will not transit to construction staging port facilities on a frequent basis. Atlantic Shores estimates that, over the course of construction of both Projects, there will be between four and twelve daily transits (equivalent to two to six daily round trips) between construction staging port facilities under consideration and the offshore construction areas.

Vessel use during O&M will be based around either a CTV or SOV logistical approach. As described further in Section 5.6 of Volume I, CTVs enable faster, more practical transport of personnel and equipment to offshore Project infrastructure, while SOVs are large vessels that offer considerable capacity for crew and spare parts, allowing for service trips that are several weeks in duration. Representative images of CTVs and SOVs are shown on Figure 5.6-1 in Volume I. In addition, SOVs commonly use smaller daughter craft and can have helipads to support use of helicopters to shuttle personnel and equipment to, from and within the WTA.

In addition to the use of CTVs and SOVs, survey vessels will likely be used for routine inspections. Surveying, monitoring, and inspection may also be conducted by unmanned aerial vehicles

(UAVs), remotely operated vehicles (ROVs), and underwater drones. Larger support vessels (e.g., jack-up vessels) may be used infrequently to perform routine maintenance activities, periodic corrective maintenance, and significant repairs (if needed). Cable laying vessels may also be used to support cable repairs if needed.

An estimated five to 11 vessels are expected to operate in the Offshore Project Area at any given time during normal O&M activities in support of both Projects, though additional vessels (a maximum of up to 22 vessels) may be required in other maintenance or repair scenarios. The total annual estimated round trips for the Projects range from 550 to 2,050 depending on if SOVs or CTVs are primarily used, respectively. The average number of vessel round trips per day in support of both Projects is estimated at two for SOV use or six for CTV use (equivalent to four to twelve transits; each round trip consists of two transits). These vessel trips may be supplemented by helicopters to assist in personnel transport. The actual level of vessel activity during O&M activities will depend on the specific maintenance needs that develop as well as the final design of the offshore facilities.

Vessel operations and frequency may increase near the port facilities during construction, O&M, and decommissioning. Vessel and port utilization will be highest during construction and decommissioning. Also, use of larger vessels will be more prevalent during the installation phase. The potential ports and surrounding waterways are expected to have the capacity for the potential vessel traffic during all Project-related activities. Further, Atlantic Shores has defined a wide range of port options, which will allow use of the most appropriate port facilities for a given activity, including consideration of the capacity of a port to accommodate the planned vessel traffic.

Atlantic Shores is proposing to establish a new O&M facility in Atlantic City and will likely establish a long-term CTV base at the O&M facility. Atlantic Shores intends to purchase and develop a shoreside parcel in Atlantic City that was formerly used for vessel docking or other port activities similar to the planned CTV use. If Atlantic Shores employs an SOV-based O&M strategy, those SOVs would likely be operated out of existing ports such as Lower Alloways Creek Township, the Port of New Jersey/New York, or another industrial port identified in Table 4.10-2 in Volume I that has suitable water depths to support an SOV.

To ensure minimum effect on existing maritime activities, Atlantic Shores will establish a Marine Coordinator who will be charged with monitoring daily vessel movements, implementing communication protocols with external vessels both in port and offshore to avoid conflicts, and monitoring safety zones. Communications with external vessels will begin prior to construction and will continue throughout the construction process. Daily coordination meetings between contractors are expected to be held to avoid conflicting operations at port facilities and transit routes to the Offshore Project Area. To provide construction zone control, the Marine Coordinator will employ radio communications and safety vessels to address any vessels entering the construction zone.

The Marine Coordinator will be responsible for coordinating with the USCG for any required Notices to Mariners (NTMs), and, during construction, will be the primary point of contact with the USCG, port authorities, State and local law enforcement, marine patrol, port operators, and commercial and for-hire fishing vessel operators. As described below, Atlantic Shores will inform mariners of construction activities, including the anticipated locations of those activities by the Marine Coordinator, allowing vessels to alter their navigation routes if needed to avoid affected areas. Measures to minimize effects to mariners include the following:

- Atlantic Shores will regularly distribute updated asset and operational awareness bulletins showing the development area, depicted on local nautical charts, with a description of the assets in the area, the activities taking place, timelines, and relevant contact information.
- Atlantic Shores will also publish announcements and share updates with print and online industry publications and local news outlets.
- All construction and installation vessels and equipment will display the required navigation lighting and day shapes[66] and make use of AIS as required by the USCG.
- Atlantic Shores has developed a "For Mariners" project webpage (www.atlanticshoreswind.com/mariners/) containing the latest news and events, real-time Project buoy data display and Project vessel tracking chart, Project vessel schedules, and Fisheries Liaison Officer (FLO) and Fisheries Industry Representative (FIR) contact information.
- Atlantic Shores also expects to establish specific methods for communicating with fishermen while they are at sea including establishing a 24-hour phone line to address any real-time operational conflicts and/or safety issues.
- Atlantic Shores will also engage with fishing tournament organizers to make them aware of planned Project vessel activity.

Additional mitigation measures are described in the NSRA (see Appendix II-S).

7.6.2.2 Installation and Maintenance of New Structures and Cables

Project-related vessels will need to position within defined work areas during installation and maintenance of new offshore structures (primarily the WTGs and OSSs) and offshore cables (export, inter-link, and inter-array). Temporary safety buffer zones will be established around work sites, which may result in minor disruptions to navigation.

During construction, temporary disruptions to navigation may occur in the WTA due to installation activities, with vessel usage mostly concentrated around specific WTG and OSS locations during installation of foundations, OSS topsides, WTGs, and scour protection. Similarly, minor disruptions to navigation will occur along ECCs due to the temporary presence of cable laying vessels. All

[66] Day shapes are mast head signals visually indicating the status of a vessel to other vessels on navigable waters during daylight hours whether making-way, anchored, or aground.

construction areas will have temporary safety buffer zones where other traffic will be temporarily precluded. Atlantic Shores anticipates that only a limited area surrounding the installation activity will be affected at any given time, leaving surrounding areas available for navigation. Similar effects and activities will take place during decommissioning.

During O&M, many maintenance activities will be based from the WTGs or OSSs and will not require in-water work other than vessels transporting technicians. More significant and less frequent maintenance procedures may require in-water work and vessels to support those procedures; however, Atlantic Shores expects that vessel use during the O&M phase will be reduced relative to vessel use during construction or decommissioning. When WTG, OSS, or cable maintenance or repair is needed, temporary safety zones will be established around maintenance vessels and activities. Minor changes to vessel traffic patterns and transit times may occur within the WTA or in the vicinity of the ECC as vessels route around the O&M vessel and its associated safety buffer zone temporarily during maintenance repair work. Survey vessels will also be used during the O&M phase for annual inspections, but any potential disruption to navigation from survey vessel use will be limited.

Atlantic Shores does not anticipate any restrictions surrounding the export cable corridors related to marine navigation or anchoring. Atlantic Shores will work with NOAA to ensure the cables are included on navigational charts for mariner awareness. Atlantic Shores notes that the cables are not buried to sufficient depths to allow for dredging above the cables, except for existing marked channels that are actively dredged where cables are buried sufficiently deep to avoid any interference to planned dredge depths. Through Atlantic Shores' efforts to issue timely updates on Project activities through its Marine Coordinator as described in Section 7.6.2.1, Atlantic Shores expects that vessels transiting the Offshore Project Area will be able to avoid any Project vessels and associated safety zones by adjusting departure and arrival times, courses, and/or planned routes.

7.6.2.3 Presence of Structures

The presence of structures (including WTGs, OSSs, offshore cables, cable protection, and scour protection) may affect vessel traffic, search and rescue (SAR) activities, marine radar and communications, and other activities.

Effects on General Navigation

During O&M, the WTA and ECCs will be open to marine traffic, other than any temporary safety zones required during limited maintenance activities. As described in Section 7.6.1.2, the WTA is not generally subject to dense traffic, which limits the scale of potential navigational effects.

The WTGs will be aligned in a uniform grid pattern with multiple lines of orientation allowing straight transit through the WTA for vessel traffic. The WTG layout provides uniform rows in an east-northeast to west-southwest direction spaced 1.0 nm (1.9 km) apart and rows in an approximately north to south direction spaced 0.6 nm (1.1 km) apart. Additionally, the WTG grid will create diagonal corridors oriented approximately northwest-southwest that are 0.54 nm (1.0 km) wide and diagonal corridors oriented approximately north-northeast that are 0.49 nm (0.9 km) wide (Figure 7.6-11). The OSSs will also be located along the same east-northeast to west-southwest rows as the WTGs, thereby preserving 1.0 nm-wide (1.9 km-wide) corridors between structures. Potential OSS locations are shown on Figure 7.6-12.

The proposed WTG and OSS layout has been designed to facilitate the transit of vessels through the WTA based on a review of existing traffic patterns. The 1.0 nm (1.85 km) east-northeast corridors will accommodate all the existing AIS-equipped fishing fleet and 99.6% of the AIS-equipped recreational vessels. A 0.60 nm (1.1 km) corridor will accommodate 99.9% of the fishing fleet and 92.4% of the recreational vessels. A 0.54 nm (1.0 km) diagonal corridor will accommodate 99% and 89% of the fishing and recreational vessels, respectively.

Atlantic Shores anticipates that larger commercial vessels (e.g., cargo, tanker, passenger, and tug-barge vessel[s]), which have dominant north-south headings, will route around the WTA and not through it. While rerouting around the WTA may add to transit time for these vessels, the increase in duration is typically 15 to 20 minutes or less.

Atlantic Shores has developed the layout of the Projects in consideration of commercial fishing patterns and in close coordination with the surf clam/quahog dredging fleet, which is the predominant commercial fishery within the WTA (Section 7.4 Commercial Fisheries and For-Hire Recreational Fishing). An independent study was conducted by Last Tow LLC on behalf of representatives of the New Jersey surf clam industry to provide Oceanside Marine (a clam fishing fleet based in Atlantic City) and LaMonica Fine Foods (a seafood processor in Millville, New Jersey) with a better understanding of fishing trips' characteristics within Atlantic Shores' Lease Area (Azevea 2020). Based on 2008–2019 Vessel Monitoring System (VMS) data for several surf clam/quahog fishing vessels that operate in the Lease Area, the study found that a significant majority of fishing vessel traffic (fishing and transiting) had headings between east-west and east-northeast to west-southwest. This finding was supported by the analysis of three years (2017–2019) of AIS data included in the Projects' NSRA (see Table C.11 in Appendix II-S), which showed that 46% of fishing vessels transit the Lease Area along tracks that range in orientation between east to west and northeast to southwest. The remaining fishing traffic (approximately 34%) and a significant proportion of the recreational vessel traffic transit north-south; this traffic will be accommodated by the nearly north-south corridors.[67]

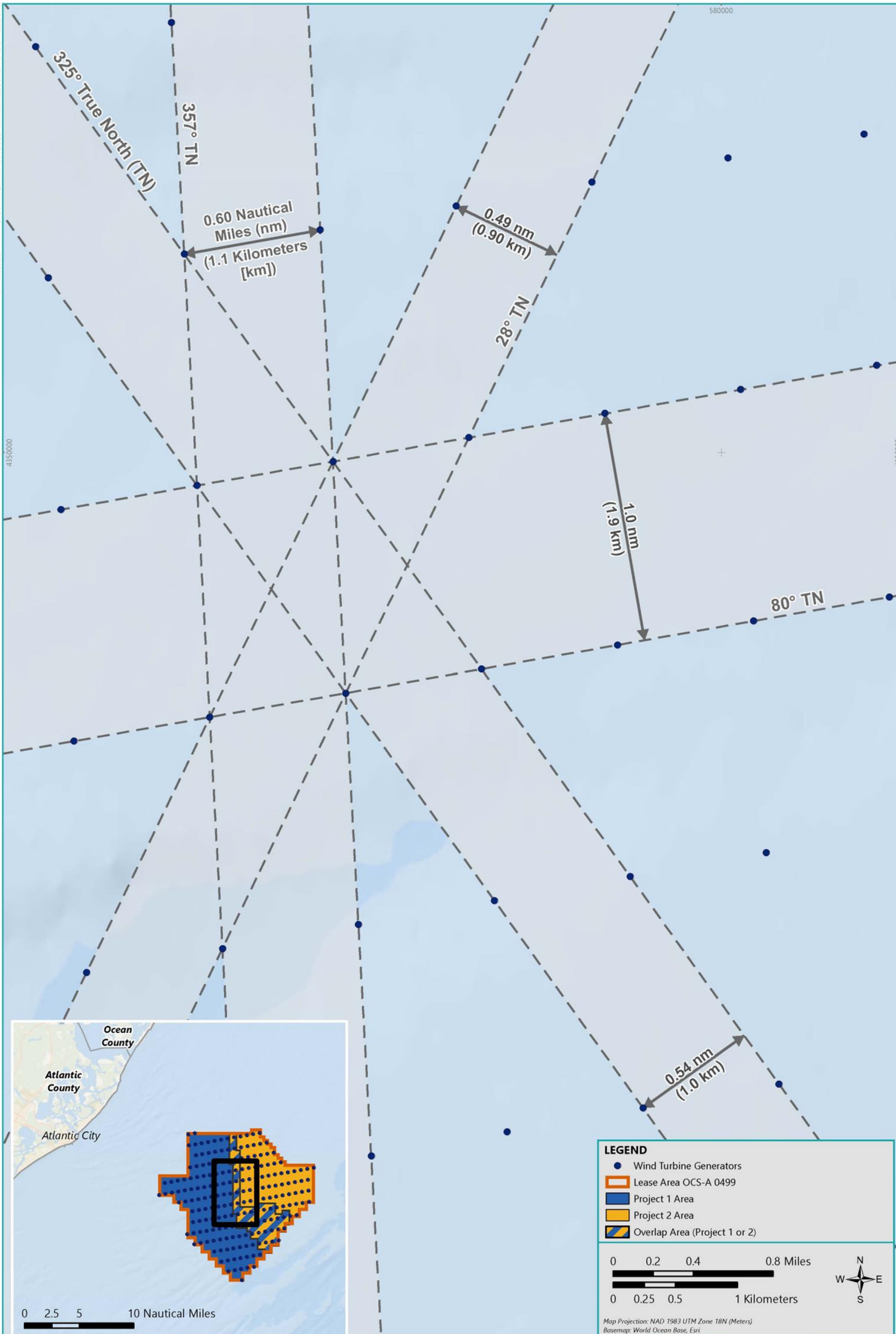
While the layout is designed to facilitate existing vessel traffic patterns, Atlantic Shores recognizes that the presence of the WTGs and OSSs may affect commercial and recreational fishing. Potential effects are described in Section 7.3, Recreation and Tourism, and Section 7.4, Commercial Fisheries and For-Hire Recreational Fishing.

Sailboat excursions will need to consider the presence of Project components in the WTA. Large sailing craft transiting in this region may have mast heights that exceed the maximum allowable

[67] The north to south rows are oriented at 357 degrees true north.

air draft and may elect to travel around the WTG field rather than through it. The minimum rotor tip clearance is 72.2 ft (22.0 m) relative to Highest Astronomical Tide (HAT) or 78 ft (23.8 m) relative to Mean Lower Low Water (MLLW). This air draft assumes calm conditions and presence of waves will reduce the draft further. Atlantic Shores will provide information on the air draft restrictions in the WTA to the USCG and NOAA, so that these restrictions can be identified by means of NTMs and on navigational charts. Note that sailing vessels are at little risk of interacting with the WTGs under normal conditions.

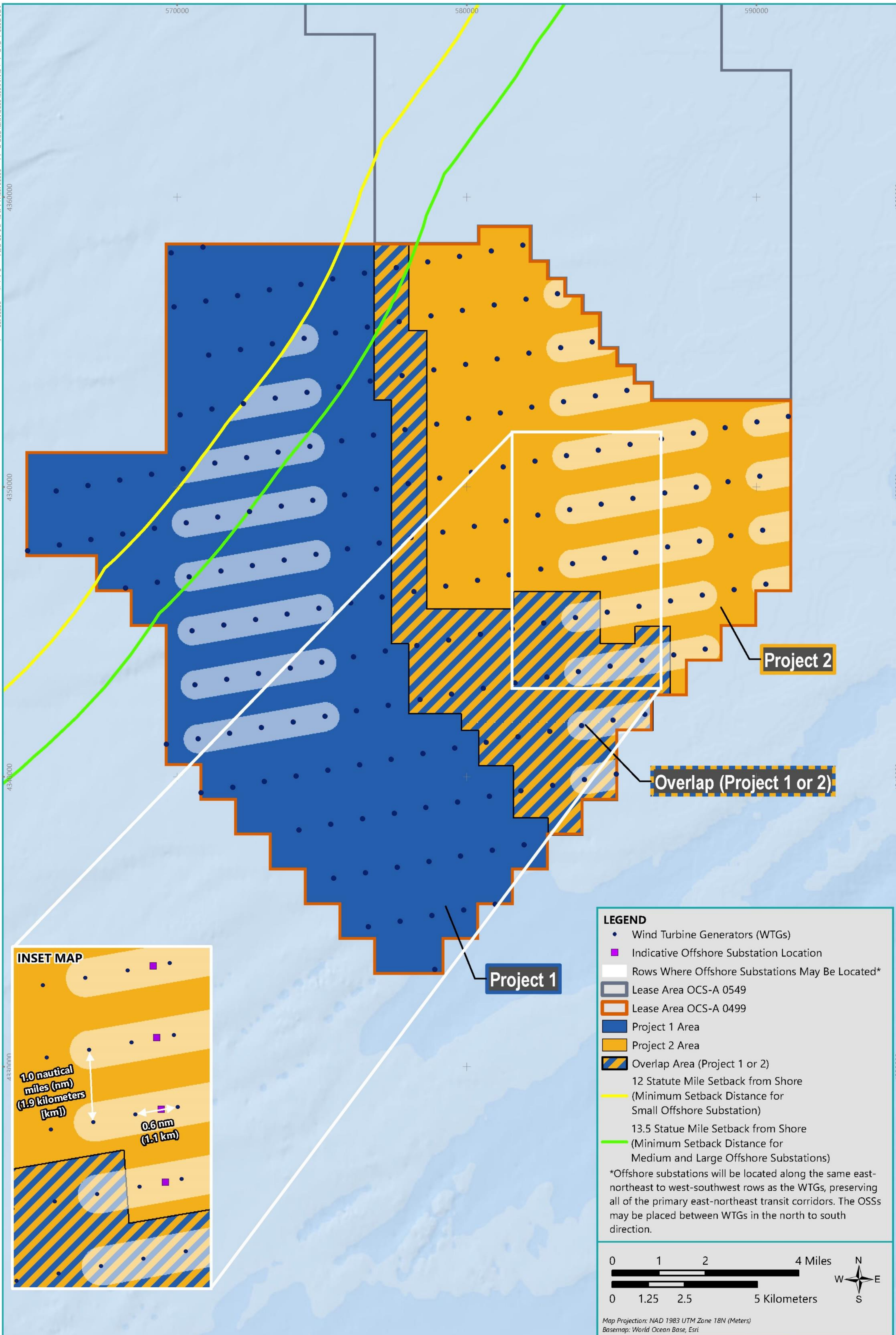
In addition to selecting a layout to facilitate vessel transit through the WTA, Atlantic Shores will further minimize and mitigate effects by marking and lighting all structures in accordance with BOEM and USCG guidelines. To aid mariners navigating within and near the WTA, each WTG position will be maintained with a PATON. Atlantic Shores will work with the USCG and BOEM to determine the appropriate marine lighting and marking schemes for the proposed offshore facilities. Based on USCG District 5 Local Notice to Mariners (LNM) 45/20, that each permanent structure (including WTGs, OSSs, and the met tower) will include unique alphanumeric identification and lights that are visible in all directions. Sound signals will be installed on select foundations in accordance with the Marking and Lighting Plan that will be developed in consultation with the USCG. Atlantic Shores will have the capability to mark each permanent structure including WTG, OSS, and meteorological position (virtually or using physical transponders) with AIS; however, the number, location, and type of AIS transponders will be determined in consultation with USCG. Additionally, Atlantic Shores is engaged in conversations with the fishing industry and other offshore wind developers to provide consistency in lighting and marking across projects and is also working with NOAA Coast Survey on hydrographic charting tools to label foundations. Hydrographic charts are becoming all virtual, and replace paper charts, providing near real-time information for mariners.



ATLANTIC SHORES offshore wind

Figure 7.6-11

WTA Layout



ATLANTIC SHORES offshore wind

Figure 7.6-12
Offshore Substation Locations

Effects on Search and Rescue

Using vessel and helicopter assets, the USCG conducts SAR missions for incidents including vessels capsizing, disabled vessels, vessels taking on water, and persons in water. A review of 14 years (2004 to 2018) of historical USCG SAR data for the coastline of New Jersey documented that there were six SAR missions within the WTA during this 14-year period. This is an average frequency of 0.5 missions per year. Commercial salvors also conduct operations to assist disabled vessels in the area.

The WTG layout and air draft clearance of the WTG rotors is not expected to affect the operation of USCG marine assets (or commercial salvors' vessels) that are in use in the area. It is expected that these marine assets will be able to safely navigate and maneuver adequately within the WTA. Atlantic Shores anticipates that the Projects will not affect travel times to and within the WTA by vessels responding to SAR distress calls.

The Projects are not expected to preclude helicopter use in the WTA. The USCG (2020) Massachusetts and Rhode Island Port Access Route Study (MARIPARS) undertook a detailed assessment of the effect of WTG spacing on aerial SAR and identified that a 1 nm (1.9 km) corridor spacing was sufficient for safe use. To address aerial SAR, a Risk Assessment Workshop was held in July 2021 to methodically review the potential impacts of the proposed offshore wind projects within the Lease Area on USCG SAR operations and to identify safeguards and additional recommended measures to mitigate identified concerns. The workshop was held over a two-day period with participation by the USCG, BOEM, Atlantic Shores, and the New Jersey Department of Environmental Protection. The workshop team evaluated 13 hazardous scenarios in four hazard categories and identified 16 recommendations to support the reduction of overall risk to USCG aerial SAR missions (See Appendix II-T4). Atlantic Shores will review these recommendations in coordination with the USCG and key stakeholders and may elect to implement recommendations that could meaningfully reduce risk to manageable levels and meet other Project criteria. As part of this work, various possible mitigations to aid in detection of disabled vessels or persons in water are being considered, as summarized below. The Projects include significant measures to avoid, minimize, or mitigate effects to SAR, all of which were evaluated in the Risk Assessment Workshop:

- a Marine Coordinator to liaise with the USCG as required during SAR activity within WTA, particularly with emergency braking of selected WTG rotors
- clear alphanumeric marking of WTGs and OSSs to assist in communication of location(s)
- provision of access ladders on Project structures for distressed mariners to access an open refuge area above the splash zone. The presence of a person on the offshore structure will be detected, for example, by cameras or intrusion detectors
- possible mitigations to assist in search detection, including installation of very high frequency (VHF) direction finding equipment, real-time weather measurements (waves,

wind, currents), and high-resolution infrared detection systems to assist in location of persons in water and/or vessels

- development of an Emergency Response Plan (ERP) to specify coordination, shutdown, and rescue procedures. The ERP will be reviewed and updated at least annually between Atlantic Shores and the USCG.

Effects on Marine Radar and Communications

Studies have been conducted to evaluate concerns that the WTGs may affect some shipborne radar systems, potentially creating false targets on the radar display or causing vessels navigating within the WTA to become "hidden" on radar systems due to shadowing created by the WTGs. The effectiveness of radar systems and any effects from WTGs will vary from vessel to vessel based on several factors, including radar equipment type, settings, and installation (including location of placement on the vessel). As has been identified in previous studies of this issue in Europe (BWEA 2007), the potential effects of WTGs may be reduced through adjustment of the radar gain control.

Recently, the USCG's (2020) MARIPARS reviewed several studies on the relationship between offshore renewable energy installations and radar interference. After reviewing these studies, the USCG concluded that, "To date, the USCG is not aware of an authoritative scientific study that confirms or refutes the concern that WTGs will degrade marine radar." According to the MARIPARS, United Kingdom studies show that, "additional mitigation measures, such as properly trained radar operators, properly installed and adjusted equipment, marked wind turbines and the use of AIS, enable safe navigation with minimal loss of radar detection." Accordingly, Atlantic Shores expects that radar operator training and dissemination of information regarding proper installation and adjustment of equipment will avoid or minimize effects to radar systems. Additionally, Atlantic Shores plans to use AIS to mark the presence of WTGs, which will further limit potential effects.

Based on a review of various studies conducted for existing offshore wind fields, the WTGs are expected to have little effect on VHF and digital select calling (DSC) communications or AIS reception.

Other Effects on Marine Transportation

Other potential effects on marine transportation associated with the WTGs, OSSs, offshore cables, and other Project components include anchoring risk, attraction of more fishing activity to the WTA, and potential increased tour vessel traffic. The presence of offshore cables within the WTA and the ECCs is not anticipated to interfere with any typical anchoring practices, as there are no designated anchoring areas in the proximity of the WTA and ECCs. All offshore cables will have a target minimum burial depth of 5 to 6.6 ft (1.5 to 2 m) and a maximum cable burial depth of approximately 10 ft (3 m). The cable burial depth is based upon a cable burial risk assessment that considers vessel types and anchor use to develop a safe, protective target burial depth for the cables (see Appendix II-A5). Atlantic Shores has determined that the target burial depth is sufficient to protect the cables from unexpected anchoring, so anchoring is not expected to interfere with the presence of cables and O&M of the Projects.

The presence of structures in the WTA may become an attraction for fishing. The foundations may create an artificial reef effect which could cause fish aggregation (see Sections 7.3 Recreation and Tourism and 7.4 Commercial Fisheries and For-Hire Recreational Fishing). This in turn could result in an increase in certain types of commercial and recreational fishing in the WTA.

7.6.2.4 Collisions and Allisions

The frequency of collisions and allisions of marine vessels may be influenced by increased vessel traffic associated with the Projects and the presence of new offshore structures (e.g., WTGs, OSS, etc.). Atlantic Shores conducted a quantitative risk assessment for existing conditions and post-construction within the WTA using Baird's proprietary Navigational and Operational Risk Model (NORM). The model utilizes raw AIS, wind, current, and visibility data as inputs along with the geometric layout and Project specific dimensions of the WTGs and OSSs. To account for non-AIS equipped vessels, fishing and recreational traffic volumes were conservatively increased by 100%, based on an analysis of the likelihood of AIS use for these vessel types (see Section 6.2 of the NSRA in Appendix II-S). The model computes the risk of vessel collision and allision with an offshore structure or vessel-by-vessel category. Three different types of possible collision directions are considered: (1) head-on; (2) overtaking; and (3) crossing. Two types of allision are considered: (1) "drifting" allisions in which the vessel loses propulsion and/or steerage (i.e., mechanical failure); and (2) "powered" allisions in which the vessel strikes the turbine under power. The study area included the WTA as well as an approximate 3.8 nm (7 km) perimeter around the Lease Area to best capture only the vessel traffic that may be appreciably affected by the installation.

The NORM model estimated that the risk of accidents before and after construction of the WTGs and OSSs within the WTA may theoretically increase by a small amount in the future. The frequency of accidents changed from 0.089 accidents per year under existing conditions (an 11-year return period) to 0.10 to 0.11 accidents per year post-construction (a 10- to 9-year return period, respectively). This risk of accidents includes both risk to existing traffic and risk to Atlantic Shores' O&M vessels. Considering only the risk to existing vessel traffic (i.e., excluding collisions between O&M vessels themselves or allisions by O&M vessels), the overall post-construction accident frequency drops to 0.095 to 0.105 accidents per year (an 11 to 10-year return period, respectively). This change from existing conditions represents one additional accident every 62 to 167 years, depending on the foundation type, which is outside of the 30-year operational life of the Projects. Although the large commercial vessels (cargo, tug-barge, passenger, etc.) are anticipated to route around the WTA, the number of encounters, and hence risk of collision, with smaller craft (fishing and recreational vessels) is expected to remain about the same. The presence of the WTG/OSS structures does cause a small allision risk, but the routing of the fishing and recreational craft down defined corridors tends to offset this risk.

As noted, much of the increase in risk is associated with the increased volume of traffic due to the transits of O&M CTVs. It has been estimated that the Projects will collectively require a total of approximately four to 12 additional daily transits (equivalent to two to six round trips per day) in the WTA will occur due to these vessels, depending on the type of vessel utilized. For the purposes of the modeling, the upper end of the estimates (12 transits per day) was assumed, which was based on the use of CTVs staged from Atlantic City. However, is important to recognize that the CTVs will be modern, highly specialized vessels manned by professional crew. They will be outfitted with recent technology in terms of marine radar, AIS and chart display. These vessels also will have specified weather thresholds in which transits will not be carried out. These additional safety factors associated with the CTVs have not been considered in the modeling.

Atlantic Shores will minimize the risk of collisions and allisions by following the mitigation measures described in Sections 7.6.2.1 and 7.6.2.2. These include marking and lighting all structures in accordance with BOEM and USCG guidelines, maintaining each WTG position with a PATON, using AIS to mark WTG positions, including unique alphanumeric identification on each foundation, providing lights on each foundation that are visible in all directions, and including sound signals on select foundations. Atlantic Shores will continue to coordinate with BOEM and USCG on measures to maintain safe navigation.

7.6.2.5 Summary of Proposed Environmental Protection Measures

Atlantic Shores is committed to avoiding, minimizing, and mitigating navigational risk and potential navigational use conflicts. This commitment includes the following environmental protection measures:

- A NSRA was conducted to assess navigation safety.
- An aerial SAR risk assessment with associated mitigation measures was prepared in coordination with the USCG, BOEM and other relevant stakeholders (see Appendix II-T4). All construction and installation vessels and equipment will display the required navigation lighting and day shapes[68] and make use of AIS as required by the USCG.
- The proposed WTG and OSS layout has been developed in consideration of commercial fishing patterns and in close coordination with the surf clam/quahog dredging fleet. The layout is designed to facilitate the transit of vessels through the WTA based on a review of existing traffic patterns.
- To facilitate safe navigation, all offshore structures will include marine navigation lighting and marking in accordance with USCG and BOEM guidance. Atlantic Shores will continue to work with the USCG and BOEM to determine the appropriate marine lighting and marking schemes for the proposed offshore facilities.

68 Day shapes are mast head signals visually indicating the status of a vessel to other vessels on navigable waters during daylight hours whether making-way, anchored, or aground.

- Each permanent structure (including WTGs, OSSs, and the met tower) will include unique alphanumeric identification and lights that are visible in all directions. Sound signals will be installed on select foundations in accordance with the Marking and Lighting Plan that will be developed in consultation with the USCG.

- Atlantic Shores will have the capability to mark each WTG, OSS, and met tower position (virtually or using physical transponders) with AIS. The number, location, and type of AIS transponders will be determined in consultation with USCG.

- WTG, OSS, met tower, and met buoy positions will be maintained with PATONs.

- WTG and OSS foundations will be equipped with access ladders to allow distressed mariners access to an open refuge area above the splash zone. The presence of a person on the offshore structure will be detected, for example, by cameras or intrusion detectors.

- The feasibility of installing VHF direction finding equipment, real time weather measurements, and high-resolution infrared detection systems to assist in detection of persons in water or vessels is being evaluated.

- An ERP will be developed to specify coordination, shutdown, and rescue procedures. The ERP will be reviewed and updated at least annually between Atlantic Shores and the BSEE with input from the USCG as appropriate.

- Updated asset and operational awareness bulletins will be regularly distributed showing the development area, depicted on local nautical charts, with a description of the assets in the area, the activities taking place, timelines and relevant contact information. Atlantic Shores will also publish announcements and share updates with print and online industry publications and local news outlets.

- A "For Mariners" project webpage (www.atlanticshoreswind.com/mariners/) has been developed that contains the latest news and events, real-time Project buoy data display and Project vessel tracking chart, Project vessel schedules, and FLO and FIR contact information.

- Specific methods for communicating with offshore fishermen while they are at sea are being established, including a 24-hour phone line to address any real-time operational conflicts and/or safety issues.

- Offshore cables will be buried at a target depth of 5 to 6.6 ft (1.5 to 2 m). The cable burial depth is based upon a cable burial risk assessment that considers vessel types and anchor use to develop a safe, protective target burial depth for the cables (see Appendix II-A5).

- A Marine Coordinator will be employed to monitor daily vessel movements, implement communication protocols with external vessels both in port and offshore to avoid conflicts, and monitor safety zones. Daily coordination meetings between contractors are expected to be held to avoid conflicting operations at port facilities and transit routes to the Offshore Project Area. The Marine Coordinator will be responsible for coordinating with the USCG for any required NTMs.

7.7 Other Marine Uses and Military Activities

This section describes the various marine and military activities within the Offshore Project Area, associated impact producing factors (IPFs), and measures to avoid, minimize, or mitigate potential effects to these resources during construction, operations and maintenance (O&M), and decommissioning. The Offshore Project Area includes the Wind Turbine Area (Project 1, Project 2, and the Overlap Area) and the export cable corridors (ECC).

The State and Federal waters associated with the Offshore Project Area support a variety of marine-based uses. This section specifically addresses military facilities, sand resources, offshore energy, cables and pipelines, and scientific research and surveys occurring within or proximate to the Offshore Project Areas.

Marine uses associated with recreation and tourism, commercial fisheries and for-hire recreational fishing, navigation and vessel traffic, and aviation and radar are addressed separately in Sections 7.3, 7.4, 7.6, and Section 7.8, respectively.

7.7.1 Affected Environment

Existing marine uses and military activities occur in the outer continental shelf (OCS) waters of the WTA to the nearshore and intertidal waters along the export cable corridors (ECCs) to each landfall site. The characterization of other marine uses in the affected environment is based on targeted assessments, State and Federal agency publications, online data portals, and mapping databases.

7.7.2 Military Facilities

Of the United States Armed Forces with installations and operations in the vicinity of the Projects, the U.S. Navy and U.S. Coast Guard (USCG) (Department of Homeland Security [DHS]) have the most significant presence in and around the Offshore Project Area. Figure 7.7-1 shows the location of military facilities within New Jersey and Table 7.7-1 provides a brief description of each military Facility's mission and/or purpose. Atlantic Shores has been conducting outreach to the Department of Defense (DoD), inclusive of the U.S. Army, Navy, Marines, and Air Force, to discuss the Projects since 2019. Atlantic Shores has also been in regular contact with the USCG, especially with respect to navigational safety. See Volume I Appendix I-A which includes a summary of coordination with agencies.

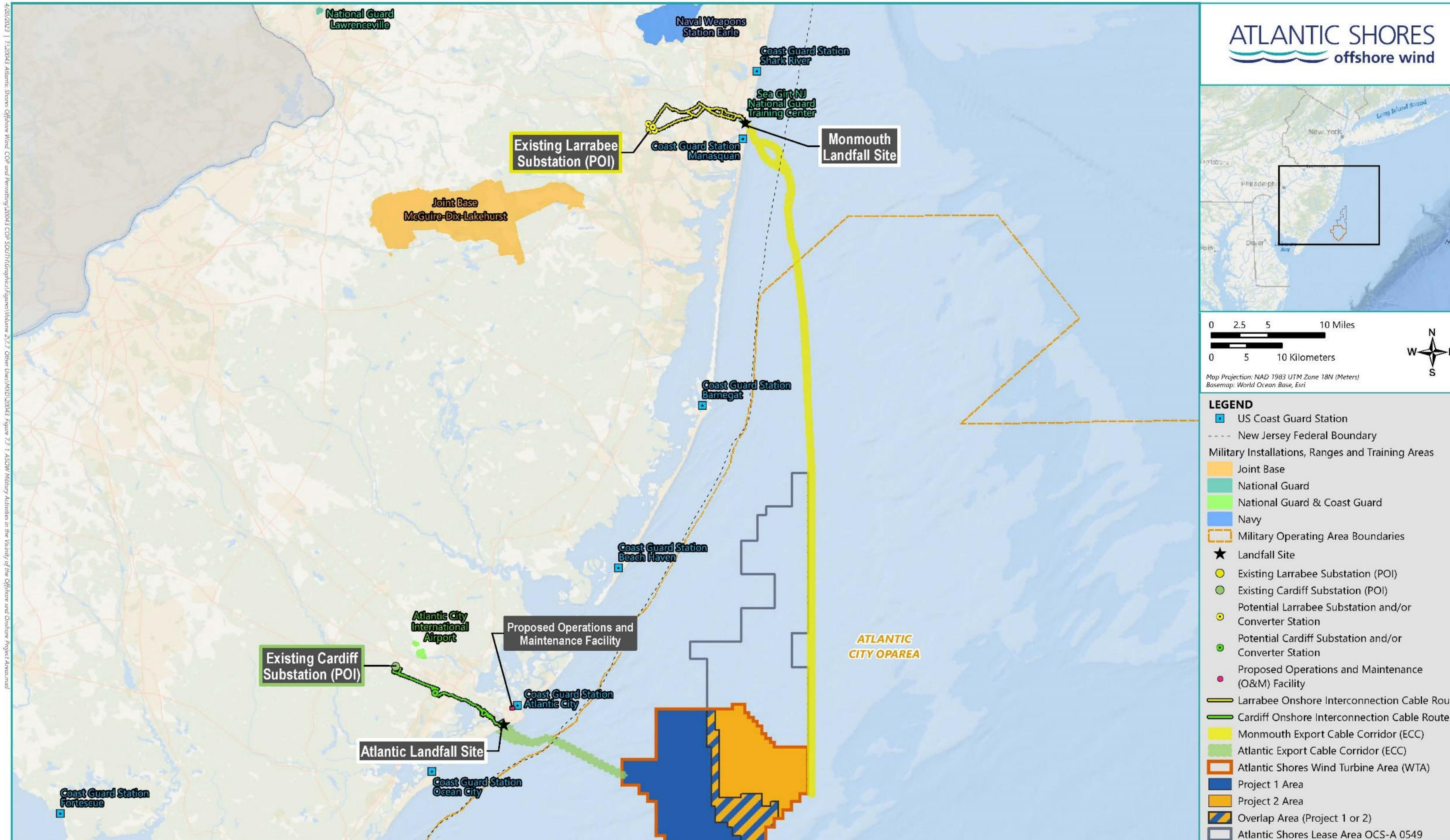


Figure 7.7-1

Military Activities in the Vicinity of the Offshore and Onshore Project Areas

Table 7.7-1 Military Facilities in Proximity to the Projects

U.S. Military Branch	Facility Name/Location	Mission/Purpose
Air Force, Navy, Army	Joint Base McGuire-Dix-Lakehurst, Trenton, Burlington and Ocean Counties, New Jersey	Provide installation support to all mission commanders and provide mission-ready, motivated, expeditionary Airmen to combatant commanders (Joint Base McGuire-Dix-Lakehurst [date unknown]).
Army	Picatinny Arsenal, Wharton, Morris County, New Jersey	Provide products and services to all branches of the U.S. military and participate in research, development, acquisition, and lifecycle management of advanced conventional weapon systems and ammunition (U.S. Army 2019).
Navy	Earle Naval Weapons Station, Earle's Waterfront, New Jersey	Provide ordnance for all Atlantic Fleet Carrier and Expeditionary Strike Groups and support strategic DoD ordnance requirements (U.S. Navy, [date unknown]).
Army National Guard	Army National Guard Training Center, Sea Girt, New Jersey	Provide training for and instruction to New Jersey's citizens soldiers, airmen, and law enforcement professionals (New Jersey Department of Military and Veterans Affairs 2020).
Air National Guard	Atlantic City Air National Guard Base, 177th Wing, Egg Harbor, New Jersey (Atlantic City International Airport)	Participation in air-to-air and air-to-ground operations designed to support ground forces, gain control of enemy airspace, and support Air Support Operations, Tactical Air Control Party (TACP) and Explosive Ordnance Disposal (GOANG, [date unknown]).
Army National Guard	Army National Guard Joint Operations Center, Lawrenceville, New Jersey	Coordinate missions for the New Jersey National Guard and act as a liaison between state leaders and the National Guard (National Guard 2020).
U.S. Coast Guard	Atlantic City Air Station, Egg Harbor, New Jersey (Atlantic City International Airport)	Support a wide range of U.S. Coast Guard operations, such as search and rescue, law enforcement, port security, and marine environmental protection for both District One and District Five of the USCG (USCG [date unknown (b)]).

Table 7.7-1 Military Facilities in Proximity to the Projects (Continued)

U.S. Military Branch	Facility Name/Location	Mission/Purpose
U.S. Coast Guard	Station Manasquan - Station #105 (Point Pleasant Beach) Atlantic City U.S. Coast Guard Station; Barnegat Light Station; Beach Haven Station; Fortescue Station; Ocean City Station 146; USCG Shark River Station 103, (Avon-by-the-Sea) Townsend Inlet Station 130; Sandy Hook Station 97	Ensure the Nation's maritime safety, security, and stewardship (USCG, [date unknown (c)]). Perform search and rescue, enforce laws and treaties, and enforce recreational boating safety (USCG [date unknown(a)]).
U.S. Coast Guard	USCG Training Center, Cape May, New Jersey	Train and provide mission support to tenant commands (USCG [date unknown (d)]).

In addition to the military facilities summarized in Table 7.7-1, there is a designated U.S. Navy at-sea area referred to as an Operating Area (OPAREA) located off the coast of New Jersey. The Atlantic City OPAREA, extends from Seaside Heights to Sea Isle City and encompasses a majority of the Offshore Project Area (see Figure 7.7-2). Comprised of surface sea space, subsurface sea space, and special use airspace (SUA), this approximately 640-acre area is used primarily for training and testing exercises by the Naval Atlantic Fleet and nearby U.S. Air Force base units (NOAA 2019). The Atlantic City SUA, within the OPAREA, is used for surface-to-air gunnery exercises and is, therefore, designated as a Warning Area for nonparticipating pilots (BOEM 2012). Additional information on aviation resources is provided in Section 7.8 Aviation and Radar.

Given the historical military practices conducted along the northern Atlantic Coastline there is potential for the presence of munitions and explosives of concern (MEC) in the Offshore Project Area. The potential presence of MEC is discussed further in Section 2.1 Geology.

7.7.3 Sand Resources

Offshore sand and gravel are important resources managed by Federal and State agencies and used for coastal protection and restoration, beach nourishment, and habitat reconstruction purposes. Within or adjacent to the Offshore Project Area, BOEM, U.S. Army Corps of Engineers (USACE), New Jersey Department of Environmental Protection (NJDEP), and New Jersey Geological and Water Survey (NJGWS) coordinate the management of areas of potential and confirmed sand resources for these coastal management and restoration activities (Figure 7.7-2). Beach nourishment projects are common along the sandy coast of New Jersey with several active and proposed projects documented for the beaches of Atlantic City, adjacent to the Atlantic ECC, and in Sea Girt, adjacent to the Monmouth ECC (NOAA 2020).

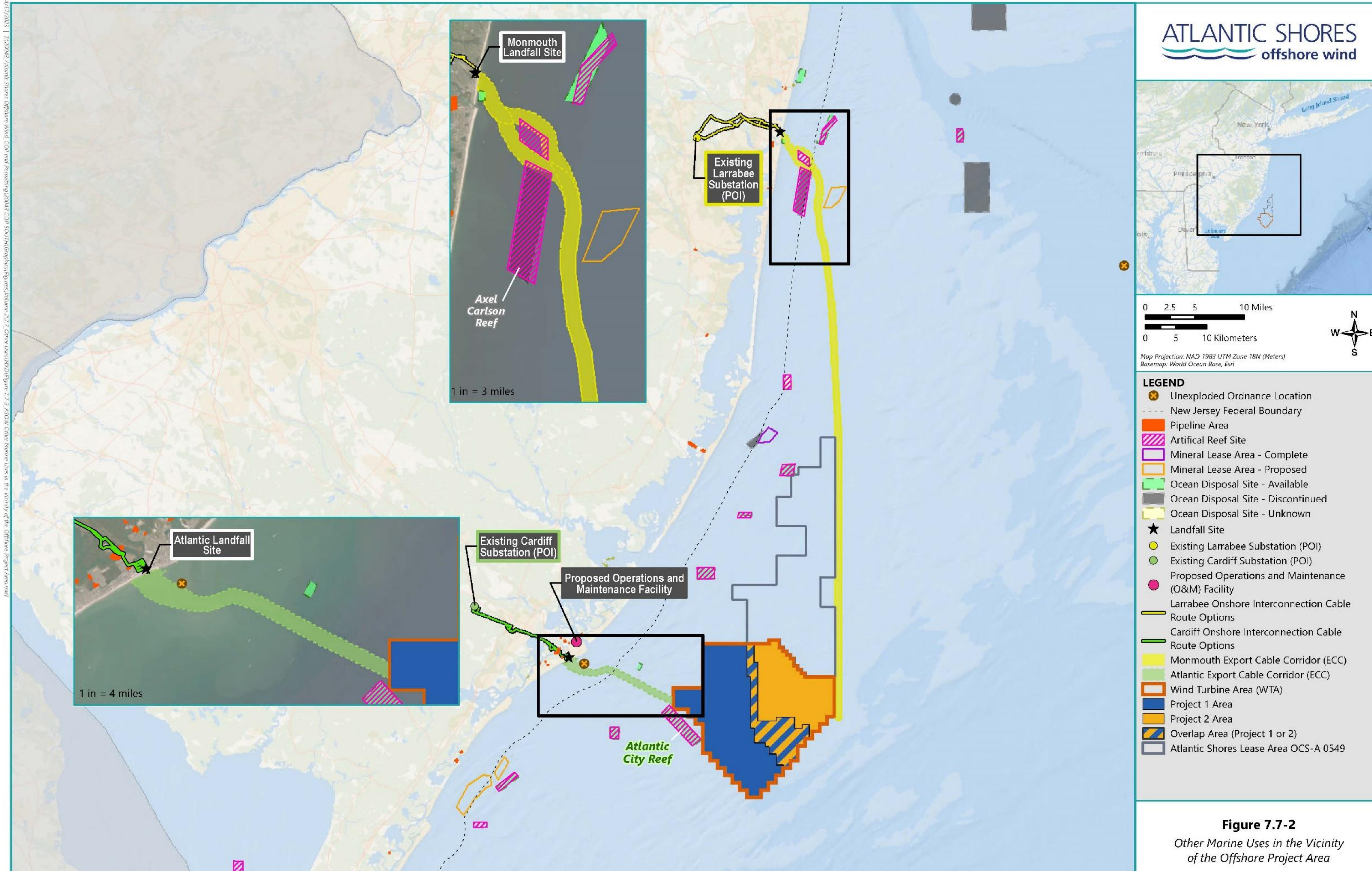


Figure 7.7-2

Other Marine Uses in the Vicinity of the Offshore Project Area

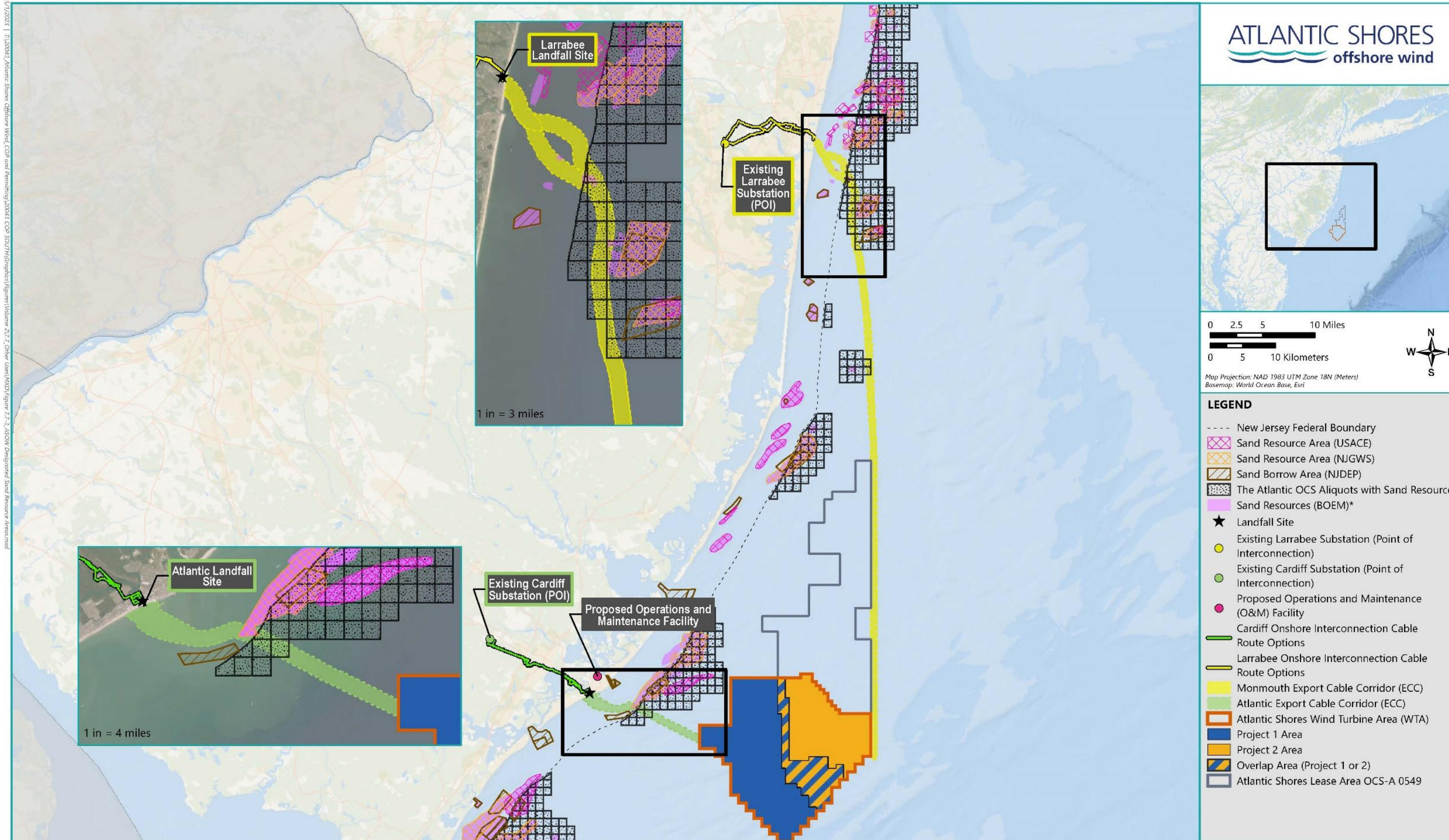


Figure 7.7-3

Designated Sand Resource Areas

5/1/2023 | T:\20043_Atlantic Shores Offshore Wind_COP and Permitting\20043 COP SOUTH\Graphics\Figures\Volume 2\7.7_Other Uses\MXD\Figure 7.7-3_ASOW Designated Sand Resource Areas.mxd

The Projects' ECCs were routed to avoid most Federal and State designated sand resource areas (see Figure 7.7-3). However, there are small segments of the Atlantic and Monmouth ECC routes that cross or are very close to mapped designated BOEM Marine Minerals Program (MMP) sand resource and borrow areas (see BOEM 2020b). Table 7.7-2 provides details on the assumed number of cubic yards of sand that would be committed to both ECCs and the assumed number of cubic yards of sand that would be maintained for use by the MMP[69]. These calculations are based on assumptions of the current design, with an assumed 6-foot depth for the entirety of the ECCs. The calculations are conservative and do not currently take into account that only the area of the cable installation trench would result in disturbance to the seafloor or unavailability and not the entirety of the ECC. Once the Projects are decommissioned, any sand resource or borrow areas that were impacted by the Projects would be reinstated for use.

[69] No USACE sand resource or borrow area will be crossed by the Monmouth or Atlantic ECCs.

Table 7.7-2 Sand Resources within the Monmouth and Atlantic ECC

ECC Location	ECC Total Acres (ac)/ Square Feet (ft²)	ECC Cubic Yards (cy)	MMP Sand Resource Area Total Area (ac/ft²)	MMP Sand Resource Total Volume (cy)	MMP Sand Resource Area within ECC (ac/ft²)	MMP Sand Resource Area within ECC (cy)	Cubic Yards Maintained for Use by MMP	Percentage of MMP Sand Resource Area within ECC
Monmouth ECC Federal Waters	22,549.1 ac (982,234,197.7 ft²)	218,274,266.1 cy	ID: F2 1,723.2 ac (75,063,603.4 ft²) ID: Shoal 236 95.4 ac (4,154,833.1 ft²)	ID: F2 16,680,800.8 cy ID: Shoal 236 923,296.3 cy	ID: F2 41.4 ac (1,801,865.0 ft²) ID: Shoal 236 75.3 ac (3,280,314.6 ft²)	ID: F2 400,414.5 cy ID: Shoal 236 728,958.8 cy	ID: F2 16,280,386.3 cy ID: Shoal 236 194,337.5 cy	ID: F2 0.18 ID: Shoal 236 0.33
Atlantic ECC Federal Waters[1]	2,735.2 ac (119,146,535.8 ft²)	26,477,008.0 cy	8,619.2 ac (375,450,838.6 ft²)	83,433,519.7 cy	6.1 ac (266,705.6 ft²)	59,267.9 cy	83,374,251.8 cy	0.22

Table 7.7-2 Sand Resources within the Monmouth and Atlantic ECC (continued)

ECC Location	ECC Total Acres (ac)/ Square Feet (ft²)	ECC Cubic Yards (cy)	MMP Sand Resource Area Total Area (ac/ft²)	MMP Sand Resource Total Volume (cy)	MMP Sand Resource Area within ECC (ac/ft²)	MMP Sand Resource Area within ECC (cy)	Cubic Yards Maintained for Use by MMP	Percentage of MMP Sand Resource Area within ECC
Monmouth ECC State Waters	3,036.9 ac (132,287,060.6 ft²)	29,397,124.6 cy	ID: Shoal 235 17.3 ac (754,067.8 ft²) ID: Shoal 236 95.4 ac (4,154,833.1 ft²)	ID: Shoal 235 167,570.6 cy ID: Shoal 236 923,296.3 cy	ID: Shoal 235 11.3 ac (491,453.3 ft²) ID: Shoal 236 20.1 ac (874,518.6 ft²)	ID: Shoal 235 109,211.8 cy ID: Shoal 236 194,337.5 cy	ID: Shoal 235 58,358.8 cy ID: Shoal 236 728,958.8 cy	ID: Shoal 235 0.37 ID: Shoal 236 0.66
Atlantic ECC State Waters[1]	2,654.62 ac (115,634,829.3 ft²)	25,696,628.7 cy	8,619.2 ac (375,450,838.6 ft²)	83,433,519.7 cy	159.7 ac (6,957,165.8 ft²)	1,546,036.9 cy	81,887,482.8 cy	6.02

1. Based on publicly available data, two sand resource areas were identified within the Atlantic ECC with the following IDs: Area G and BI-J. However, these two areas have identical spatial extents. Therefore, though there are two different IDs for the two areas, they were only counted once due to the identical spatial extent.

Atlantic Shores is actively coordinating with BOEM, as well as the NJDEP and USACE regarding project interactions with sand resources in these areas and intends to collaborate to devise a cable layout strategy that meets Federal and State requirements and industry BMPs. Additional information is presented in Section 2.1 Geology.

7.7.4 Offshore Energy

Figure 1.2-1 of Volume 1 – Project Information illustrates the BOEM Lease Areas and associated offshore wind projects in proximity to New Jersey. In addition to Atlantic Shores, there are four active offshore Mid-Atlantic wind energy projects in development: Empire Wind I and II (Equinor), Ocean Wind (Orsted), and Skipjack Wind (Orsted). The only operating offshore wind facility along the Mid-Atlantic coast is the 12 MW Coastal Virginia Offshore Wind Project located approximately 180 miles (mi) to the south of the WTA.

7.7.5 Cables and Pipelines

The ECCs will cross existing marine infrastructure, including submarine cables and pipelines (see Figure 7.7-2). The Monmouth ECC could encounter up to 15 crossings, while the Atlantic ECC could have up to four crossings. These maximum number of crossings assumes that other offshore wind energy cables may be installed prior to the start of Project construction. It is also estimated that up to ten inter-array cable crossings and up to two inter-link cable crossings may be required. Atlantic Shores is currently coordinating with cable owners regarding crossing methods and/or setbacks. Additional detail is provided in Section 2.1.1.2.4.

Data describing existing pipelines were obtained from NOAA nautical charts and maps. In areas where one or more pipelines are present within protected waters such as harbors, rivers, bays, estuaries, or other inland waterways, the location is designated as a 'pipeline area'. One mapped pipeline area of unknown origin is present onshore along the Cardiff onshore interconnection cable route, located within the Great and Turtle Gut Thoroughfares (Figure 7.7-2). These waterbodies will be crossed by the onshore interconnection cable via trenchless technologies such as horizontal directional drill (HDD), jack-and-bore, and/or jack piping to avoid any pipelines. According to the NOAA nautical charts and maps, there is no evidence that either ECC route will require a submarine pipeline crossing.

Atlantic Shores has coordinated with the Naval Seafloor Cable Protection Office (NSCPO) and the North American Submarine Cable Association (NASCA) regarding locations of naval submarine cable infrastructure. After review, NSCPO did not have any comments on the Projects (C. Creese, personal communication June 26, 2020). Atlantic Shores will continue coordinating with these organizations as the Projects continue.

7.7.6 Scientific Research and Surveys

Off the coast of New Jersey, agency-sponsored research and survey efforts are conducted by the Northeast Fisheries Science Center (NEFSC), NJDEP, and the Northeast Area Monitoring and

Assessment Program (NEAMAP) led by the Virginia Institute of Marine Sciences. The following in-water studies have historically traversed the Offshore Project Area: NEFSC multi-species bottom trawls, NJDEP trawls, NEFSC clam surveys, and NEAMAP trawl surveys. Gear used for these surveys include 4-seam bottom and otter trawls, with the exception of NEFSC clam surveys, which used a hydraulic dredge.

In addition to in-water surveys, aerial surveys to measure the abundance of marine mammals and sea turtles are conducted from Maine to the Florida Keys as part of the Atlantic Marine Assessment Program for Protected Species (AMAPPS) by NOAA. NOAA NEFSC conducts these surveys within the Offshore Project Area utilizing aircraft that fly 600 feet (ft) (183 meters [m]) above the water surface at 110 knots (200 kilometers per hour [km/h]) (NEFSC, 2020).

7.7.7 Potential Impacts and Proposed Environmental Measures

The potential IPFs which may affect other marine uses, including commercial, recreational, and scientific uses and military activities, during construction, O&M, or decommissioning of the Projects are presented in Table 7.7-2.

Table 7.7-3 Impact Producing Factors for Other Marine Uses

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Vessel Traffic	•	•	•
Anchoring and jack-up vessels	•	•	•
Installation and maintenance of new structures and cables	•		•
Presence of structures and cables		•	

The maximum PDE analyzed for all IPFs is the maximum offshore build-out of the Projects as described in Section 4.11 of Volume I.

7.7.8 Vessel Traffic

Construction, O&M, and decommissioning of the Projects will introduce additional vessels and vessel movements in the Offshore Project Area. The construction period will see the greatest increase in offshore vessel traffic.

Increased vessel traffic will occur during construction, O&M, and decommissioning, as described in detail in Section 7.6 Navigation and Vessel Traffic. On average, approximately two to six vessel round trips per day between shore and the Offshore Project Area are expected during construction and O&M. Decommissioning vessel traffic is anticipated to be similar to construction vessel traffic.

Atlantic Shores will manage vessel activities to minimize disruptions to the maximum extent practicable.

Atlantic Shores has completed a Navigation Safety Risk Assessment (NSRA) in support of the Projects (see Section 7.6 Navigation and Vessel Traffic). The NSRA identifies potential hazards to navigation and associated consequences that might be created by the Projects during its lifecycle. A range of vessel types navigate the Offshore Project Area, including commercial (cargo), commercial (fishing), recreational, military, scientific and passenger vessels. A Project-specific vessel traffic analysis and navigational risk modeling analysis were introduced in Section 7.6 Navigation and Vessel Traffic and are included in the NSRA as Appendix II-S.

Vessels associated with other marine uses, including military activities, operating in or near the Offshore Project Area, could experience short-term, localized disruption due to the avoidance of Project vessel traffic during construction, O&M, and decommissioning. However, based on the AIS data evaluated for the NSRA, military and other vessel traffic makes up a small proportion of recorded vessel traffic within the Offshore Project Area. Most non-fishing vessel traffic is concentrated in the eastern portions of the WTA and generally moves in north-south or north-northeast and south-southwest courses. Vessel traffic from other marine use and military activities is expected to have a very low risk of interacting with vessels during any phase of the Projects.

Atlantic Shores has actively engaged marine user groups, including the DoD and DHS, throughout Project development and has adopted navigational safety risk mitigation strategies to decrease the already low potential for vessel-related effects in the Offshore Project Area. These strategies are based on data collection and analysis, USCG consultations, and input from mariners across various industries including commercial and recreational fisheries, marine trades, and recreational boating. The strategies developed to date include the following:

- Construction vessels will display appropriate navigation lights and day shapes as per regulatory requirements.
- Coordination with USCG and mariners to enhance information flow about Project activities to decrease navigational risks during all Project phases.
- An Emergency Response Plan will be developed in coordination with the USCG. The emergency plan will outline all the emergency response protocols and points of contact, and it will be revised annually through a face-to-face meeting with the USCG to ensure the familiarity of key personnel. The emergency plan will influence and help guide many of the elements listed directly below.
- A Marine Coordination Center will be established, led by a Marine Coordinator. The Marine Coordinator will be the Atlantic Shores' primary point of contact with USCG, port authorities, State and local law enforcement, marine patrol, port operators, and commercial operators (e.g., ferry, tourist, and fishing boat operators).

- A construction communications plan is to be developed with details for working (radio) channels, crisis communications, and other communication protocols.
- Non-regulatory and regulated safety buffers will be demarcated around working areas and communicated to stakeholders.
- Atlantic Shores will regularly coordinate with the USCG and NOAA on chart updates as components (e.g., foundations, WTGs, OSSs) are constructed and regarding the issuance of Local Notices to Mariners (LNM).
- Coordination will occur with local port authorities on the development of vessel traffic management plans for the various staging ports.
- Coordination will occur with USCG on operational protocols for the WTG braking system, and any SAR activity that might occur within the WTA or working areas. Additional information on ways Atlantic Shores is coordinating with USCG on SAR is provided in Section 7.6 Navigation and Vessel Traffic.
- Per Lease requirements regarding National Security and Military Operations, Atlantic Shores will conduct activities in recognition of safety and security issues and military agency notification mandates.
- Coordination between Atlantic Shores and the DoD Military Aviation and Installation Assurance Clearinghouse, Army National Guard, and the USCG, is ongoing and will continue through the permitting construction, O&M, and decommissioning phases. Additional details regarding vessel use and traffic are provided in Section 7.6 Navigation and Vessel Traffic.

7.7.9 Anchoring and Jack-Up Vessels

Anchoring and jack-up vessels may interact with existing submarine cables, sand resources, and MEC through direct seafloor disturbance. These effects will be greatest during construction, as routine O&M and decommissioning activities would have limited interaction with these other uses.

To address human safety and environmental risks associated with anchoring and jack-up vessel interactions with these other uses, Atlantic Shores has incorporated avoidance strategies into the design of the Projects. Atlantic Shores will also continue coordinating with cable owners that have assets within the Offshore Project Area regarding crossing methods and setbacks and with resource agencies that manage the sand resources. Atlantic Shores is also committed to completing pre-construction HRG surveys to detect and implement risk management steps to avoid MEC (see Section 2.1 Geology).

7.7.10 Installation and Maintenance of New Structures and Cables

The installation and maintenance of new foundation structures and offshore cables includes installation of associated scour and cable protection. These activities may interact with submarine cables, sand resources, and MEC through direct seafloor disturbance. Potential effects from installation and maintenance of new structures (i.e., WTGs, OSSs, and meteorological [met] tower) and cables include the potential damage to existing cables, restricting access to sand resources, and MEC interactions (see Section 2.1 Geology). These effects will be greatest during the construction, as routine maintenance activities would have limited interaction with these other uses.

The installation of new structures, particularly the submarine cables, will require crossing of several existing submarine cables, as described in Section 7.7.1.4. Any cable crossing will be carefully surveyed and, if the cable is still active, Atlantic Shores will develop a crossing agreement with its owner. At each crossing, before installing the Atlantic Shores cable, the area around the crossing will be cleared of any marine debris. Depending on the status of the existing cable and its location, such as burial depth and substrate characteristics, cable protection may be placed between the existing cable and Atlantic Shores' overlying cable. However, if sufficient vertical distance exists, such protection may be avoided. It is likely that the presence of an existing cable will prevent Atlantic Shores' cable from being buried to its target burial depth. In this case, cable protection may be required on top of the proposed cable at the crossing location. Cable protection infrastructure is discussed in detail in Section 4.5.8 of Volume I. Examples of cable protection infrastructure may include rock placement, grout-filled bags, rock bags, half-shell pipes for mechanical protection, and concrete mattresses. Final crossing details of existing cables and pipelines will be determined in consultation with the respective owners/operators. Following installation of the proposed cables, the cable crossing will be surveyed again to ensure proper installation.

7.7.11 Presence of Structures and Cables

Within the Offshore Project Area, the presence of installed structures (including WTGs, OSSs, offshore cables, cable protection, and scour protection) may affect vessel traffic (including military and scientific research vessels) during the O&M stage of the Projects.

Atlantic Shores has participated in several meetings with military staff (e.g., Air Force, Navy, Marine Corps), U.S. Fleet Forces Command, and the DoD Clearinghouse, to present Project information, receive feedback and guidance to support Lease Area development activities, and establish a strategy for information sharing and engagement. Atlantic Shores will continue to coordinate with military staff and DoD throughout the life of the Projects.

The presence of cables, cable protection, and scour protection may result in impediments to other, future marine uses such as submarine energy and telecommunications infrastructure and sand borrowing.

Some fisheries research and surveys conducted by Federal or State agencies may occur within the WTA and Atlantic Shores will continue to consult with these agencies to avoid and minimize any possible effects to this work. The proposed WTG and OSS layout for the Projects has been designed to facilitate the transit of vessels through the WTA based on a review of existing traffic patterns. Further, Atlantic Shores' construction and O&M monitoring will provide additional contributions to scientific surveys and research.

The presence of structures and cables may also limit sand borrowing in very small portions of designated areas along the ECCs but not within the WTA.

7.7.12 Summary of Proposed Environmental Protection Measures

The majority of potential effects to other marine uses, including military activities, are expected to be localized to specific areas of construction activity and structures. Atlantic Shores has incorporated design elements and taken precautionary steps and commitments to avoid, mitigate, and monitor the Project's effects on marine uses and military activities during construction, O&M, and decommissioning. Additional avoidance and mitigation measures and tools will be evaluated further as the Projects progress through development and permitting and in coordination with BOEM, DoD, DHS, state jurisdictional agencies and other stakeholders.

The following environmental protection measures are proposed to mitigate potential Project-related impacts to marine uses and military activities:

- Desktop assessments of military activities, sand resources, and offshore energy, cables, and pipelines have been conducted to characterize marine uses and military activities.
- Offshore Project infrastructure has been sited and designed to avoid or minimize impacts to sand resource areas, cables/pipelines, and known MEC (see Section 2.1 Geology) to the maximum extent practicable.
- The Project facilities will avoid stormwater outfalls and water intake structures that are identified during constructability studies, stakeholder consultation, and preconstruction surveys to the maximum extent practicable. Atlantic Shores will adhere to any buffers or offsets in accordance with state or local requirements to conduct work near these outfalls or structures.
- Cable protection infrastructure will be employed where offshore cables are proposed to cross existing submarine cables. Atlantic Shores is coordinating with cable owners that own assets within the Offshore Project Area regarding crossing methods and setbacks.
- Coordination will continue with military staff and DoD throughout the life of the Projects.
- Consultation will continue with agencies and other research entities regarding scientific research and surveys in the Offshore Project Area. Atlantic Shores construction and O&M monitoring will provide additional contributions to scientific surveys and research.

- A Marine Coordinator will be employed to monitor daily vessel movements, implement communication protocols with external vessels both in port and offshore to avoid conflicts, and monitor safety zones.

7.8 Aviation and Radar

This section describes aviation and radar resources present in the Offshore Project Area, which includes Project 1, Project 2, the Overlap Area, and the export cable corridors (ECCs). This section also assesses the associated impact producing factors (IPFs), and measures to avoid, minimize, or mitigate potential impacts to these resources during construction, operation and maintenance (O&M), and decommissioning of the Projects. Atlantic Shores is committed to minimizing and mitigating impacts to aviation and radar resources and will coordinate with the appropriate regulatory agencies to complete the appropriate consultations and obtain the required approvals.

For evaluations of airports and their associated procedures, the Lease Area and an approximate 25 nm (46 km) buffer around the Lease Area was evaluated to be consistent with industry best practice.

Aviation resources include the navigable airspace in the vicinity of the WTA, defined as the airspace at or above the minimum altitudes of flight that include the airspace needed to ensure safety in the takeoff and landing of aircraft. The U.S. Congress has charged the Federal Aviation Administration (FAA) with administering airspace in the public interest as necessary to ensure the safety of aircraft and its efficient use.

Radar is a technology whereby radio waves are transmitted into the air and are then received when they have been reflected by an object in the path of the beam. Radar range is determined by measuring the time it takes (near the speed of light) for the radio wave to go out to the object and then return to the receiving antenna. The direction of a detected object from a radar site is determined by the position of the rotating antenna when the reflected portion of the radio wave is received. Radar is used to support navigation, military surveillance, and weather monitoring and coastal conditions.

The Projects are subject to regulations under 49 U.S.C. § 44718 and 14 CFR Part 77, FAA Orders, and government-published Terminal Procedures and Aeronautical Data[70], which provide the FAA with jurisdiction and a mandate to review all structures within U.S. territorial airspace (defined as 12 nautical miles [nm, 22 km]) measured from the low-water line along the coast). The FAA's objective in conducting aeronautical studies is to ensure that proposed structures do not affect the safety of air navigation or the efficient utilization of navigable airspace by aircraft. The result of an aeronautical study is the issuance of a determination of 'hazard' or 'no hazard' that can be

[70] Joint Order 7400.2N – Procedures for Handling Airspace Matters; FAA Order 8260.3E – United States Standard for Terminal Instrument Procedures; FAA Order 8260-58B – United States Standard for Performance Based Navigational (PBN) Instrument Procedure Design; Technical Operations Evaluation Desk Guide for Obstruction Evaluation / Airport Analysis (1.6.1); United States Government Flight Information Publication, US Terminal Procedures; National Airspace System Resource Aeronautical Data.

used by the proponent to obtain necessary local construction permits and Joint Order 7400.2N[71] instrument approach areas (see Appendix II-T1 OE/AA Report). The requirements for filing with the FAA for proposed structures vary based on a number of factors including height, proximity to an airport, location, and frequencies emitted from the structure (FAA 2021). Structures, vessels, and/or cranes that exceed 14 CFR §77.9 Notice Criteria and Joint Order 7400.2N instrument approach areas in height will require review and filing with the FAA per 14 CFR §77.7.

While the FAA is responsible for reviewing all structures within 12 nm (22 km), BOEM will consult with the FAA regarding airspace impacts beyond 12 nm (22 km)) and is responsible for regulating renewable energy activities on the outer continental shelf in accordance with 30 CFR Part 585. Structures that fall under FAA and/or BOEM jurisdiction must also be reviewed by the Department of Defense (DoD) and the U.S. Department of Homeland Security (DHS) to ensure no interference with testing and training operations and/or radar systems. Beyond the FAA jurisdictional boundary, BOEM is anticipated to work with the FAA to promote a cohesive hazard assessment and lighting/marking scheme using the BOEM-adopted FAA Marking and Lighting Guidance (BOEM 2019; FAA Marking and Lighting Advisory Circular 70/7460/1M, 11/16/2020). Atlantic Shores plans to request approval from the FAA to install an Aircraft Detection Lighting System (ADLS) which will provide visual and environmental benefits due to reduction in the operation time of required lighting (see Sections 4.3 Birds, 4.4 Bats, 5.0 Visual Resources, and 6.1 Historic Properties). To support this request, an ADLS analysis was conducted for the WTA (see Appendix II – M4 ADLS Report).

The assessment of aviation and radar resources included evaluation of the Lease Area OCS-A 0499 (Lease Area) and an approximate 25 nm (46 km) buffer around the Lease Area, consistent with industry best practice. The focus of the assessment was on structures that would meet or exceed the FAA's threshold for review of 200 ft (61 m) in height for WTGs.

7.8.1 Affected Environment

The information presented in this section is based on FAA requirements and an Obstruction Evaluation/Airspace Analysis (OE/AA) Report that was completed to characterize the existing airspace surrounding the WTA and support the preliminary assessment of the WTGs potential effects on airspace. The OE/AA Report has been included as Appendix II-T1.

In addition to the aforementioned study, Atlantic Shores has completed a preliminary navigation and radar screening study (see Appendix II-T2) to assess the potential for Project WTGs to be within the line of sight of radars serving as military or civilian surveillance and air traffic control, weather radar, coastal High Frequency (HF) radar, and impacts to navigational aids.

[71] Joint Order 7400.2N – Procedures for Handling Airspace Matters

The following sections provide a description of existing aviation and radar resources based on Atlantic Shores' site-specific studies as well as the requirements of 14 CFR Part 77, FAA Orders, and government-published Terminal Procedures and Aeronautical Data.

7.8.2 Aviation

Aviation activity or air traffic volume within the WTA is varied and consists of flights to and from public, private-use, and military airports in proximity to the WTA as summarized in Table 7.8-1. The locations of these airports are presented in Appendix II-T1 (Figure 1). The largest and most active of these are the Atlantic City International Airport, located 20.4 mi (32.8 km) northwest of the WTA, and Ocean City Municipal Airport which is located 19.2 mi (30.9 km) west of the WTA.

Table 7.8-1 Airports within Proximity to the WTA

Airport Name or Designation	Municipality Name
Public	
Atlantic City Intl. (ACY)	Egg Harbor Township
Camden County (19N)	Berlin
Cross Keys (17N)	Williamstown
Eagles Nest (31E)	West Creek
Hammonton Muni (N81)	Hammonton
Kroelinger (29N)	Vineland
Millville Muni (MIV)	Millville
Ocean City Muni (26N)	Ocean City
Southern Cross (CO1)	Williamstown
Vineland-Downstown (28N)	Vineland
Woodbine Muni (OBI)	Woodbine
Private-Use	
Alliance Airport (23NJ)	Pittsgrove
AT&T Cedarbrook Heliport (NJ04)	Atco
Atlantic City Medical Center (JY28)	Pamona

Table 7.8-1 Airports within Proximity to the WTA (Continued)

Airport Name or Designation	Municipality Name
Atlantic City Medical Center Heliport (0NJ0)	Atlantic City
Atlantic County Helistop (99NJ)	Northfield
Atsion Helistop (5NJ5)	Trenton
Bayside State Prison (JY32)	Leesburg
Bertino Heliport (49NJ)	Hammonton
Binder Winslow Airport (26JY)	Winslow
Breezey Acres Farm Heliport (JY30)	Waterford
Cape Regional Medical Center Heliport (26NJ)	Cape May Court House
Coyle Field Airport (NJ20)	Chatsworth
Dix Field Airport (0NJ6)	Linwood
Forked River Heliport (66NJ)	Forked River
Germania Heliport (51NJ)	Cologne
Golden Nugget Atlantic City Heliport (NJ48)	Atlantic City
Harrah's Landing Seaplane Based (58NJ)	Atlantic City
Heli-Ray Airport (25JY)	Waterford
Ideal Air Strip (NJ69)	Hammonton
Indian Mills Heliport (7NJ0)	Medford
J L Gentile Heliport (29NJ)	Buena
Kennedy Health System Heliport (9NJ9)	Washington Township
Kennedy Memorial Hospital Heliport (JY11)	Stratford
N U I Heliport (68NJ)	Somerville
New Freedom Switching Station Heliport (7NJ1)	Winslow
Oyster Creek Generating Station Heliport (5NJ8)	Forked River
Paramount Air Airport (JY04)	Green Creek
Shore Medical Center (87NJ)	Somers Point
Soaring Sun Seaplane Base (21JY)	Harvey Cedars
Sony Music Heliport (27NJ)	Pitman
Southern Ocean Medical Center (NJ89)	Manahawkin
Steel Pier Taj Mahal Heliport (28NJ)	Atlantic City
Steeplechase Pier Heliport (NJ57)	Atlantic City

Table 7.8-1 Airports within Proximity to the WTA (Continued)

Airport Name or Designation	Municipality Name
Stone Harbor Golf Club Heliport (NJ08)	Cape May Court House
Strawberry Fields Airport (89NJ)	Mays Landing
Two Can Sam Heliport (86NJ)	Vineland
Virtua-Voorhees Hospital Heliport (85NJ)	Voorhees
William B. Kessler Memorial Hospital Heliport (2JY3)	Hammonton
WJRZ Radio Heliport (38NJ)	Manahawkin
Military	
Warren Grove Range (NJ24)	Chatsworth

As the WTGs defined by the maximum Project Design Envelope (PDE) for the Projects will exceed 200 ft (61 m), each WTG located within 12 nm (22 km) will require review by the FAA in accordance with 14 CFR Part 77.9. Of the 200 WTGs in the WTA, up to 43 will require filing with the FAA (U.S. Territorial Airspace), including up to 41 within Project 1 and up to 2 within Project 2 (each including the Overlap Area).

Aviation activities are managed by FAA using a variety of flight rules to establish safe altitudes, flight paths, and obstruction (e.g., natural terrain and or structure) clearances for aircraft using the airspace. The WTA will overlap with one or more FAA flight paths associated with the Atlantic City International Airport (ACY) that require obstacle clearances of 1,000 ft (304.8 m) above the height of the WTGs. Atlantic Shores will coordinate with the FAA through the FAA filing process for potential mitigations and changes to airspace, if required.

Based on the OE/AA Report (see Appendix II-T1), portions of the WTA also overlap with various FAA terminal radar control facilities (TRACONs) and Air Route Traffic Control Centers (ARTCCs) that provide approach control services to aircraft arriving, departing, or transiting regional airspace (see also Section 7.8.1.2). These specifically include TRACON minimum vectoring altitude sectors for Atlantic City (ACY), and Philadelphia (PHL). Some of these sectors have existing obstacle clearances of 649 ft (197.8 m) AMSL. Atlantic Shores will coordinate with the FAA through the FAA filing process for potential mitigations and changes to airspace, if required.

Atlantic Shores conducted an Air Traffic Flow Analysis (see Appendix II-T3) to determine if there is evidence of current and historic flights within FAA managed airspace to determine requirements for potential mitigation prior to formal filing and review under 14 CFR Part 77 and FAA Order 7400.2M. The findings in the Air Traffic Flow Analysis indicate that turbines at 1,048 ft (319.4 m) AMSL and below would not affect a significant volume of operations; and it is possible that the FAA would not object to increasing the affected altitudes of the various procedures and radar control facility charts to accommodate turbines. These mitigation options are available and are subject to FAA approval.

Military Airspace

Atlantic Shores also reviewed military airspace, training routes, special use airspace, warning areas, and SAR activities that overlap with the WTA.

The New Jersey and Delaware Air National Guard and the U.S. Navy use portions of the WTA for flight training. These training routes are discussed in Appendix II-T1 OE/AA Report. Warning Areas W-107A and W-107C as well as VR-1709 (managed by the 177th Fighter Wing of the NJ Air National Guard) also overlay the WTA (see Figure 13 in Appendix II-T1).

In addition to the designated military airspace within the offshore Project Area, the USCG will conduct flights over the water associated with the Offshore Project Area to support SAR missions using both vessel and helicopter assets. The USCG conducts SAR missions for offshore incidents including, but not limited to vessels capsizing, disabled vessels, vessels taking on water, and persons in the water. A review of fourteen years (2004 to 2018) of historical USCG SAR data for the coastline of New Jersey documented that there were six SAR missions within the WTA during this 14-year period. This is an average frequency of 0.43 missions per year, with most incidents appearing to involve marine, not aerial, rescue. A detailed assessment of USCG SAR was conducted as part of the Search and Rescue Risk Assessment Workshop Summary Report included as Appendix II-T4.

Atlantic Shores has participated in several meetings with military staff 2019-2020 (e.g., Air Force, Navy, Marine Corps) and the Military Aviation and Installation Assurance Siting Clearinghouse (Clearinghouse) to present Project information, discuss interactions with military airspace, training routes and assets; explore minimization and mitigations measures; and establish a process for information sharing and engagement. During consultations with the Marine Corps, it was confirmed that operations that overlap within the identified warning areas primarily support transit and not training activities (G. Simon, pers. comm., May 7, 2019). During discussion with the Clearinghouse, staff indicated that much of their concerns regarding military airspace had been addressed during the New Jersey Wind Energy Area siting and Leasing process with BOEM (S. Sample, pers. comm. October 16, 2020). However, DoD requested that Atlantic Shores maintain communications with the Clearinghouse and military staff as Project development advances to ensure any items of potential concern could be proactively addressed. As with other stakeholder groups, Atlantic Shores is committed to this request.

7.8.3 Radar

Radar facilities that overlap with the Offshore Project Areas include those that support air traffic control, military surveillance, High frequency (HF) coastal radars, and weather monitoring.

To support the understanding of radar facilities operating in the Offshore Project Areas, Atlantic Shores conducted an initial analysis for Long Range Radar (LRR) and NEXRAD using the DoD Preliminary Screening Tool (PST) on the FAA Obstruction Evaluation/Airport Airspace Analysis website. This analysis provides a cursory indication of whether wind turbines may be within line-of-sight of one or more radar sites, and likely to affect radar performance. The PST LRR analysis accounts for air route and airport surveillance radar associated with the FAA, DoD and DHS. The PST NEXRAD analysis accounts for DoD, FAA, and National Oceanic and Atmospheric Administration (NOAA) Weather Surveillance Radar. The preliminary results indicate that the Project 1 will overlap with LRR but neither Project will influence NEXRAD Radar. Specifically, the LOS analysis results show that some of the wind turbines will be within line-of-sight of and will interfere with the Gibbsboro ARSR-4 and the McGuire AFB DASR radar facilities. The overlap with LRR will require further consultation with FAA, DoD, and DHS to determine potential effects and potential mitigating measures, if required.

Preliminary screening, and results from the Radar and Navigational Aid Screening Study (see Appendix II- T2) also revealed that the WTA will overlap with various NOAA high-frequency coastal radar sites used to support ocean observations. Further consultation with NOAA and NWS will be required to determine potential effects (see Section 7.8.2.2) and potential mitigating measures, if required. As with other stakeholder groups, Atlantic Shores is committed to this collaboration.

7.8.4 Potential Impact Producing Factors and Proposed Environmental Protection Measures

The following sections summarize the potential effects to aviation, radar, and military operations during construction, O&M and decommissioning along with proposed avoidance and mitigation measures. The potential IPFs which may affect aviation and radar resources during construction, O&M, or decommissioning are presented in Table 7.8-2.

Table 7.8-2 Impact Producing Factors for Aviation and Radar Resources

Impact Producing Factors	Construction and Installation	Operations and Maintenance	Decommissioning
Installation and Maintenance of New Structures	•	•	•
Presence of Structures	•	•	

The WTGs and construction equipment (e.g., cranes) are Project elements that will have the potential to affect aviation and radar resources during the Project's lifecycle given their height above 200 ft (61 m). At the end of the Project's useful life, the WTGs will be decommissioned and removed resulting in no further impacts. The OSSs, onshore substations, port areas will be evaluated for 14 CFR Part 77.9 Notice Criteria and FAA filing requirements based on final engineering design and final requirements for construction, O&M and decommissioning.

Impacts to aviation, SAR, military airspace, and radar are based on the Project Design Envelope (PDE) for the maximum potential offshore Project build-out of WTGs in a uniform grid pattern with 1.0 nm) (1.9 km) by 0.6 nm (1.1 km) spacing and 1,048.8 ft (319.7 m) MLLW WTGs as detailed in Section 1.1 and Table 4.3-1 of Volume I.

7.8.5 Installation and Maintenance of New Structures

Aviation and/or radar facilities could be affected by the use of vessels and equipment (e.g., cranes) during construction, O&M and decommissioning of new offshore structures. The effects would result from the potential that tall structures could interfere with air traffic and/or radar transmission within the WTA. If vessels, and/or cranes required to support construction, O&M or decommissioning exceed 14 CFR Part 77.9 Notice Criteria and JO 7400.2N Instrument Approach Areas, Atlantic Shores will file accordingly with the FAA.

7.8.6 Presence of Structures

The WTGs within the WTA will overlap with FAA flight procedures and flight paths, military airspace and various FAA, NOAA and DoD/DHS radar systems. The following sections summarize the potential effects on these resources including next steps and proposed mitigations.

Aviation

As previously stated, all structures exceeding 14 CFR Part 77.9 Notice Criteria located within territorial airspace must be submitted to the FAA for evaluation. Given the maximum tip height of the WTGs exceeds 499 ft (152 m), the proposed WTGs within U.S. Territorial Airspace will be considered obstructions under 14 CFR Part 77.17(a)(1); therefore, the FAA will require further study and a public comment period. However, structures in excess of 499 ft (152 m), are potentially feasible provided the proposed procedural changes to FAA operations do not affect a significant volume of operations. Atlantic Shores conducted an Air Traffic Flow Analysis (see Appendix II-T3) to determine if there is evidence of historic flights within FAA managed airspace to determine the potential to modify FAA operational procedures and/or adjust airspace and/or other mitigation requirements through formal filing and review under Federal Regulations, FAA Orders, and Flight Information Publications (see References). The findings in the Air Traffic Flow Analysis indicate that turbines at 1,048 ft (319.4 m) AMSL and below would not affect a significant volume of operations; and it is possible that the FAA would not object to increasing the affected altitudes of the various procedures and radar control facility charts to accommodate turbines. These mitigation options are available and are subject to FAA approval.

Consultation with military staff, the Clearinghouse, and the USCG indicate that airspace overlapping the Offshore Project Areas supports both military transit and aerial SAR operations. Although the FAA does not consider impact on military airspace or training routes, the FAA will notify DoD of proposed structures within these segments of airspace to support evaluation and review. As previously stated, Atlantic Shores is committed to coordinating through the Clearinghouse and the USCG to assess and mitigate possible effects of Project activities throughout all phases of development and operations.

Atlantic Shores is committed to maintaining maritime safety and has specifically designed the WTA layout to accommodate predominant vessel traffic that minimizes effects to existing maritime activities (see Section 7.4 Navigation and Vessel Traffic). Atlantic Shores will mark and light all structures in accordance with FAA, BOEM, and USCG guidelines.

Atlantic Shores has also committed to implementing a comprehensive set of measures to avoid, minimize, or mitigate effects to SAR and improve search efforts overall. The measures include, but are not limited to, installing a direction finder system, high-resolution infrared cameras, and weather monitoring devices; employing a Marine Coordinator to liaise with the USCG; and developing an Emergency Response Plan (ERP).

Additionally, Atlantic Shores prepared a comprehensive risk assessment of aerial SAR (see Appendix II-T4 to further evaluate effects of the Projects on USCG SAR missions and identify additional risk mitigation strategies.

Based upon the layout of the WTA in combination with the planned risk assessment and associated mitigation and monitoring, it is expected the successful implementation of USCG aerial SAR missions will not be negatively affected.

Radar

As discussed in Section 7.8.1.2, the WTA overlap with radar facilities that support air traffic control, military surveillance, and weather monitoring. Based on the preliminary screening analysis supported by the Clearinghouse PST and the Radar and Navigational Aid Screening Study (see Appendix II-T2), WTGs may affect radar by causing unwanted radar returns (i.e., clutter) resulting in a partial loss of target detection or false targets within and in proximity to the WTA. Other radar effects could include a partial loss of weather detection and false weather indications. Atlantic Shores is committed to continue working to further evaluate potential effects to these radar facilities in coordination with the FAA, DoD, DHS, National Weather Service (NWS), and NOAA and identify potential mitigating measures, if required.

7.8.7 Summary of Proposed Environmental Protection Measures

Several environmental protection measures will be implemented to avoid and minimize potential impacts from the Projects on aviation and radar resources, including but not limited to the following:

- Site-specific studies for the WTGs were conducted including an OE/AA Analysis (Appendix II-T1) and preliminary air traffic flow (Appendix II-T3) and radar screening (Appendix II-T2) studies to determine impacts to aviation and radar resources, respectively.

- An aerial SAR risk assessment (Appendix II-T4, including associated mitigation measures, has been prepared in coordination with USCG and submitted as part of the 2021 COP supplement to mitigate risk to SAR operations within the WTA.

- To aid mariners in distress and support the USCG SAR operations, Atlantic Shores has committed to implementing the following approaches and innovative technologies within the wind farm:
- Coordinated with USCG to design a Project that provides sufficient WTG spacing to allow for safe aerial SAR.
- Install a direction finder system to assist with the location of vessels in distress and persons overboard with a transponder.
- Install high-resolution infrared cameras to detect, day or night and in all weather conditions, thermal images (e.g., vessels or a person in the water) across the entire Lease Area.
- Install weather monitoring devices.
- Hire a Marine Coordinator to liaise with the USCG as required during SAR activity within WTA, particularly with emergency braking of selected WTG rotors.
- Develop an ERP to specify coordination, shutdown, and rescue procedures. The ERP will be reviewed and updated at least annually between Atlantic Shores and the USCG.
- Atlantic Shores will mark and light all structures in accordance with FAA, BOEM and USCG guidelines.
- Continue ongoing Project coordination with FAA, BOEM, the DoD through the Clearinghouse, NWS, and the USCG.

7.9 Onshore Transportation and Traffic

This section describes onshore transportation systems and traffic patterns in the Onshore Project Area, associated impact producing factors (IPFs), and measures to avoid, minimize, or mitigate potential effects to these resources during construction, operations and maintenance (O&M), and decommissioning.

Atlantic Shores has conducted a desktop assessment of onshore transportation and traffic to inform Project design decisions. Project construction, O&M, and decommissioning activities are designed to minimize effects to onshore transportation and traffic. Where the onshore interconnection cable routes pass through or near important transportation corridors, specialty installation techniques, including horizontal directional drilling (HDD), pipe jacking, and jack-and-bore, will be used to avoid and minimize traffic effects. Atlantic Shores will also adhere to voluntary seasonal construction restrictions and local ordinances that restrict hours of construction to avoid peak traffic usage.

7.9.1 Affected Environment

Installation of onshore Project facilities will occur in Monmouth and Atlantic Counties in New Jersey. Atlantic Shores has also identified potential port facilities in New Jersey, New York, the Mid-Atlantic, and New England that may be used for activities, including but not limited to staging activities, crew transfers, and loading. This section describes the affected environment within those portions of Atlantic and Monmouth Counties where onshore Project components may be located, followed by a description of potential port facilities.

7.9.1.1 Atlantic County, New Jersey

Onshore Project components in Atlantic County include the Atlantic Landfall Site, Cardiff onshore interconnection cable route options (herein referred to as the onshore interconnection cable routes), new onshore substation and/or converter station site options, and potential upgrades to the existing Cardiff Substation point of interconnection (POI). Additionally, the Projects will be supported by a new O&M facility that Atlantic Shores is proposing to establish in Atlantic City, New Jersey (see Figure 7.9-1). These onshore facilities are described in detail in Sections 4.7 through 4.9 and Section 5.5 of Volume I.

The Atlantic Landfall Site will be located on a parcel of land that is currently used as a public parking lot bounded by Pacific, South Belmont, and South California Avenues and California Avenue within Atlantic City in Atlantic County, New Jersey. This landfall site will include underground transition vaults associated with the Atlantic export cables (one per export cable) (see Figure 7.9-1).

The Cardiff Onshore Interconnection Cable Route is an approximately 22 mile (mi) (35 kilometer [km]) underground transmission route that largely uses existing linear infrastructure corridors to connect the Atlantic Landfall Site to the existing Cardiff Substation POI (see Figure 7.9-1). The Cardiff Onshore Interconnection Cable Route passes through three towns or cities including: Egg Harbor Township, Pleasantville City, and Atlantic City.

To prepare for interconnection to the electrical grid, the interconnection cables will connect to a substation and/or converter station along the cable route before continuing to the existing Cardiff Substation POI. The Cardiff onshore substation and/or converter site is located in Egg Harbor Township (see Figure 7.9-1). The Cardiff Onshore Interconnection Cable Route is described in detail in Section 4.8.1 of Volume I.

The Cardiff Onshore Interconnection Cable Routes pass through or in the vicinity of several important transportation routes. Starting at the Atlantic Landfall Site and moving towards the POI, these include a hurricane evacuation route along Route 40 just west of Bader Airfield, the interchange of Routes 40 and 322, a railroad ROW, and the Garden State Parkway. Additionally, there are bus routes located along Route 40.

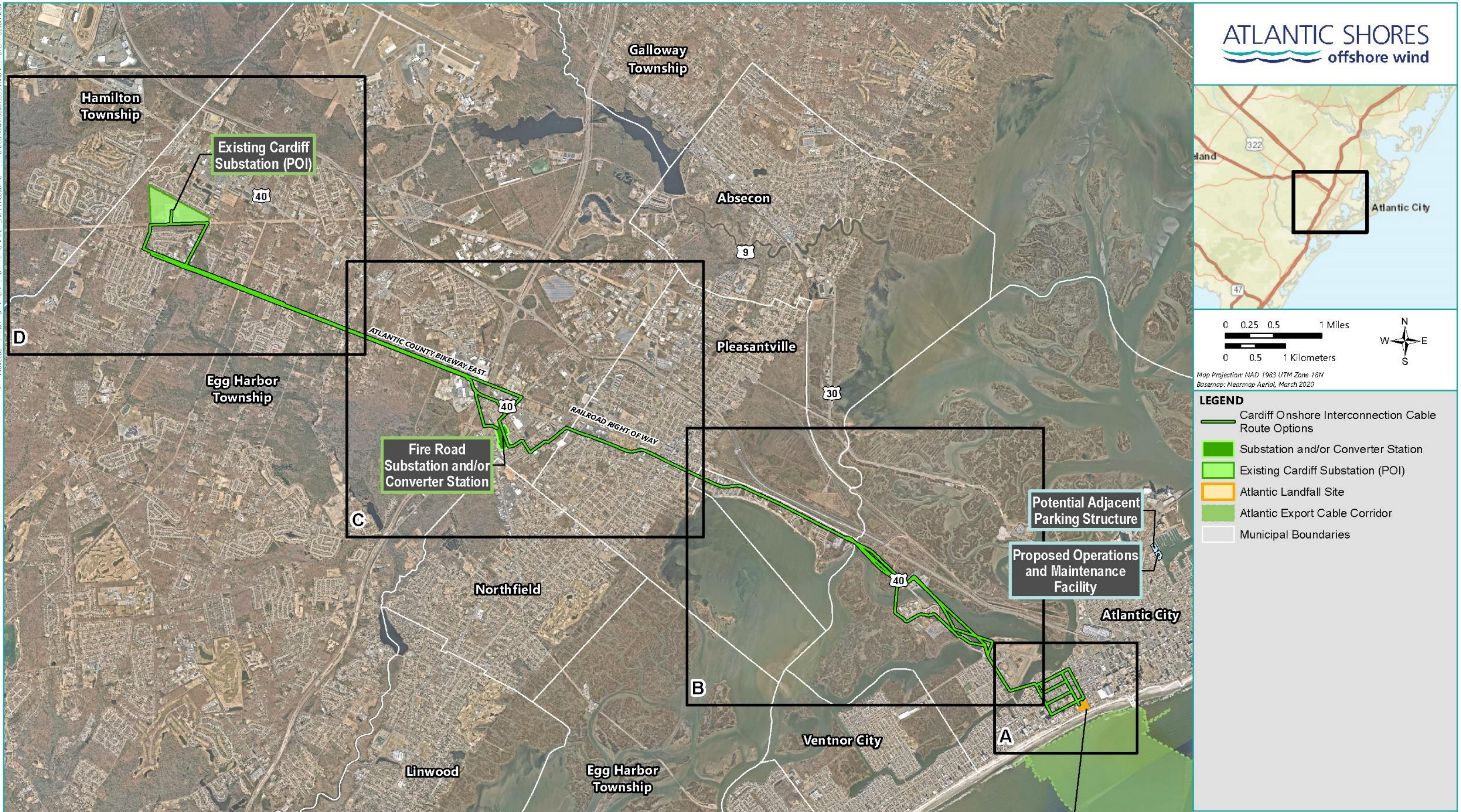
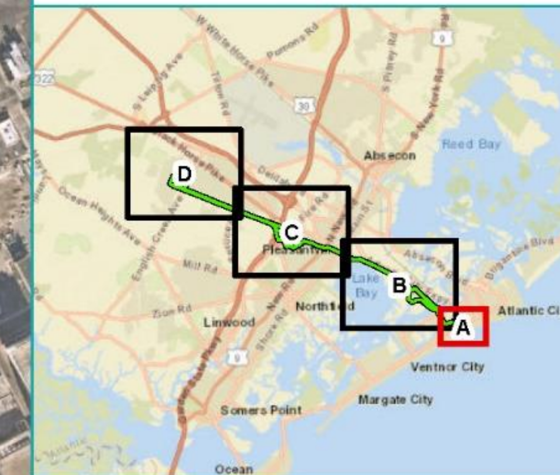


Figure 7.9-1 Index

Atlantic Landfall Site, Cardiff Onshore Interconnection Cable Route, and Onshore Substation Site Atlantic County, New Jersey

ATLANTIC SHORES
offshore wind



0 0.1 0.2 Miles

0 0.1 0.2 Kilometers

N W E S

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

LEGEND

- Cardiff Onshore Interconnection Cable Route Options
- Atlantic Landfall Site
- Atlantic Export Cable Corridor
- Municipal Boundaries

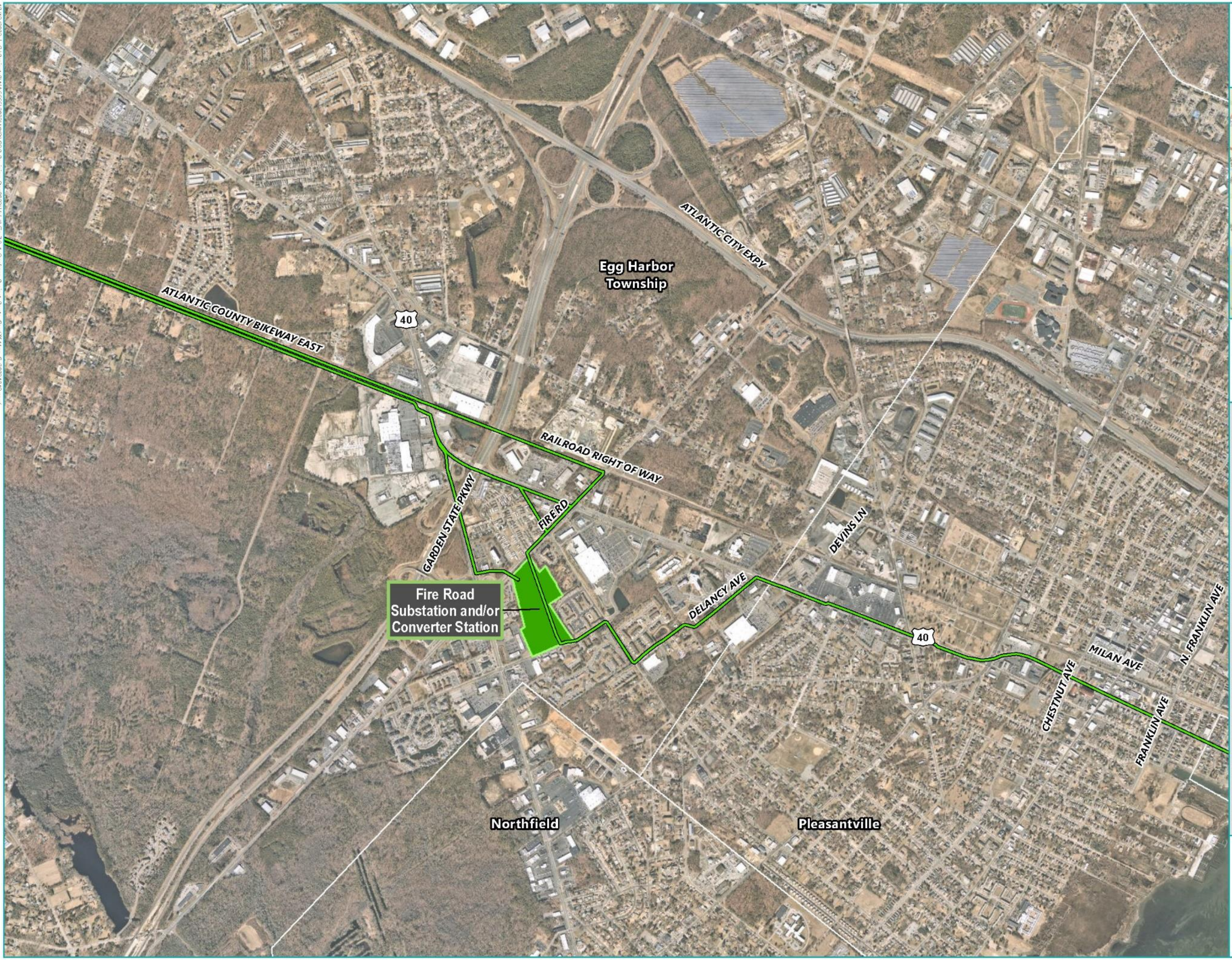
Figure 7.9-1A

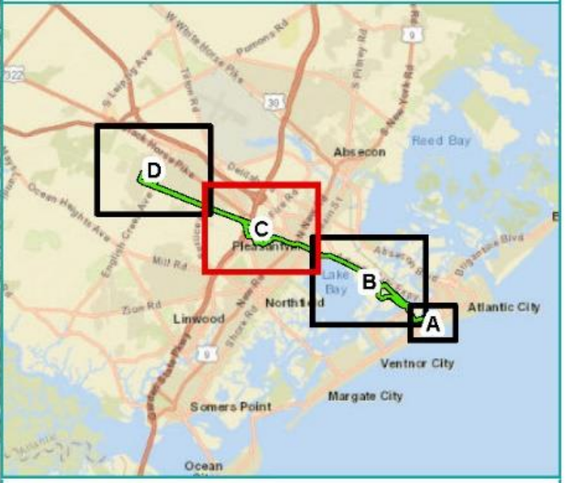
Atlantic Landfall Site, Cardiff Onshore Interconnection Cable Route, and Onshore Substation Site
Atlantic County, New Jersey

Figure 7.9-1B

Atlantic Landfall Site, Cardiff Onshore Interconnection Cable Route, and Onshore Substation Site Atlantic County, New Jersey

ATLANTIC SHORES offshore wind





0 0.2 0.4 Miles
0 0.25 0.5 Kilometers
N W E S

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

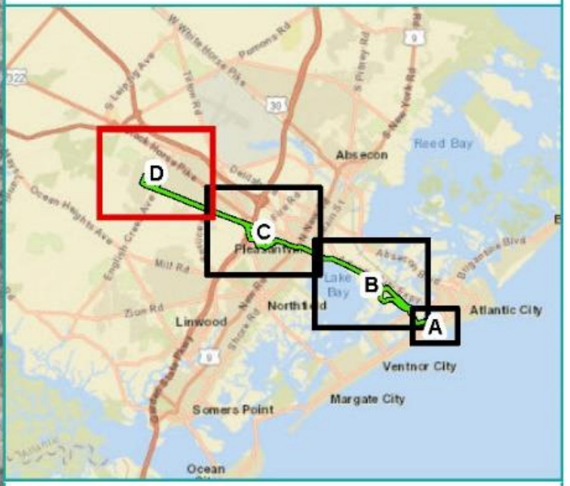
LEGEND

- Cardiff Onshore Interconnection Cable Route Options
- Substation and/or Converter Station
- Municipal Boundaries

Figure 7.9-1C

Atlantic Landfall Site, Cardiff Onshore Interconnection Cable Route, and Onshore Substation Site Atlantic County, New Jersey

ATLANTIC SHORES offshore wind



0 0.2 0.4 Miles

0 0.25 0.5 Kilometers

N W E S

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

LEGEND

- Cardiff Onshore Interconnection Cable Route Options
- Existing Cardiff Substation (POI)
- Municipal Boundaries

Figure 7.9-1D

Atlantic Landfall Site, Cardiff Onshore Interconnection Cable Route, and Onshore Substation Site
Atlantic County, New Jersey

7.9.1.2 Monmouth County, New Jersey

Onshore Project components in Monmouth County, New Jersey include the Monmouth Landfall Site, Larrabee onshore interconnection cables, a new onshore substation and/or converter station, and potential upgrades to the existing Larrabee Substation POI. These onshore facilities are described in detail in Sections 4.7 through 4.9 of Volume I.

The Monmouth Landfall Site is located within the Borough of Sea Girt on the southeast corner of the Army National Guard Training Center (NGTC). The Larrabee Onshore Interconnection Cable Route begins at the Monmouth Landfall Site and is an approximately 23 mi (37 km) underground transmission route that largely uses existing linear infrastructure corridors (including roadway ROWs and bike paths) from the Monmouth Landfall Site to the existing Larrabee Substation POI (see Figure 7.9-2). The Larrabee Onshore Interconnection Cable Route passes through four towns or boroughs including Howell Township, Wall Township, Manasquan Borough, and Sea Girt Borough. The Larrabee onshore substation and/or converter station site is in Howell Township (Figure 7.9-2).

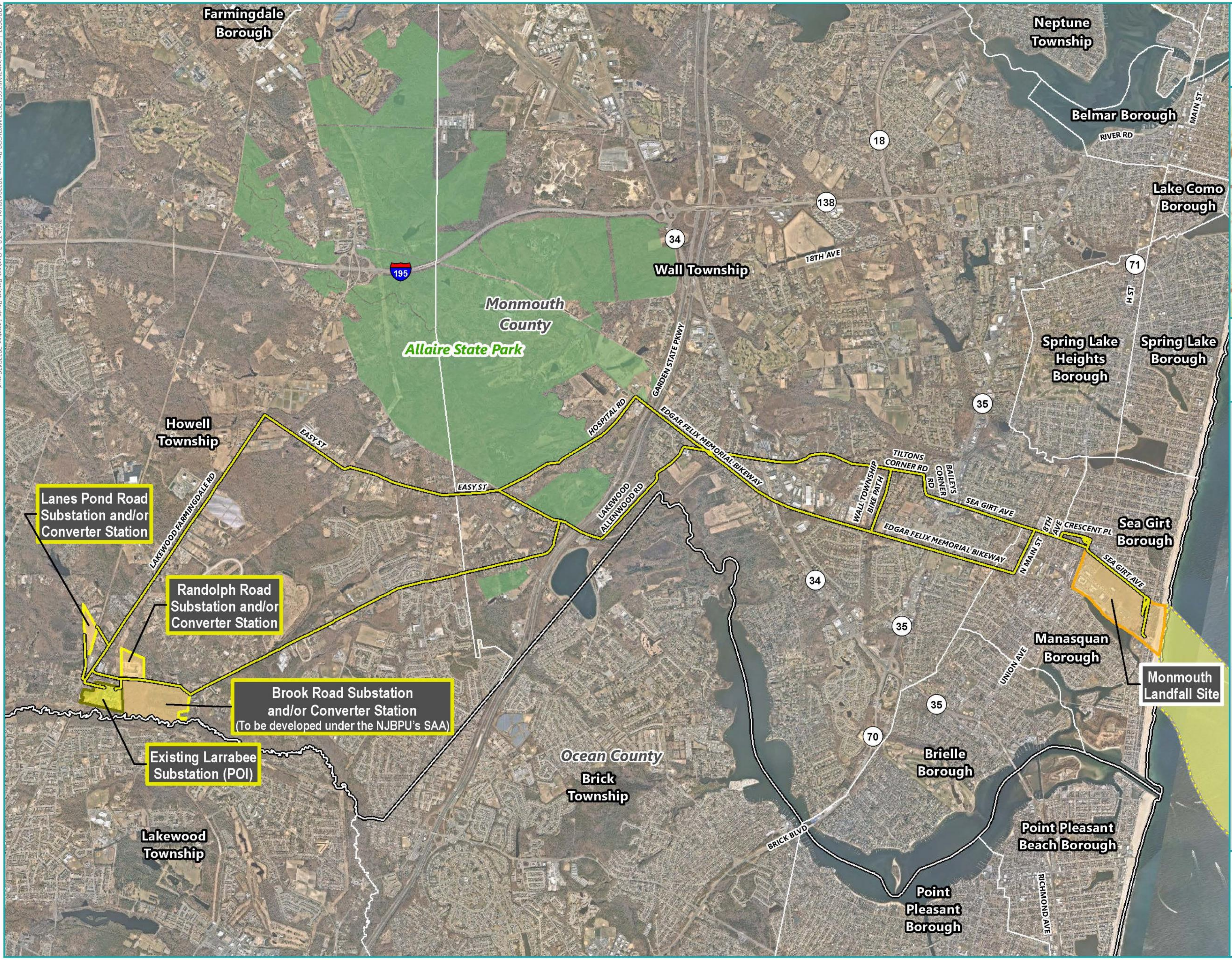
The Larrabee Onshore Interconnection Cable Route occurs within or adjacent to several important transportation routes. Starting at the Monmouth Landfall Site, the route travels west along Sea Girt Avenue and crosses a New Jersey Department of Transportation (NJDOT) surface commuter rail line to New York City. Farther to the west, the route crosses State Route 34 and the Garden State Parkway. Additionally, several bus routes operate in the area, including along Routes 34, 35, 71, and 49.

7.9.1.3 Port Utilization

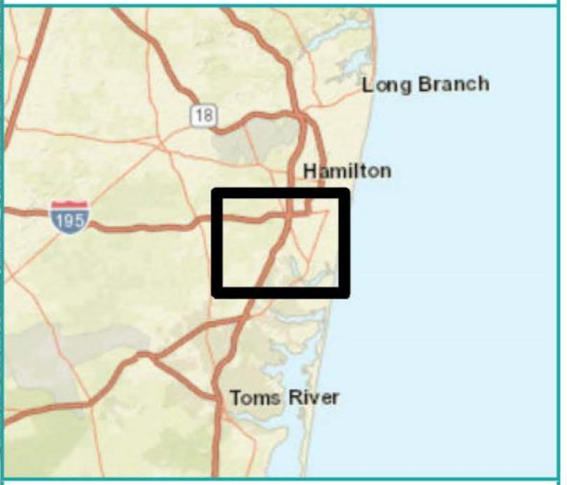
Atlantic Shores has identified several port facilities in New Jersey, New York, the Mid-Atlantic, and New England that may be used for major construction staging activities for the Projects. In addition, some components, materials, and vessels could come from U.S. Gulf Coast, Canadian, and European ports.

Potential construction ports are listed in Section 4.10.3 of Volume I. All ports that may be used are either existing facilities or planned facilities that are expected to be developed by others to support the offshore wind industry. Atlantic Shores does not propose developing any construction or staging port facilities. Activities such as refueling, restocking supplies, sourcing parts for repairs, and potentially some crew transfer, may occur out of ports other than those identified.

Potential O&M ports are described in Section 5.5 of Volume I.



ATLANTIC SHORES offshore wind



0 0.25 0.5 1 Miles

0 0.5 1 Kilometers

N S E W

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

LEGEND

- Larrabee Onshore Interconnection Cable Route Options
- Substation and/or Converter Station Option
- Existing Larrabee Substation (POI)
- Monmouth Export Cable Corridor
- Monmouth Landfall Site
- Allaire State Park
- Municipal Boundaries
- County Boundaries

Figure 7.9-2

Monmouth Landfall Site, Larrabee Onshore Interconnection Cable Route, and Onshore Substation Sites
Monmouth County, New Jersey

7.9.2 Potential Impacts and Proposed Environmental Protection Measures

The IPFs which may affect onshore transportation and traffic during Project construction, O&M, or decommissioning are presented in Table 7.9-1.

Table 7.9-1 Impact Producing Factors for Onshore Transportation and Traffic

Impact Producing Factors	Construction & Installation	Operations & Maintenance	Decommissioning
Onshore Transportation and Traffic	●		●
Port Utilization	●		●

The maximum Project Design Envelope (PDE) analyzed is the maximum onshore build-out of the Projects for onshore transportation and traffic, and the maximum offshore build-out of the Projects for port utilization (see Section 4.11 of Volume I).

7.9.2.1 Onshore Transportation and Traffic

The onshore interconnection cable routes were selected primarily to make use of existing roadway ROWs, utility ROWs, and/or bike paths to avoid or minimize traffic, and transportation-related effects. Given the dense, urban nature of much of the Onshore Project Area, some portions of each onshore interconnection cable route pass through or near transportation corridors. In these areas, Atlantic Shores has evaluated measures to minimize effects.

The Cardiff Onshore Interconnection Cable Routes crosses the Garden State Parkway; however, the crossing will occur at an overpass and therefore will avoid effects to transportation and traffic on the Garden State Parkway. Additionally, the Cardiff Onshore Interconnection Cable Routes runs along a railway ROW; however, this segment of the ROW is a largely inactive rail spur and no impacts to rail traffic are expected.

The Larrabee Onshore Interconnection Cable Routes cross the NJDOT surface commuter rail line to New York City. Atlantic Shores will avoid impacts to the rail line by using trenchless specialty crossing techniques such as HDD, pipe jacking, or jack-and-bore to install the cable beneath the railroad (see Section 4.8.3 of Volume I). Atlantic Shores will coordinate work with NJDOT where needed.

Construction and the associated land disturbance will be limited to discrete areas and therefore, will impact only a specific area for a short period of time. Atlantic Shores will adhere to voluntary seasonal construction restrictions for certain portions of the onshore interconnection cable routes to avoid impacts during peak usage periods. For the Cardiff Onshore Interconnection Cable Route, no onshore construction will occur during the summer (generally from Memorial Day to Labor Day), subject to ongoing coordination with local authorities. Aside from peak summer traffic, these roads also function as a coastal evacuation route, and this seasonal restriction will avoid any interference with that emergency response function. For the Larrabee Onshore Interconnection Cable Route, no summer construction will also occur from the Monmouth Landfall Site to the point at which the route exits the bike path near Allaire State Park at Hospital Road (subject to ongoing coordination with local authorities). This restriction will minimize traffic and recreational disruptions during construction in this area.

Atlantic Shores will also work with local municipalities to develop a Traffic Management Plan (TMP) prior to construction to avoid and minimize traffic- and transportation-related effects. The TMP will be reviewed and approved by the NJDOT for the I-195 corridor and will also pertain to county and local roads. Best management practices (BMPs) for the TMP are expected to include traffic control measures such as signage, police details, lane closures, and detours, among others. Additional specific traffic management strategies implemented by the Projects may include, but will not be limited to, alternate traffic routes, reduced speeds, signal adjustments, physical barriers and channeling devices, alternate truck routes, and others.

Atlantic Shores will also inform the public regarding onshore construction locations and schedules. Information regarding the construction of the Projects may be made available via the Atlantic Shores website, news releases, community meetings, or other means. No meaningful effects or interruptions in service are expected for any bus routes operating along the onshore interconnection cable routes.

Construction hours will be developed in accordance with local noise ordinances. While Atlantic Shores is not anticipating significant nighttime work, any nighttime work deemed necessary will be coordinated with the local authorities. Periodic maintenance of the onshore facilities may be required during the O&M phase of the Projects. Access for maintenance is expected to take place through manholes, thereby avoiding or minimizing land disturbance and impacts to transportation and traffic. Decommissioning effects are expected to be similar to construction.

7.9.2.2 Port Utilization

Project construction, O&M, and decommissioning will require the use of existing ports, which may cause a temporary, minor increase in traffic during construction and decommissioning. As described in Section 7.9.1.3, Atlantic Shores will utilize existing or planned ports that can support offshore wind, including the required workforce. During construction and decommissioning, it is expected that dozens of workers will be required at the port(s) used by the Projects. Although public transit may be available, most workers are expected to commute in their private vehicles. It is expected that parking for commuting workers will be provided onsite. Truck deliveries are not anticipated to be significantly different compared to normal port operations. During O&M, fewer personnel are expected at each port to support the Projects than during the construction and decommissioning periods. Accordingly, Project-related transportation and traffic are not expected to result in any incremental increase in the scope and nature of transportation and traffic associated with existing port activities.

It is expected that the O&M facility will provide between 61-110 permanent jobs in technical services, project planning, data analysis, WTG maintenance and repair, cable and foundation monitoring, and substation maintenance. The number of personnel based at the O&M facility will fluctuate based on the phase of each Project (e.g., commissioning, operations), seasonal maintenance schedules, and logistics decisions regarding crew transfer. The number of personnel may also evolve over the life of the Projects. Similar to other ports that will be used for the Projects, most workers are expected to commute in their private vehicles to the O&M facility and a potential adjacent parking structure may be provided on-site. Alternatively, existing surface lots in Atlantic City could be used. Transportation infrastructure near the O&M facility is expected to be adequate to support the anticipated personnel and traffic associated with the O&M facility is not expected to result in significant changes to existing traffic volumes and conditions.

7.9.2.3 Summary of Proposed Environmental Protection Measures

Project construction, O&M, and decommissioning activities are designed to minimize effects to onshore transportation and traffic:

- A desktop assessment has been conducted of onshore transportation and traffic to inform Project design decisions.
- Voluntary, seasonal construction restrictions will be implemented, and local construction hour ordinances will be followed to avoid peak traffic usage.
- A TMP that includes traffic control measures (e.g., signage, police details, lane closures, and detours, and implementation of BMPs) will be developed and implemented.
- The public will be informed of construction locations and schedules using a variety of communication tools (e.g., via the Atlantic Shores website, news releases, community meetings, or other means).

8.0 IN-AIR NOISE AND HYDROACOUSTICS

This section summarizes the in-air noise and underwater acoustic reports included as Appendices II-U and II-L, respectively.

- The Onshore Noise Report includes a baseline sound monitoring program that measured existing ambient sound levels near the proposed onshore substations and/or converter stations, modeling that predicted future sound levels when the onshore substations and/or converter stations are operational, computer modeling of onshore construction noise, and a comparison of predicted sound levels with applicable noise criteria. The purpose of this assessment is to demonstrate that construction and operations and maintenance (O&M) of the Project will meet all applicable onshore noise regulations. The Onshore Noise Report, included as Appendix II-U as reference, will be updated based upon the latest onshore substation and/or converter station sites within the Onshore Project Area and submitted to BOEM upon completion. Similarly, Figures 8.1-1 through 8.1-4 are included as reference. Atlantic Shores does not anticipate significant differences from the information and conclusions provided within the current Onshore Noise Report due to the proximity to, and similarities with, the previously analyzed sites.
- The Underwater Acoustic and Animal Exposure Modeling of Construction Sound Report includes acoustic modeling of pile driving activities and a predicted number of individual animals potentially exposed to sound levels above regulatory thresholds that may elicit a behavioral response or cause injury.

Section 8.1 summarizes the in-air noise assessment and Section 8.2 summarizes the underwater noise assessment.

8.1 In-Air Noise

The Onshore Noise Report (see Appendix II-U) analyzes potential in-air sound level effects from the construction and O&M of the Projects' onshore facilities. This analysis focuses on potential impacts of the Projects to people living and working in the community (see Section 7.3 Recreation and Tourism). While Atlantic Shores recognizes that there may be some temporary minor effects on terrestrial wildlife, the focus of the in-air noise analysis is the human element.

Atlantic Shores has conducted a noise assessment of Project construction and O&M activities to support compliance with applicable noise regulations, as well as to support both facility design and construction planning to ensure noise generated by the Projects does not have a negative effect on surrounding communities. Localized and short-term generation of in-air noise may occur during construction. O&M of the onshore substations and/or converter stations (referred to as the "onshore site[s]") may result in minor and localized noise generation. Operational noise from the Projects' onshore facilities will emanate from the onshore substation and/or converter station components, primarily the power and step-up transformers, variable shunt reactors (VSR), voltage source converter (VSC) reactors, harmonic filter reactors, and fan banks.

The following sections cover applicable noise regulations, the results of a baseline onshore sound level monitoring program, modeled onshore operation sound levels, modeled onshore construction sound levels, and proposed sound-level protection measures.

8.1.1 Noise Regulations

Pursuant to the State of New Jersey's Noise Control Act of 1971, the New Jersey Department of Environmental Protection (NJDEP) promulgated noise regulations to control noise from stationary commercial and industrial sources in 1974 (see N.J.A.C. 7:29). The noise regulations establish broadband (A-weighted[72]) limits, as well as octave band level limits for daytime (7 a.m. to 10 p.m.) and nighttime (10 p.m. to 7 a.m.) continuous noise sources at industrial, commercial, or community service facilities.

The Projects' onshore sites are continuous noise sources[73] that fall under the category of "industrial facility." Thus, the most stringent broadband noise limits for the onshore sites would be 65 A-weighted decibels (dBA) during the day and 50 dBA at night. The sound level limits do not apply to construction noise which is regulated at the local level by allowing construction activity during specific hours and days of the week.

8.1.2 Baseline Sound Level Monitoring Program

To characterize the existing soundscape of the Onshore Project Area, an ambient (baseline) sound level monitoring program was conducted in August 2020 and November 2021 around the Projects' original sites for the Larrabee and Cardiff onshore substation and/or converter stations. The Larrabee Onshore Interconnection Cable route will also include three additional substation and/or converter station options at Lanes Pond Road Substation Site, Randolph Road Substation Site, and Brook Road Substation Site. The Cardiff Onshore Interconnection Cable route will also include an additional substation and/or converter station option at Fire Road Substation Site. At each onshore substation and/or converter station site, two to four sound monitoring locations were selected to represent nearby residences and commercial sites (i.e., noise sensitive receptors) in various directions from the onshore substation and/or converter station. Figure 8.1-1 shows the sound level measurement locations around the original locations of the Larrabee onshore substations and/or converter stations, and Figure 8.1-2 shows the sound level measurement locations around the original location of the Cardiff onshore substation and/or converter station. At each monitoring location, sound levels were monitored for 20 minutes during the day and for 20 minutes at night using a programmable, attended sound level meter. The sound level meter measured A-weighted broadband levels and one-third octave bands from 6.3 hertz (Hz) to 10,000

---

72 Environmental sound is typically composed of acoustic energy across a wide range of frequencies; however, the human ear does not interpret the sound level from each frequency as equally loud. To compensate for the physical response of the human ear, the A-weighting filter is commonly used for describing environmental sound levels. The A-weighting filters the frequency spectrum of sound levels to correspond to the frequency response of the human ear (attenuating low and high frequency energy similar to the way people hear sound).

73 NJDEP also regulates noise from impulsive (very short duration) noise sources; impulsive noise sources occurring less than four times per hour must have sound levels less than 80 dBA. However, the impulsive noise limits do not apply to the onshore sites because these are continuous noise sources.

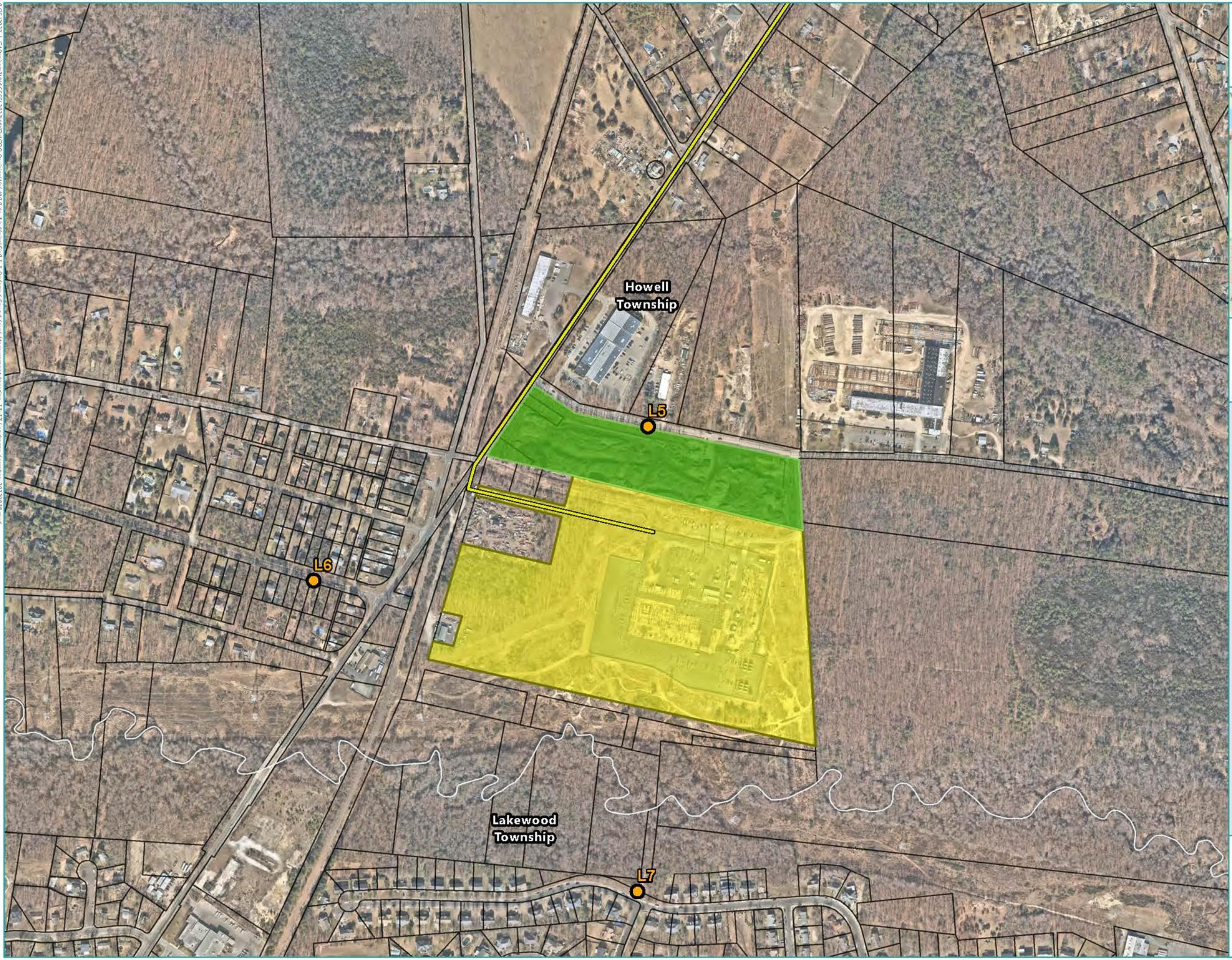
Hz. Meteorological observations (e.g., local wind speed, relative humidity, and temperature) were also made at each monitoring location using handheld instrumentation.

Collected ambient sound level data were processed per American National Standards Institute (ANSI) standards to remove monitoring periods that experienced elevated ground-level wind speeds (greater than 5 meters per second [m/s]) or precipitation. Seasonal noise (e.g., insect noise) was removed from the ambient sound level measurements using a high-frequency natural sound (HFNS) filter. The baseline sound level monitoring results are presented in Section 6 of Appendix II-U. Many of the monitoring locations measured existing sound levels above the NJDEP sound level limits.

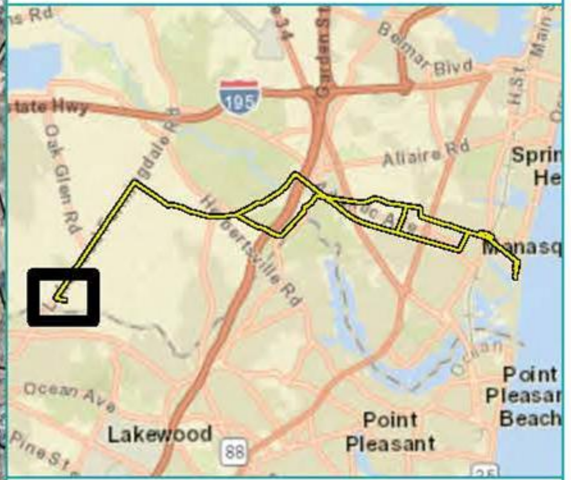
8.1.3 Onshore Operational Noise

The analysis of onshore in-air operational noise examined expected sound levels from the Projects' onshore site equipment. The proposed onshore site design and specific equipment will depend on whether the onshore interconnection cables are high voltage alternating current (HVAC) or high voltage direct current (HVDC). Because HVDC equipment is expected to be primarily indoors, it is anticipated that the HVDC design would have generally lesser sound impacts on the surrounding community than the HVAC design. However, given that there is a possibility that the proposed onshore substations and/or converter stations may consist of a combined HVAC/HVDC configuration, sound level modeling was conservatively performed including the equipment from both designs as it represents the reasonable worst-case scenario under a Project Design Envelope (PDE) approach.

Project-only sound levels were modeled at numerous commercial and residential receptors using Cadna/A noise calculation software. All modeled onshore site noise sources (e.g., transformers, shunt reactors, and harmonic filters) were assumed to be operating simultaneously. At both of the originally proposed onshore sites, noise control features were incorporated into the modeling to limit sound level impacts in neighboring communities. Noise control design features included sound power level specifications for some pieces of equipment, as well as barrier walls at both of the original potential onshore sites (i.e., the Larrabee site and Cardiff site). These noise control features were added for the onshore sites to demonstrate compliance with the NJDEP noise regulations at the nearest noise sensitive receptors. The ultimate noise control solution will be decided in final design and will consider quieter equipment, noise barrier walls, site layout, or some combination of these elements to ensure compliance with the applicable noise regulations at the time of construction.



ATLANTIC SHORES offshore wind



0 225 450 Feet
0 65 130 Meters

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

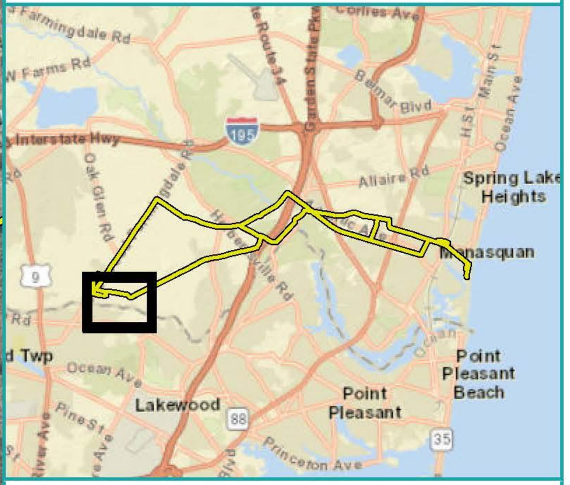
LEGEND

- Sound Level Measurement Location
- Larrabee Onshore Interconnection Cable Route Options
- Existing Larrabee Substation (POI)
- Originally Proposed Substation and/or Converter Site
- Parcel Boundaries
- Municipal Boundaries

Figure 8.1-1

Sound Monitoring Locations - Larrabee Onshore Interconnection Cable Route and Originally Proposed Onshore Substation and/or Converter Station
Monmouth County, New Jersey

ATLANTIC SHORES offshore wind



0 150 300 600 Feet

0 60 120 Meters

N W E S

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, July 2020

LEGEND

- Sound Level Measurement Location
- Larrabee Onshore Interconnection Cable Route Options
- Substation and/or Converter Station Option
- Existing Larrabee Substation (POI)
- Municipal Boundaries
- County Boundaries

Figure 8.1-1B

Sound Level Measurement Locations - Brook Road Substation and/or Converter Station Option for the Larrabee Onshore Interconnection Cable Route Atlantic County, New Jersey

Figure 8.1-2

Sound Level Measurement Locations - Fire Road Substation and/or Converter Station for the Cardiff Onshore Interconnection Cable Route Atlantic County, New Jersey

Table 8.1-1 compares the broadband sound level modeling results for the originally proposed onshore sites to the NJDEP noise regulations described in Section 8.1.1. Modeled sound levels showed that, assuming noise control features (i.e., combination of quieter equipment and/or barrier walls) are employed, noise levels from the originally proposed onshore sites comply with the A-weighted sound limits at all modeled receptors.[74] Once the final onshore site is selected and design is complete, the noise mitigation measures will be refined. Figure 8.1-3 illustrates the location of each receptor with respect to the originally proposed Larrabee onshore site while Figure 8.1-4 illustrates the location of each receptor with respect to the originally proposed Cardiff onshore site.

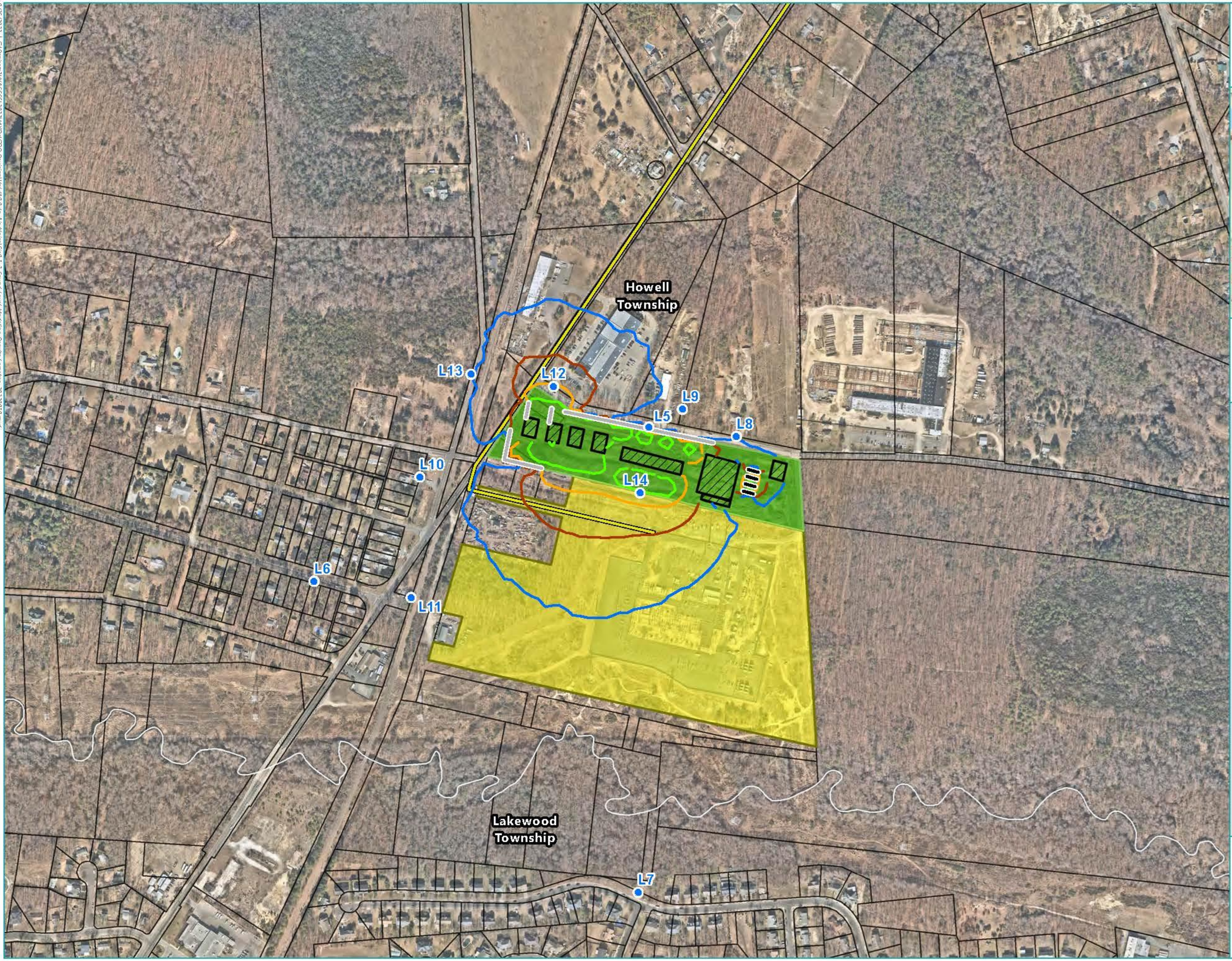
Table 8.1-1 Onshore Site Sound Level Results

Receptor IDs	Receptor Land Use	Modeled Project-Only Sound Levels (dBA)	NJDEP Sound Level Limit (Day, dBA)	NJDEP Sound Level Limit (Night, dBA)
Larrabee – Randolph Road Mulching Site				
L5*, L12, L14	Commercial	46-63	65	65
L6*, L7*, L8, L9, L10, L11, L13	Residential	42-50	65	50
Cardiff – Vacant Commercial Center Site				
C10, C11	Commercial	62	65	65
C1*, C2*, C3*, C4, C5, C6, C7, C8, C9, C12	Residential	44-50	65	50

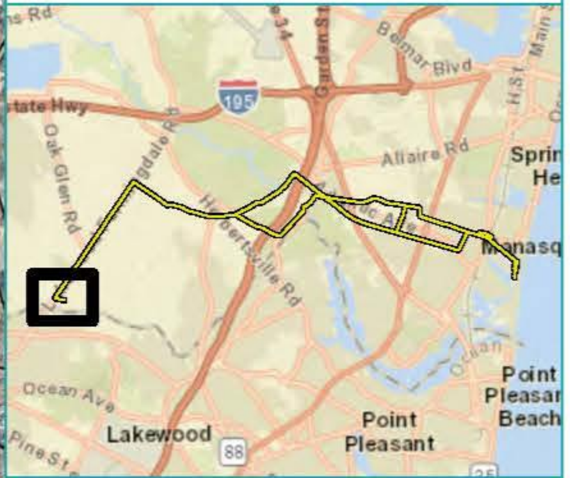
Note:

* Denotes that the receptor was also a sound level measurement location (see Section 8.1.2).

74 Because the onshore sites are in the early design stage, no octave band sound level data were available for the equipment included in the model. Therefore, octave band sound levels from the onshore sites could not be evaluated against the NJDEP octave band limits.



ATLANTIC SHORES
offshore wind



0 225 450 Feet
0 65 130 Meters

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

LEGEND

- Modeling Receptor
- Modeled On-site Buildings
- Sound Barriers
- Firewalls
- Larrabee Onshore Interconnection Cable Route Options
- Existing Larrabee Substation (POI)
- Originally Proposed Substation and/or Converter Site
- Parcel Boundaries
- Municipal Boundaries

Predicted Sound Level (dBA)

- 50
- 55
- 60
- 65

Figure 8.1-3

Sound Modeling Result - Larrabee Onshore Interconnection Cable Route and Originally Proposed Onshore Substation and/or Converter Station
Monmouth County, New Jersey

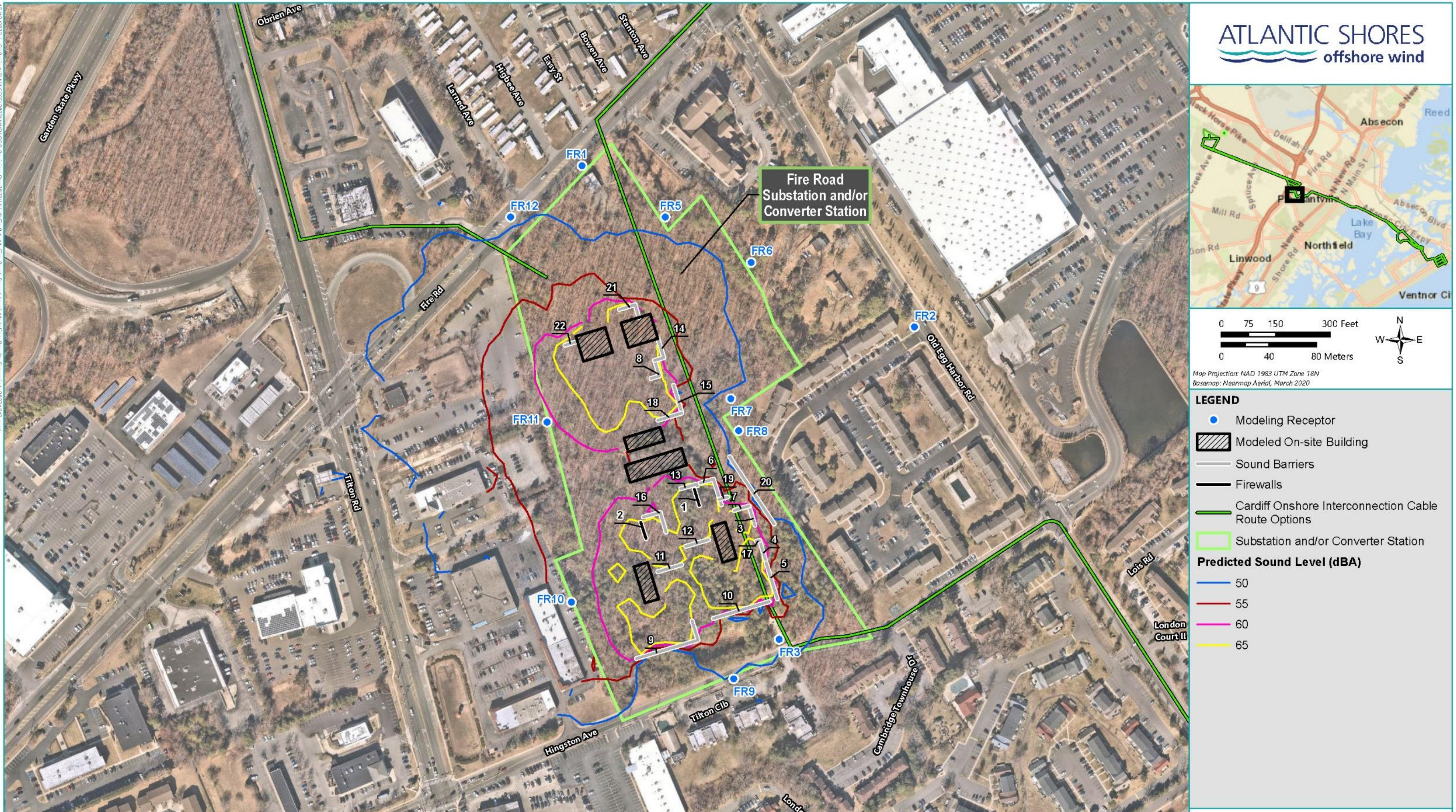
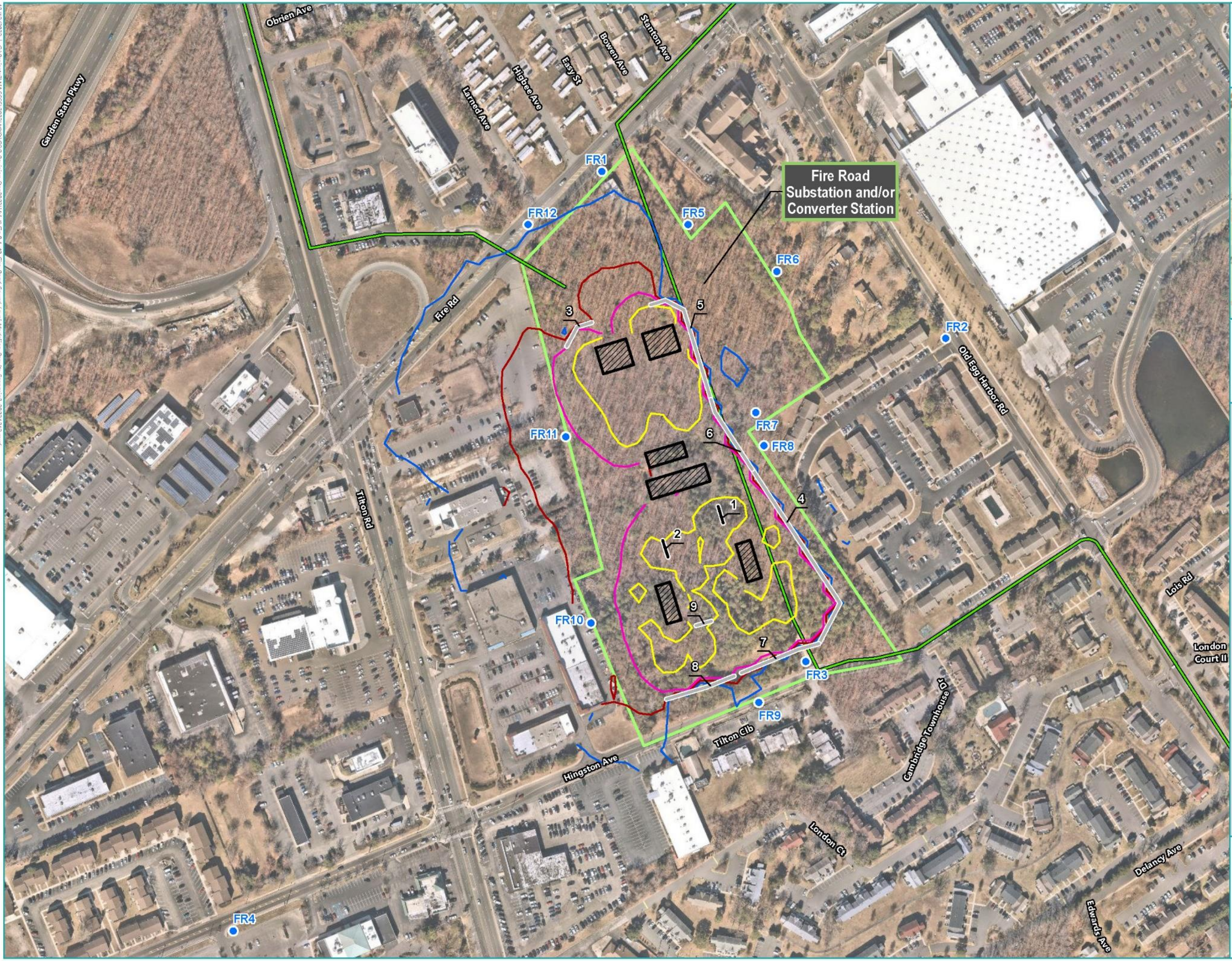
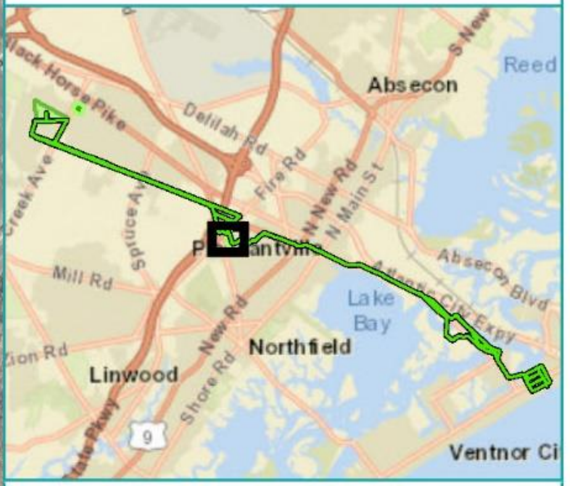


Figure 8.1-4A

Sound Level Modeling Results (Scenario 1) - Fire Road Substation and/or Converter Station for the Cardiff Onshore Interconnection Cable Route Atlantic County, New Jersey



ATLANTIC SHORES
offshore wind



0 75 150 300 Feet
0 40 80 Meters

Map Projection: NAD 1983 UTM Zone 18N
Basemap: Nearmap Aerial, March 2020

LEGEND

- Modeling Receptor
- Modeled On-site Building
- Sound Barriers
- Firewalls
- Cardiff Onshore Interconnection Cable Route Options
- Substation and/or Converter Station

Predicted Sound Level (dBA)

- 50
- 55
- 60
- 65

Figure 8.1-4B

Sound Level Modeling Results (Scenario 2) - Fire Road Substation and/or Converter Station for the Cardiff Onshore Interconnection Cable Route Atlantic County, New Jersey

8.1.4 Onshore Construction Noise

There will be temporary noise from the construction of the Projects' onshore sites, installation of the onshore interconnection cables, and horizontal directional drilling (HDD) at the landfall sites where the export cables transition from offshore to onshore. As noted in Section 8.1.1, the NJDEP sound level limits do not apply to construction noise; construction noise is regulated by local ordinances that allow construction during specific hours and days of the week. Construction hours will adhere to local ordinances, and Atlantic Shores anticipates that typical construction hours will extend between 7 am and 6 pm (weekdays), depending on local noise ordinances. Construction activities will be conducted outside of the peak tourism season (generally Memorial Day to Labor Day). While Atlantic Shores is not anticipating significant nighttime work, any nighttime work deemed necessary will be coordinated with the local authority.

Onshore site construction will resemble typical construction at a power plant or mainland substation. Construction equipment can be expected to include excavators, concrete trucks, backhoes, cranes, typical grading equipment, and other support vehicles. Based on maximum sound levels provided by the U.S. Environmental Protection Agency (EPA) (1971) for five major phases of construction (i.e., ground clearing, excavation, foundations, erection, and finishing), sound levels from onshore site construction were estimated at receptors nearby the originally proposed onshore sites using modeling (see Table 8.1-2). Figure 8.1-1 shows the location of receptor IDs L5-L7, and Figure 8.1-2 shows the location of receptor IDs C1-C4.

Table 8.1-2 Extrapolated Maximum Sound Levels for Onshore Site Construction Phases

Receptor ID	Approx. Distance to Substation Property Line (feet [ft])	Estimated Sound Level (dBA)				
		Ground Clearing	Excavation	Foundations	Erection	Finishing
Larrabee – Randolph Road Mulching Site						
L5	30	88	92	92	83	88
L6	1,090	57	61	61	52	57
L7	1,885	52	56	56	47	52
Cardiff – Vacant Commercial Center Site						
C1	100	78	82	82	73	78
C2	105	78	82	82	73	78
C3	740	61	65	65	56	61

Installation of the onshore interconnection cables and concrete duct bank will require typical construction equipment such as dump trucks, front-end loaders, concrete trucks, and excavators. Onshore interconnection cable installation will also require specialized construction vehicles such as winches and cable reel trucks. Onshore interconnection cable installation will generate noise levels that are periodically audible along the route. Noise and construction equipment will be similar to that for typical public works projects (e.g., road resurfacing, storm sewer installation, etc.).

The offshore-to-onshore export cable transition will be accomplished using HDD at the landfall sites. The Monmouth Landfall Site is located within the Borough of Sea Girt in Monmouth County, New Jersey at the U.S. Army National Guard Training Center. The Atlantic Landfall Site, revised from the originally proposed location between Albany Avenue and California Avenue, will now be located on a parcel of land that is currently used as a public parking lot bounded by Pacific, South Belmont, and South California Avenues and California Avenue within Atlantic City in Atlantic County, New Jersey.

Table 8.1-3 summarizes the expected maximum sound levels at the nearest residential receptors around the HDD at each landfall site, assuming the loudest portion of HDD activity is onshore. The modeled sound levels do not include any noise control, although it is expected that mitigation measures will be developed as the design advances. Such mitigation measures may include use of a low noise/muffled generator, portable sound walls (temporary noise barriers) as needed, blocking the path of equipment, and working with municipalities to coordinate work schedules.

Table 8.1-3 Modeled Sound Levels from HDD Activity

Receptor ID	Sound Level (dBA)
Monmouth Landfall Site	
10 2nd Ave	63
45 Beachfront	58
9 Sea Girt Ave	55
1001 Ocean Ave	49
Atlantic Landfall Site Option 1 – S California Avenue[1]	
2923 Sunset Ave	77
403 E Main St	61
24 S California Ave	67

[1] Data presented is associated with original HDD landfall location. Sound level modeling will be updated based on the revised location of HDD landfall location.

8.1.5 Summary of Potential Effects and Proposed Environmental Protection Measures

Results of the onshore noise assessment are used to understand potential effects to members of the public (see Section 7.3 Recreation and Tourism), although Atlantic Shores recognizes that noise may also have a limited effect on terrestrial wildlife. These types of effects to wildlife are addressed in Sections 4.2 Coastal and Terrestrial Habitat and Fauna, 4.3 Birds, and 4.4 Bats.

Operation of the onshore sites will be designed to comply with the NJDEP sound level limits and will include sound level mitigation as needed. While intermittent increases in noise levels are expected during onshore construction, Atlantic Shores will make every reasonable effort to minimize noise impacts from construction. Construction-period mitigation measures may include using quieter equipment, assuring the functionality of equipment, and adding mufflers or noise-reducing features, using portable sound walls (i.e., temporary noise barriers), and replacing back-up alarms on trucks and equipment with strobes, as allowed within Occupational Safety and Health Administration (OSHA) regulations.

Atlantic Shores is proposing to adhere to seasonal construction restrictions during the peak tourist season to minimize effects from temporary noise. No onshore construction in areas near the coast, including HDD at the landfall sites, will occur during the summer (generally from Memorial Day to Labor Day), subject to ongoing coordination with local authorities. Additionally, the daily hours of operation for onshore construction activities, including HDD, will be developed in accordance with municipal noise ordinances. Any work that needs to extend outside allowed construction hours will be discussed with local officials and waivers will be obtained, if necessary. To further minimize the effects of construction noise, Atlantic Shores will maintain strong communication and public outreach with adjacent neighbors about the time and nature of construction activities.

8.2 Underwater Noise

The Underwater Acoustic and Animal Exposure Modeling of Construction Sound Report (see Appendix II-L1) provides acoustic modeling of pile driving activities, including a predicted number of individual animals potentially exposed to sound levels that may elicit a behavioral response or cause injury, as well as a qualitative assessment of other anthropogenic noise sources. Atlantic Shores is in the process of updating the acoustic modeling based on new data and will submit an updated Appendix II-L1 upon completion. Construction activities will result in the short-term generation of underwater noise from pile driving and other Project activities such as high resolution geophysical (HRG) surveys and vessel engines, thrusters, and propellers. Atlantic Shores has conducted underwater acoustic and animal exposure modeling to support the Projects' understanding of the potential effects of construction noise on marine wildlife, namely marine mammals, sea turtles, and fish, along with the associated options for mitigation. The following sections describe the model inputs and the modeling steps. Detailed results of the hydroacoustic modeling, potential effects to marine organisms, and mitigation measures are presented in Sections 4.5 Benthic Resources, 4.6 Finfish, Invertebrates, and Essential Fish Habitat, 4.7 Marine Mammals, and 4.8 Sea Turtles.

8.2.1 Model Inputs

The hydroacoustic modeling considers the proposed development of the Wind Turbine Area (WTA) in its entirety (i.e., for Projects 1 and 2 combined) and is based on parameters included in the PDE detailed in Section 4.0 of Volume I. For both Projects, Atlantic Shores is proposing to install up to 200 wind turbine generators (WTGs), up to 10 offshore substations (OSSs), and one permanent meteorological (met) tower in the WTA over a 2-year offshore construction period. The PDE includes two piled foundation types that are the focus of the hydroacoustic modeling: monopiles and jackets. The jacket foundations may be "pre-piled" (where piles are driven, and the jacket is subsequently set on the piles) or "post-piled" (where the piles are driven through guides mounted to the base of each jacket leg after the jacket is set on the seafloor).

The hydroacoustic modeling includes the following key inputs:

- Foundation types:
    - WTG and met tower foundations may include monopiles or jackets. If jackets (Project 2 only), foundations are pre-piled and may include up to four piles.
    - OSS foundations are post-piled jackets and may include up to 24 piles.
- Pile diameters:
    - Under the maximum design scenario in the Project PDE, monopile foundations have a diameter of up to 49.2 feet (ft) (15.0 meters [m]).
    - Under the more realistic "base-case" scenario, monopile foundations have a diameter of up to 39.4 ft (12.0 m).
    - Jacket piles have a diameter of up to 16.4 ft (5.0 m).
- Hammer energy, model, and number of strikes:
    - The maximum expected hammer size for installation of monopiles is up to 4,400 kilojoules (kJ) whereas the maximum expected hammer size for jacket pin piles is 2,500 kJ.
    - The representative make and model of impact hammers and the hammer energy schedule used in the acoustic modeling are presented in Table 1 of Appendix II-L1.
- Site-specific conditions including bathymetry, sound speed in the water column, and seabed geoacoustics:
    - Modeling was conducted at two sites representing the range of water depths within the WTA: Location 1 was at a water depth of 118 ft (36.1 m) and Location 2 was at a water depth of 92 feet (28.1 m) (see Figure 2 in Appendix II-L1).

- Installation schedule:
    - Pile driving occurs in the months of May to December.
    - Only one monopile or four jacket piles are installed per day, with no concurrent pile driving.

The expected number of days of piling each month are provided in Table 8.2-1 (see also Table 3 of Appendix II-L1). Construction Schedule 1 assumes all WTGs and the met tower will be supported by 49.2 ft (15.0 m) monopile foundations. Construction Schedule 2 assumes all WTGs and the met tower will be supported by pre-piled jacket foundations. In both Schedules 1 and 2, the OSS jacket foundations were modeled assuming post-piled installation.

Table 8.2-1 Modeled Foundation Installation Schedules for Monopile and Jacket Foundation Approaches, Atlantic Shores Offshore Wind Project

Construction month	Schedule 1: WTG Monopile Two Year Duration		Schedule 2: WTG Monopile and Jacket Two Year Duration				Schedule 3: WTG Monopile One Year Duration	
	WTG Monopile 15 m diameter MHU4400S (1 pile/day)	**OSS Jacket 5 m diameter** IHCS2500 (4 piles/day)	**WTG Monopile 15 m diameter** MHU4400S (1 pile/day)	**WTG Jacket 5 m diameter** IHCS2500 (4 piles/day)	**OSS Jacket 5 m diameter** IHCS2500 (4 piles/day)	**WTG Monopile 15 m diameter** MHU4400S (1 pile/day)	**WTG Monopile 15 m diameter** IHCS2500 (2 piles/day)	**OSS Jacket 5 m diameter** IHCS2500 (4 piles/day)
May	13	0	8	5	0	9	3	0
Jun	35	12	20	15	12	8	16	6
Jul	45	0	25	20	0	10	15	6
Aug	37	12	19	18	12	0	25	6
Sep	32	0	18	14	0	1	12	6
Oct	29	0	16	13	0	13	6	0
Nov	9	0	5	4	0	3	1	0
Dec	1	0	1	0	0	1	0	0
Total Piling Days	**201**	**24**	**112**	**89**	**24**	**45**	**78**	**24**
Total Piles	**201**	**96**	**112**	**356**	**96**	**45**	**156**	**96**
Total Foundations	**201**	**4**	**112**	**89**	**4**	**45**	**156**	**4**

1 One, 4-legged jacket foundation installation is assumed per day.
2 One monopile foundation installation is assumed per day.
3 The WTG jacket foundation is pre-piled, and the OSS jacket foundation is post-piled.
4 Total under WTG monopile foundation includes one met tower monopile foundation.

8.2.2 Modeling Process

The hydroacoustic modeling and assessment process involved five primary steps to evaluate the potential risk from acoustic exposure for marine mammals, sea turtles, and fish:

- Source modeling was conducted to determine sound transmission from impact pile driving. Sound transmission to marine organisms can occur directly through the water, as a result of reflection from the water's surface or seabed, or as a result of sound being re-radiated from the seabed into the water. The sound source modeling and the accompanying forcing functions for impact pile driving were computed for each pile type using GRLWEAP 2010 (GRLWEAP, Pile Dynamics 2010).

- Sound propagation modeling was used to estimate the three-dimensional sound fields generated from pile driving activities. Specifically, the propagation modeling determined distances to regulatory-defined acoustic thresholds that may elicit a behavioral response or cause injury to marine species; these distances to acoustic thresholds are referred to as "acoustic ranges." Behavioral thresholds are provided relative to sound pressure levels (SPL or L_p) and injurious thresholds are provided relative to sound exposure levels (SEL or L_E) and peak pressure levels (PK or L_{PK}).[75] Propagation modeling used the Marine Operations Noise model (MONM) and Full Wave Range Dependent Acoustic Model (FWRAM) developed by JASCO.

- The use of noise abatement systems (NAS) such as bubble curtains was incorporated into the modeling. To account for the likely minimum sound reduction resulting from NAS, hypothetical broadband noise attenuation levels of 6 decibels (dB), 10 dB, and 15 dB were incorporated into the model results for exposure ranges (described in Step 4) and exposure estimates (described in Step 5).

- As described in Sections 4.7 Marine Mammals and 4.8 Sea Turtles, animal movement modeling was conducted to account for the fact that an animal will not remain in a static position for the duration of pile driving. The animal movement modeling incorporated realistic behaviors (e.g., diving, foraging, aversion, and surface times) for the simulated animals (animats) used in the modeling. The results of the animal movement modeling were used to estimate the received sound levels for animals near the construction area. The results were also used to calculate the radial distances from the pile (referred to as "exposure ranges") within which 95% of animats may be exposed above the relevant thresholds for behavioral response or injury for marine species. Animal movement modeling used the Animal Simulation Model Including Noise Exposure (JASMINE) developed by JASCO.

- Following the completion of the preceding modeling steps, the number of animals exposed to sound levels above threshold values was estimated using the local animal densities to scale the number of animats exposed above threshold criteria in the model. While exposure estimates were calculated for a range of hypothetical noise attenuation levels as described in Step 3, the exposure estimates used to assess potential effects to marine mammals and sea turtles (described in Sections 4.7 Marine Mammals and 4.8 Sea Turtles, respectively) conservatively included 10 dB as an achievable sound reduction level when one NAS is in use during pile driving, based on a recent analysis of NAS (Bellmann

[75] See Section 2.5 of Appendix II-L1 for a description of injurious and behavioral acoustic thresholds used to evaluate potential effects to marine mammals. Acoustic thresholds used to evaluate potential effects to fish and sea turtles are discussed in Section 2.6 of Appendix II-L1.

et al. 2020). The assumption represents the minimum sound reduction expected from NAS, such as bubble curtains.

8.2.3 Summary of Potential Effects and Proposed Environmental Protection Measures

The hydroacoustic analysis predicted the sound fields generated by the Projects and potential effects to marine species. To reduce the effects of underwater noise on marine wildlife, Atlantic Shores will implement reasonable NAS (e.g., bubble curtains, sleeves, and hydro-dampeners) to achieve a minimum of 10 dB of attenuation. The model results include conservative assumptions and do not consider the mitigation measures that Atlantic Shores is proposing in addition to use of a NAS, which are expected to substantially reduce risk. Detailed results of the hydroacoustic modeling, potential effects to marine wildlife, and environmental protection measures are presented in Sections 4.5 Benthic Resources, 4.6 Finfish, Invertebrates, and Essential Fish Habitat, 4.7 Marine Mammals, and 4.8 Sea Turtles. As described further in those sections, environmental protection measures during impact pile-driving activities include, but are not limited to, the following:

- Seasonal restrictions on construction activity to avoid months (January to April) when North Atlantic right whale densities are higher
- Initiation of pile driving only when it is expected that pile driving can be completed during daylight hours
- Equipment operating procedures (e.g., soft starts, ramp-downs, and shut-downs)
- Daytime and nighttime visual monitoring by NOAA Fisheries-approved Protected Species Observers (PSOs)
- Use of Passive Acoustic Monitoring (PAM)
- Evaluation of innovative monitoring technologies such as, autonomous underwater vehicles and unmanned aerial systems
- Designation of species-specific shutdown and clearance zones.

9.0 PUBLIC HEALTH AND SAFETY

The Projects will produce clean, renewable energy from offshore wind. While construction, O&M, and decommissioning activities associated with the Projects will generate some air pollutant emissions (see Section 3.1 Air Quality) and wastes (see Section 7.0 of Volume I), the generation of energy from offshore wind itself is emission-free and waste-free, and thus poses minimal risks to public health and safety. In fact, as described in Section 2.2 of Volume I, the Projects will have significant environmental and public health benefits. By displacing electricity from pollution-emitting fossil fuel power plants that otherwise would be required to serve the projected increase in electric demand within regional electric markets over the life of each Project, the Projects will result in a region-wide net decrease in harmful air pollutant emissions. Such emissions damage sensitive ecosystems (by contributing to acid rain, ocean acidification, and ground level ozone/smog) and are linked to increased rates of public health issues (e.g., early death, stroke, heart attacks, and respiratory disorders). The Projects will also result in a net decrease in greenhouse gas (GHG) emissions that contribute to climate change.

This section discusses potential public health and safety concerns and issues that may arise during the life of the Projects, including public access and security, electromagnetic fields (EMF), and non-routine and low probability events such as vessel allisions and collisions, accidental spills, and significant infrastructure failure. For the purposes of this analysis, public health and safety concerns are anticipated to be the same for Project 1 and Project 2.

Health, safety, security, and environmental (HSSE) protection are critical components of all Atlantic Shores planning and activities. Atlantic Shores is committed to full compliance with applicable HSSE regulations and codes throughout the pre-construction, construction, O&M, and decommissioning phases of the Projects. As described in Section 1.5.3 of Volume I, Atlantic Shores will implement the following HSSE plans: Safety Management System (SMS), Oil Spill Response Plan (OSRP), and Spill Prevention, Control, and Countermeasure (SPCC) Plan. Many of the events described in this section are unlikely to occur. The Atlantic Shores HSSE plans and systems further reduce the risk that such events may arise and prescribe the response actions needed to address any incidents that do manifest.

9.1 Public Access and Security

Atlantic Shores will employ numerous strategies to ensure that the Projects' facilities are secure and to keep the public safe during offshore construction, O&M, and decommissioning. As described in Section 1.4.2 of Volume I, Atlantic Shores will keep stakeholders informed about the Projects through several stakeholder engagement tools including, but not limited to, employing a Community Liaison Officer, maintaining an up-to-date and interactive Projects website, and providing Projects updates via various social media platforms.

Offshore

As described in the draft SMS provided as Appendix I-E, access to the offshore facilities will be controlled by the Site Manager (or designated subordinate), and personnel intending to transfer to the offshore facilities must have the necessary training and certificates (e.g., sea survival training), medical fitness for duty verification, and site-specific induction training. The wind turbine generator (WTG), offshore substation (OSS), and met tower foundations will include signage in multiple locations (e.g., near the boat landing) restricting access to authorized individuals. However, the access ladders on the WTG and OSS foundations will be designed to allow distressed mariners access to an open refuge area above the splash zone. Beyond the refuge area, a locked door will prevent access to the OSS or WTG work platform or interior. The presence of a person on the offshore structure will be detected, for example, by cameras or intrusion detectors.

The offshore cables will be buried beneath the seabed to sufficient depths or protected with cable protection (in limited areas) to prevent damage from marine activities.

During offshore construction or O&M activities, it is anticipated that temporary safety buffer zones will be established around the working areas to reduce hazards. These safety buffer zones will only cover a small portion of the Wind Turbine Area (WTA) or Export Cable Corridors (ECCs) and will be limited to the duration of work being conducted.

Onshore

During onshore interconnection cable installation, active worksites will be secured. When no work is being performed, trenches or holes will either be temporarily covered, or barricades will be used in compliance with local construction permit requirements. Atlantic Shores will develop a Traffic Management Plan (TMP) to avoid and minimize traffic- and transportation-related effects during onshore construction (see Section 7.9.2.1). Best management practices (BMPs) for the TMP are expected to include traffic control measures such as signage, police details, lane closures, and detours, among others. The TMP will be reviewed with police and fire departments and local authorities to address emergency vehicle access. Once the onshore interconnection cables are installed, access to the cables will be restricted via manhole covers.

For the construction of the onshore substations and/or converter stations, temporary fencing and signage will be installed to prevent public access to the construction site. Site access will be gated, and security personnel will be located at the gate during construction work hours. Once the onshore substation and/or converter station is operational, a security plan will control site access by employing permanent fencing (with earth grounding), screening barriers, camera systems, signage, and physical barriers.

9.2 Non-Routine and Low Probability Events

Non-routine and low probability events are defined as incidents of high potential consequence that are not likely to occur. The types of non-routine and low probability events that could occur during construction, O&M, and/or decommissioning of the Projects include the following:

- vessel allisions (a vessel striking a stationary object such as a WTG or OSS), collisions between vessels, and accidental vessel grounding
- severe weather and natural events
- offshore, coastal, and onshore spills and other accidental releases
- significant infrastructure failure, including cable damage or displacement
- terrorist attacks.

The following subsections provide information regarding these types of non-routine and low probability events and the measures Atlantic Shores has taken to ensure that the potential risks associated with these events (should they occur) have been minimized to the maximum extent practicable.

9.2.1 Vessel Allisions, Collisions, and Grounding

Allisions occur when a vessel strikes a stationary object, such as a WTG or OSS. Collisions occur when a vessel strikes another moving object, such as a vessel. Grounding occurs when a vessel strikes the seabed in shallow waters.

The Projects' Navigation Safety Risk Assessment (NSRA) provided as Appendix II-S analyzed the risk of two types of allisions: drifting allisions and powered allisions. Drifting allisions occur when a vessel loses propulsion and/or the ability to steer and is transported by currents and wind into a structure. Powered allisions occur when a vessel strikes a structure while moving under power as the result of human error. The NSRA also analyzed three types of collisions between vessels (head-on, overtaking, and crossing). Given the bathymetric conditions of the WTA, accidental vessel grounding was not considered a significant source of risk, although shallower water is present in each ECC near the landfall sites.

The NSRA found that the presence of structures and increase in vessel traffic due to the Projects may cause a small potential increase in accident frequencies. The frequency of accidents changed from 0.089 accidents per year under existing conditions (an 11-year return period) to 0.10 to 0.11 accidents per year post-construction (a 10- to 9-year return period, respectively). This risk of accidents includes both risk to existing traffic and risk to Atlantic Shores' O&M vessels. Considering only the risk to existing vessel traffic (i.e., excluding collisions between O&M vessels themselves or allisions by O&M vessels), the overall post-construction accident frequency drops to 0.095 to 0.105 accidents per year (an 11- to 10-year return period, respectively). This change from existing conditions represents one additional accident every 62 to 167 years, depending on the foundation type, which is outside of the 30-year operational life of the Projects. Although large commercial vessels (e.g., cargo, tug-barge, passenger, etc.) are anticipated to route around the WTA once the WTGs and OSSs are installed, the number of encounters (and hence the risk of collision) with smaller craft (fishing and recreational vessels) is expected to remain about the same. The presence of the WTG/OSS structures does cause a small allision risk, but the routing of the fishing and recreational craft down defined corridors tends to offset this risk.

As described in Section 7.6.2.3, the WTG layout will create 1.0 nautical mile (nm) (1.9 kilometer [km]) wide corridors in an east-northeast to west-southwest direction); 0.6 nm (1.1 km) wide corridors in an approximately north to south direction; 0.54 nm (1.0 km) diagonal corridors running approximately northwest to southeast; and 0.49 nm (0.9 km) diagonal corridors running approximately north-northeast to south-southwest (see Figure 7.6-11). Given the low level of vessel traffic density in the WTA, these corridors are expected to organize vessel traffic through the WTA and limit vessel interactions that may have otherwise occurred in open water conditions. However, this slight reduction in collision risk is counteracted by the small allision risk created by the presence of the WTGs and OSSs. See Section 7.6.2.4 and the NSRA provided as Appendix II-S for additional discussion of the changes in collision and allision risk due to the Projects.

In addition to the Projects' uniform grid layout, other mitigating factors that reduce the risk of vessel allisions and collisions include the following:

- **Location of the WTA.** The WTA is within the New Jersey Wind Energy Area (NJWEA), which was sited by the Bureau of Ocean Energy Management (BOEM) to avoid shipping lanes, traffic separation schemes, and fishing hotspots (see Section 1.3.1 of Volume I). The traffic density for all vessels is concentrated in the nearshore areas west of the WTA. At its closest point, the WTA is located approximately 8.7 mile (mi) (14 km) from the New Jersey shoreline.

- **Marine Navigation Lighting and Marking.** To enhance navigation safety, the Projects WTGs, OSSs, and met tower will be equipped with marine navigation lighting and marking in accordance with U.S. Coast Guard (USCG) and BOEM guidance. Based on USCG District 5 Local Notice to Mariner (LNM) 45/20, Atlantic Shores expects to include unique alphanumeric identification on each WTG and/or foundation, yellow flashing lights on each foundation that are visible in all directions, and Mariner Radio Activated Sound Signals (MRASS) on select foundations. An Automatic Identification System (AIS) will be used to mark each WTG, OSS, and met tower position (virtually or using physical transponders). See Section 5.3 of Volume I, Section 7.6.2, and the NSRA (provided as Appendix II-S) for additional discussion of lighting and marking. The location of the Projects' offshore facilities will also be provided to USCG and the National Oceanic and Atmospheric Administration (NOAA) for inclusion on nautical charts.

- **Adherence to USCG and International Maritime Regulations.** The use of USCG lighting on vessels and mariners' adherence to Federal and international regulations, such as the

International Regulations for Preventing Collisions (COLREGs), will reduce the risk of vessel collisions and allisions.

While vessel collisions and allisions are unlikely due to these mitigating factors, Atlantic Shores will develop an Emergency Response Plan (ERP) for a range of emergency situations, including allisions between vessels and structures, vessels in distress, man overboard, and search and rescue (SAR) (see Volume I Appendix I-E). The potential effects from the Projects on USCG SAR activities within and near the WTA, should a collision or allision occur, are discussed in Section 7.6.2.3. Atlantic Shores is proposing a variety of mitigation measures to assist with USCG SAR activities, including implementation of WTG rotor emergency braking systems to set and maintain the position of WTG moving parts during a SAR event, measures to assist in search detection (e.g., installation of very high frequency [VHF] direction finding equipment and high-resolution infrared detection systems) and access ladders on the WTG and OSS foundations to allow distressed mariners access to an open refuge area (see Section 7.6.2.3).

Should a collision or allision result in a spill, Atlantic Shores will adhere to the protocols outlined in the OSRP (see Section 9.2.3 and Volume I Appendix I-D).

9.2.2 Severe Weather and Natural Events

Severe weather such as hurricanes, extratropical cyclones (e.g., nor'easters), and tropical storms have been recorded within or in the vicinity of the WTA and ECCs (see Section 2.2 Physical Oceanography and Meteorology). These weather events have the potential to injure personnel and cause structural damage to the Projects' offshore facilities (BOEM 2012). Although extremely unlikely, severe flooding and/or coastal erosion from a major storm could cause damage to the Projects' onshore facilities. The Projects are not located in a region considered to be seismically active (see Section 2.1 Geology) and the Projects' facilities will be designed to meet relevant seismic stability criteria; therefore, the potential for catastrophic damage to the Projects' facilities from an earthquake is extremely low. Significant infrastructure failure/damage, which may result from severe weather, earthquakes, and other natural events, is discussed further in Section 9.2.5.

The Projects' facilities are designed to withstand severe weather events based on site-specific meteorological, oceanographic, and geological conditions and will conform to all applicable standards (e.g., American Clean Power Association [ACP], International Electrotechnical Commission [IEC], American Petroleum Institute [API], and International Organization for Standardization [ISO] standards). The maximum scenario meteorological, oceanographic, and geological conditions on which the Project design will be based will be detailed in the design basis and verified by the independent Certified Verification Agent (CVA) as part of the Facilities Design Report (FDR) and Fabrication and Installation Report (FIR). In particular, the WTGs are designed to reference wind speeds for type certification[76] (see Section 4.3.1 of Volume I), although a site-

[76] Type certificates are issued by an accredited certification body to independently verify that a WTG (or other renewable energy equipment) is designed and manufactured in accordance with all applicable requirements/standards.

specific assessment of the WTGs will be performed for the Projects. The WTGs will continuously adjust the angle of the blades and the direction of the rotor nacelle assembly based on wind speed and direction to maintain safe operating limits. During a high wind event, the WTGs will automatically shut down when wind speeds exceed the WTGs' maximum operational limit (see Section 4.3.1 of Volume I).

As described in Section 1.5.2 of Volume I, Atlantic Shores will employ a third-party CVA to conduct an independent assessment of the design of the Projects' facilities and the planned fabrication and installation activities. The CVA will certify to BOEM that the Projects are designed to withstand the site-specific environmental and functional load conditions appropriate for its intended service life.

9.2.3 Offshore Spills, Discharges and Accidental Releases

Offshore spills, discharges or inadvertent releases may result from accidents during vessel refueling, equipment malfunction or breakage, vessel collisions/allisions/grounding, or inadvertent releases of grout during foundation installation. As described in Section 7.0 of Volume I, the Projects' solid and liquid wastes will be treated, released, stored, and/or disposed of in accordance with applicable Federal, State, and local regulations to reduce the risk of spills, discharges, and accidental releases.

While spills during vessel refueling are not expected, if a spill occurs, it is likely to be small in volume and aerial extent. The USCG reports that over the last two decades (2000–2019), the average petroleum oil spill size in U.S. waters for vessels other than tank ships and tank barges was 117 gallons (443 liters) (Bureau of Transportation Statistics 2020). A petroleum oil spill of this size is expected to dissipate rapidly and evaporate within days; thus, any effects would be temporary and localized. The risk of spills from Project vessels will be minimized through compliance with USCG regulations for the prevention and control of oil spills found at 33 CFR Part 155. Project vessels will also comply with USCG waste and ballast water management regulations and vessels covered under the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Vessel General Permit (VGP) are also subject to the effluent limits contained in the VGP (see Section 7.0 of Volume I).

The OSSs and WTGs will include secondary containment for oil-filled equipment to prevent discharges or inadvertent releases due to equipment malfunction or breakage. Grout may be used to stabilize foundation joints. To minimize any inadvertent release of grout, proper grouting procedures will be utilized to minimize any overflow.

In the event of a spill, Atlantic Shores and its contractors will follow the procedures outlined in the Projects' OSRP, which defines spill prevention measures as well as provisions for communication, coordination, containment, removal, and mitigation of a spill (see Volume I Appendix I-D for a draft of the OSRP). As described in Section 1.5.3.2 of Volume I, Project personnel will undergo routine training on the content of the OSRP to ensure they are familiar with the OSRP's requirements and are prepared to respond to emergencies. In addition to the overarching OSRP, contractors will also have plans to immediately contain and stop a spill in accordance with applicable regulations.

9.2.4 Coastal and Onshore Spills, Discharges, and Accidental Releases

Coastal and onshore spills or accidental releases may include trash and debris, spills during refueling, accidental release of lubricating or hydraulic oils from onshore construction equipment, spills of waste and chemicals stored onshore, or releases associated with horizontal directional drilling (HDD) activities at the landfall sites.

Solid waste, trash, and debris generated by the Projects will be disposed of in accordance with applicable Federal, State, and local regulations. Waste will be stored and properly disposed of onshore or incinerated offshore and project vessels must meet the USCG's waste management regulations. Atlantic Shores will also require offshore contractors to participate in a marine trash and debris prevention training program.

Refueling and service of construction vehicles and equipment will be conducted in a manner that protects coastal habitats, wetlands, and drinking water supplies from spills and accidental releases. Refueling and major equipment maintenance will be performed offsite (e.g., at commercial service stations or a contractor's yard) to the maximum extent practicable. Any refueling will be performed by well-trained and knowledgeable personnel. To minimize the potential effect of a fuel or oil spill (should one occur), proper spill containment gear and absorption materials will be maintained onsite to enable immediate response.

As described in Section 7.0 of Volume I, all onshore waste likely to cause environmental harm will be stored in designated, secure, and bermed locations away from depressions and drainage lines that carry surface water until collected by the selected waste contractor. To minimize and control spills, spill kits will be provided at all locations where hazardous materials are stored.

To prevent accidental releases at the onshore substation and/or converter station sites, full-volume containment will be provided for major oil-containing equipment (e.g., oil-filled transformers and reactors), which could be comprised of individual containment systems (pits) or a central collection system with a pump (see Section 4.9.2 of Volume I). Any oil containment system will be sized to contain the oil in a single piece of equipment plus rainwater, melted snow, or washdown sized in accordance with applicable industry standards. Any indoor lead-acid batteries that are used will also be outfitted with spill containment and absorbent mats.

Atlantic Shores will develop and maintain an SPCC Plan per 40 CFR Part 112, which will identify what oil materials are stored at the onshore facilities, how oil is delivered and transferred, facility spill prevention and control procedures, spill response and notification procedures, inspections, recordkeeping, and reporting requirements. Atlantic Shores will also submit Discharge Prevention, Containment, and Countermeasure (DPCC) and Discharge Cleanup and Removal (DCR) plans per N.J.A.C. 7:1E to the New Jersey Department of Environmental Protection.

HDD at the landfall sites will use a drilling fluid comprised of bentonite (an inert, non-toxic clay) and water to lubricate the drill head and extract excavated material from the bore hole (see Section 4.7.1 of Volume I). Drilling fluids likely will be managed within a contained system and will be collected for reuse or proper disposal. Although unlikely, an inadvertent release of pressurized drilling fluid (i.e., drilling fluid seepage or "frac-out") could occur during HDD. Since the drilling fluid is an inert, non-toxic clay and, if released, would likely occur in small amounts, the released HDD material would be expected to cause only minor and temporary turbidity effects. Preconstruction planning, engineering, and design practices can greatly mitigate the chance of an inadvertent release. To further reduce the risk of drilling fluid seepage during HDD, the position of the drill head and drilling fluid pressure will be closely monitored. Atlantic Shores will develop an HDD Inadvertent Release Plan for activities at the landfall sites.

9.2.5 Significant Infrastructure Failure

While highly unlikely, it is possible that the Projects could experience a significant structural, electrical, or hydraulic failure. To minimize the possibility of significant component failure, the Projects will undergo a thorough and well-vetted structural design process in accordance with applicable standards (e.g., ACP, IEC, API, and ISO standards) and based on site-specific conditions. As discussed in Section 9.2.2, the Projects' design will be reviewed by a third-party CVA as well as BOEM and the Bureau of Safety and Environmental Enforcement (BSEE).

To further reduce the risk of significant damage, interruption of service, or other corrective maintenance, Atlantic Shores will adhere to a rigorous monitoring, inspection, and preventive maintenance program (see Section 5.4 of Volume I). All Project facilities, including the WTGs and OSSs, are designed to operate autonomously without on-site attendance by technicians. The Projects will be equipped with a Supervisory Control and Data Acquisition (SCADA) system to interface between the WTG controllers, OSSs, onshore substations and/or converter stations, and all environmental and condition monitoring sensors, and to provide detailed performance and system information (see Section 5.1 of Volume I). The condition monitoring systems (CMS) of various subsystems are centralized into the SCADA system so that this data can be used to identify underperformance issues and major equipment failures before they occur. The SCADA system is configured to provide notifications of any alarms or warnings from Project components. Using the SCADA system, each Project's operator will monitor the status, production, operation, and performance of the Project 24 hours per day.

Atlantic Shores is proposing to establish an O&M facility in Atlantic City to provide preventative maintenance and repair services for the Projects. Minor repairs can be performed via regular maintenance vessels, whereas larger, structural repairs may require support vessels and a larger team of technicians.

The target burial depth of the Projects' offshore cables is designed to substantially reduce the risk of cable damage or displacement caused by anchors, fishing gear, or erosion/scour due to major storms. Cable protection will be used (in limited areas) if sufficient cable burial is not achieved (see 4.5.7 of Volume I). Therefore, the Projects' offshore cables are not expected to be damaged or displaced. Nevertheless, as described in Section 5.1 of Volume I, the export cables are expected to use technology (such as a distributed temperature system [DTS], distributed acoustic sensing [DAS] system and/or online partial discharge [OLPD] monitoring) to constantly monitor cable temperature at points along their length to help identify anomalous conditions (i.e., potential changes in cable burial depth). The inter-array cables and inter-link cables (if used) may also use DTS, DAS, or OLPD. Cable surveys will be performed at regular intervals to identify any damage or issues associated with potential scour and depth of burial (see Section 5.4.4 of Volume I). In the unlikely event that cable damage or displacement occurs, the cables will be repaired as soon as possible. Cable repair activities will be similar to cable installation activities (although they would be isolated to a smaller area).

Catastrophic damage to Project onshore concrete duct bank and splice vaults, which are buried underground, is extremely unlikely but may occur due to severe weather or other natural events (see Section 9.2.2). There is also a remote possibility that the duct bank or splice vaults could be damaged by an unrelated construction project. If the duct bank or splice vaults are damaged, any overlying cover would be excavated, and the damaged section would be repaired. If needed, this repair work will be similar to the initial installation process, but the extent of the activities and associated temporary effects would be smaller.

9.2.6 Terrorist Attacks

Although extremely unlikely, the Project's facilities could be targeted by terrorists. The effects of a terrorist attack would depend on the magnitude and location of the attack; given the dispersed nature of the Project offshore facilities, it is unlikely that an attack would affect all offshore structures. Terrorist attacks could cause spills/discharges or significant infrastructure damage to the WTGs, OSSs, offshore cables, onshore interconnection cables, or onshore substations and/or converter stations, which are described in Sections 9.2.3, 9.2.4, and 9.2.5. The response to such incidents is covered in the Project's Facility Security Plan and ERP.

9.3 Electromagnetic Fields and Human Health

This section describes EMFs and human health in relation to the Projects' onshore facilities. All onshore EMF levels are expected to be well below guidelines protective of public health. The potential effects of EMF from the Projects' offshore facilities on marine life are discussed in Sections 4.5 Benthic Resources, 4.6 Finfish, Invertebrates, and Essential Fish Habitat, 4.7 Marine Mammals, and 4.8 Sea Turtles.

EMFs consist of two component fields: electric fields and magnetic fields. These fields are created by positive and negative electric charges. EMFs are produced by electric power and by natural sources. People experience EMFs during daily living from sources such as household wiring, electric devices (e.g., hair dryers, vacuum cleaners), and appliances. All people experience the Earth's natural magnetic field as well. In the northern United States, the Earth's steady direct current (DC) magnetic field is about 550 milligauss (mG).

Electric field strength is a function of voltage (the "pressure" that drives the flow of electricity). It is measured in kilovolts per meter (kV/m). Electric fields are generated by the flow of current through transmission cables and decline rapidly with distance from the source. Atlantic Shores is proposing to install the Projects' onshore interconnection cables underground. Importantly, electric fields from underground cables are readily blocked by the cable sheath and intervening concrete, soil, and other materials.[77] Accordingly, underground transmission cables such as those proposed by Atlantic Shores do not create a risk of public exposure to *electric fields*. Therefore, this section is focused on the low-level *magnetic fields* that will be produced by the Projects' underground onshore interconnection cables and other onshore facilities.

Magnetic fields are produced by electric current, which is the flow of electric charges (normally measured in amperes [amps or A]). Magnetic fields are measured in mG and decline rapidly with distance from a power source. Common household items have magnetic fields in the range of 10 to 600 mG, depending on the distance from the source. Individuals also occasionally experience much higher levels of magnetic fields from medical imaging devices (e.g., magnetic resonance imaging [MRI] uses a magnetic field of 30,000,000 mG).

The following sections describe human health considerations associated with potential magnetic fields generated from the Projects.

9.3.1 EMF Standards and Guidelines

The U.S. alternating current (AC) electrical power grid operates at 60 cycles per second (60 hertz [Hz]). There are no Federal standards or guidelines for 60 Hz EMF exposure from power lines and related facilities. A number of states have issued guidelines or standards for EMF levels, typically within and at the edge of utility transmission rights-of-way (ROWs). These State guidelines or standards generally are based on historically acceptable EMF levels within and at the boundaries of transmission ROWs. Typically, these EMF standards include limits for electric fields and limits for magnetic fields. The New Jersey Board of Public Utilities (NJBPU) has a State guideline for electric fields[78] but not for magnetic fields.

The primary guidance with respect to EMF exposure from power lines and related facilities has been developed by national and world health organizations; these guidelines are designed to be protective against any adverse health effects. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) has published guidelines on magnetic and electric field exposure which have been endorsed by the World Health Organization. For the general public, with the assumption of continuous exposure, ICNIRP recommends limiting one's exposure to magnetic fields to 2,000 mG for variable fields (i.e., AC). For steady magnetic fields (i.e., DC), ICNIRP (2010) recommends limiting magnetic fields to 5,000 mG (ICNIRP 2010). These guidelines, and similar

[77] More precisely, as stated in the EMF assessment (see page three of Appendix II-I), "The electric field from the shielded power cables is blocked by the grounded cable armoring as well as the earth and therefore, the shielded cables will not be a direct source of any electric field outside the cables."

[78] See for example NJBPU Docket No. E013111047 dated November 21, 2014; https://www.bpu.state.nj.us/bpu/pdf/boardorders/2014/20141121/11-21-14-2C.pdf.

guidelines established by other organizations, are widely considered to be highly conservative and adequately protective of health and safety.

Atlantic Shores conducted an extensive EMF assessment, including modeling of magnetic field levels in the immediate vicinity of the landfall sites, the underground onshore interconnection cables, and the onshore substations and/or converter stations (see Appendix II-I). The detailed EMF assessment also includes modeling for the offshore elements of the Projects (i.e., export cables, inter-link cables, inter-array cables, and OSSs). As described in Section 4.5 of Volume I, Atlantic Shores is considering three transmission options:

- **Option 1–HVAC Transmission.** In this option, each Project would utilize HVAC cables, and each Project would be installed within its own ECC and its own onshore ROW.
- **Option 2–HVDC Transmission.** In this option, each Project would utilize HVDC cables, and each Project would be installed within its own ECC and its own onshore ROW.
- **Option 3–HVAC and HVDC Transmission.** In this option, one Project would utilize HVAC cables, and the other Project would utilize HVDC cables.

The full range of cable options (230–275 kilovolts [kV] high voltage alternating current [HVAC] cables, 320–525 kV high voltage direct current [HVDC] cables, and/or combined HVAC and HVDC cables) as well as all representative arrangements (duct banks, onshore HDDs) were analyzed. This work provided the quantitative basis for the summaries of magnetic levels and comparisons to relevant health protective guidelines, which are described in Sections 9.3.2 through 9.3.4.

9.3.2 Landfall Sites (via Horizontal Directional Drilling)

As described in Section 4.7 of Volume I, the offshore-to-onshore transition between the submarine export cables and the underground onshore interconnection cables will occur at two landfall sites. The Monmouth Landfall Site is located within a disturbed portion of the southeast corner of the Army National Guard Training Center (NGTC) in the Borough of Sea Girt in Monmouth County, New Jersey. The underground transition vaults (one per export cable) will be located in the southeast corner of the NGTC property in a previously disturbed area. The Atlantic Landfall Site will be located on a parcel of land that is currently used as a public parking lot bounded by Pacific, South Belmont, and South California Avenues and California Avenue within Atlantic City in Atlantic County, New Jersey (see Figure 4.8-1 in Volume I). This landfall site will include underground transition vaults associated with the Atlantic export cables (one per export cable).

The offshore-to-onshore cable transition will be accomplished by HDD. At the landfall sites, HDD bores will be completed for each of the export cables coming ashore. The export cables will be pulled through HDD conduits inserted into the bore holes and jointed to the onshore interconnection cables in underground transition vaults (one per export cable) located near the onshore HDD entrance/exit point. The HDD trajectory for each bore is expected to be approximately 1,969 feet (ft) (600 meters [m]) long at the Atlantic Landfall Site and approximately 3,281 ft (1,000 m) long at the Monmouth Landfall Site. The trajectory of the bores will be a gently sloped arc which will pass beneath the beach and the intertidal zone. The preliminary HDD designs for the Atlantic Landfall Site and the Monmouth Landfall Site are provided on Figures 4.8-1 and 4.8-2 of Volume I, respectively.

To assess EMF at the landfall sites, the Projects' cables were conservatively modeled using a full load current of 1,200 amps at 230 or 275 kV. The modeling results are provided in Appendix II-I as Cases 29 and 31, respectively (see Figures 4-76 and 4-80 of Appendix II-I). For ease of reference, the 230 kV case is provided as Figure 9.3-1. The maximum modeled magnetic field at the seabed at each landfall site is shown as approximately 1 amperes/meter (A/m) or approximately 12.5 mG. There are four peaks depicted in the magnetic field cross-section, corresponding to the four export cables being brought ashore via HDD at each landfall site. The peak values fall off very quickly with lateral distance from the cable centerlines. The modeled peak value of 12.5 mG is less than 1% of the ICNIRP health-protective magnetic field guidance of 2,000 mG. The results for the 275 kV case are similar.

9.3.3 Onshore Interconnection Cables

Underground electric power cables have been used for many decades in urban environments and are the preferred means for onshore transmission in the offshore wind arena. The Projects' onshore interconnection cables will travel underground from the landfall sites primarily along existing roadways, utility ROWs, and/or bike paths to the new onshore substation and/or converter station sites. From the onshore substations and/or converter stations, the onshore interconnection cables will continue to the proposed points of interconnection (POIs). The Larrabee Onshore Interconnection Cable Route connects the Monmouth Landfall Site to the existing Larrabee Substation POI. The Larrabee Onshore Interconnection Cable route will include a new substation and/or converter station at the Lanes Pond Road Site or the Randolph Road Site or the interconnection to a substation and/or converter station at the Brook Road Site developed under the New Jersey Board of Public Utilities (NJBPU) State Agreement Approach (SAA). The Cardiff Onshore Interconnection Cable Route connects the Atlantic Landfall Site to the existing Cardiff Substation POI. The Cardiff Onshore Interconnection Cable route will also include an additional substation and/or converter station option at Fire Road Site. As described in Section 4.8 of Volume I, the Cardiff and Larrabee Onshore Interconnection Cable Routes are approximately 12 mi long for the Larrabee Onshore Interconnection Cable Route and 14 mi (19 km) long for the Cardiff Onshore Interconnection Cable Route. Along each route, the onshore interconnection cables will be installed in buried concrete duct banks, with each cable housed in a high-density polyethylene (HDPE) or Polyvinyl Chloride (PVC) conduit. Typical cover over the buried duct bank (e.g., along roadway ROWs) will be approximately 3 ft (0.9 m).[79] The onshore interconnection cables will employ HVAC technology (up to four circuits for each Project consisting of up to twelve

[79] The maximum coverage over the top of the cable conduits could be up to 30 ft (9 m) in some specialty installation scenarios.

230 kV to 275 kV cables), HVDC technology (one circuit for each Project consisting of two 320 kV to 525 kV cables), and/or a combined HVAC/HVDC arrangement (four 275 kV HVAC circuits for one Project and one 525 kV HVDC circuit for the other Project).

As detailed in Appendix II-I, the HVAC underground onshore interconnection cables were modeled using a current of 1,200 amps at 230 or 275 kV for several different ROW configurations (e.g., roadway, bike path, existing ROW, etc.). For the 230 kV four-circuit, narrow ROW case, the maximum modeled magnetic field was approximately 17 A/m (212.5 mG). The modeled levels fall to approximately 3 A/m (37.5 mG) at a distance of 16.4 ft (5 m) on either side of the duct bank centerline. For ease of reference, the graphical results from Appendix II-I (Figure 4-104) are provided as Figure 9.3-2. The levels for the 275 kV case are slightly higher (19 A/m). In all cases, the modeled magnetic fields are well below the health-protective magnetic field guidance per ICNIRP of 160 A/m or 2,000 mG.

The HVDC underground onshore interconnection cables were modeled using a current of 2,000 amps at 320 or 525 kV. For the 320 kV HVDC cable circuit, a maximum magnetic field of 47 A/m (587 mG) was modeled. For the 525 kV HVDC cable circuit (monopole mode), a maximum magnetic field of 48 A/m (600 mG) was modeled. For ease of reference, the graphic representation of the modeling is provided as Figures 9.3-3 and 9.3-4, respectively (see Figures 4-114 and 4-132 from Appendix II-I). These modeled results are well below the applicable ICNIRP health protective guideline for static magnetic fields (400 A/m or 5,000 mG).

To analyze a combined HVAC/HVDC onshore interconnection arrangement, a single scenario was modeled with four 275 kV HVAC circuits and one 525 kV HVDC circuit in a single trench. It should be noted that this case was modeled using a range of HVAC and HVDC voltages, and that the data presented for the 275 kV HVAC/525 kV HVDC case are conservatively presented as having the maximum MF level of all configurations considered. Under this scenario, a maximum magnetic field of 78 A/m (975 mG) was modeled. For ease of reference, the graphic representation of the modeling is provided as Figure 9.3-5 (see Figure 4-110 from Appendix II-I). These modeled results are well below the applicable ICNIRP health protective guideline for time-varying magnetic fields (180 A/m or 2,000 mG).

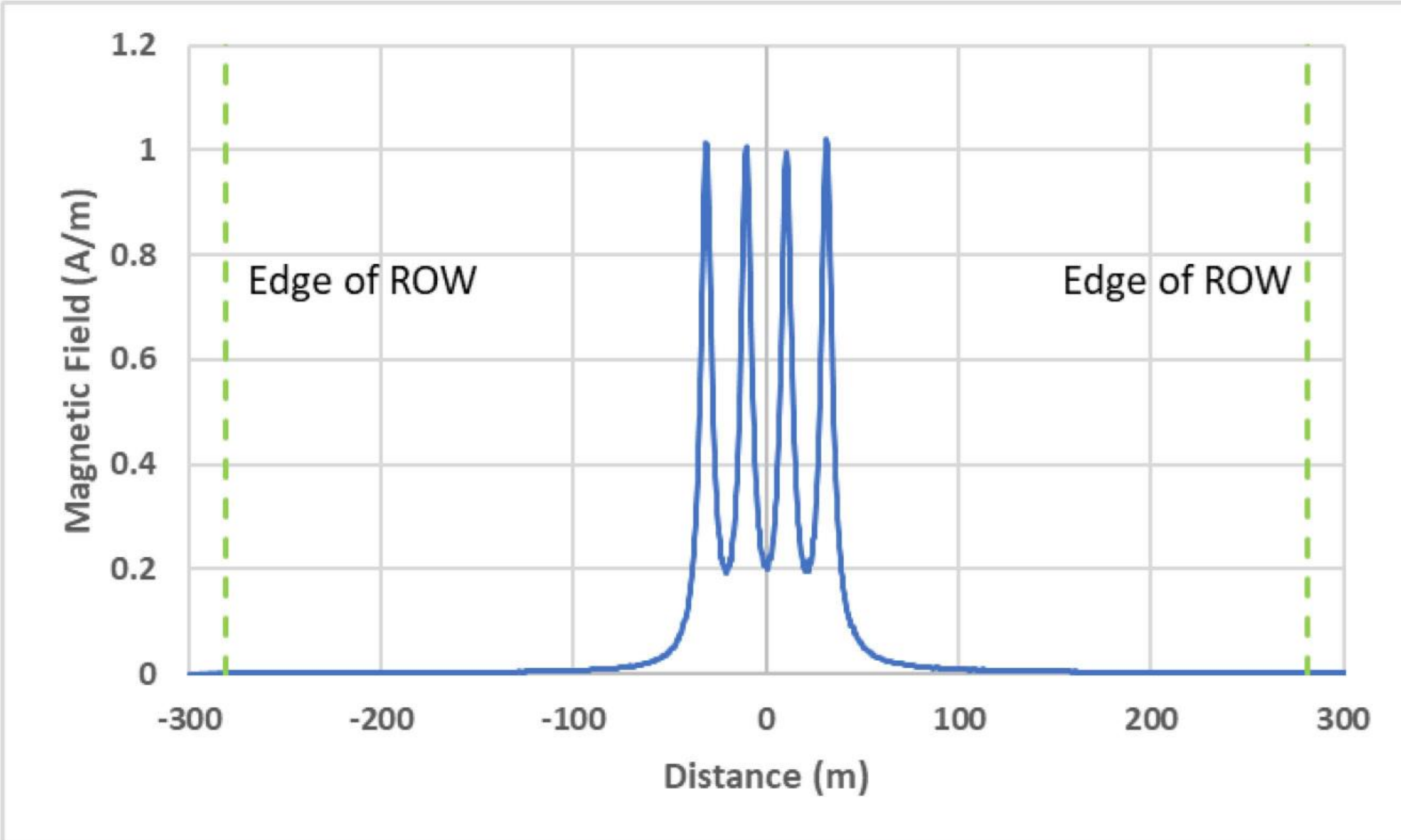
9.3.4 Onshore Substation and/or Converter Station

As described in Section 4.9 of Volume I, the Project includes two onshore substations (one for each POI). At each onshore substation and/or converter station site, the transmission voltage will be stepped up or down, as necessary, in preparation for interconnection with the electric grid at either the existing Cardiff Substation POI or the existing Larrabee Substation POI. At this point in Project development, several onshore substation and/or converter station options are being considered (HVAC with 230 to 275 kV incoming voltage; HVDC with 320 to 525 kV incoming voltage; and air-insulated switchgear or gas-insulated switchgear design). A quantitative assessment of potential onshore substation and/or converter station EMF levels for a conceptual level 230 kV air-insulated switchgear design is provided in Section 4.2.2 of Appendix II-I.

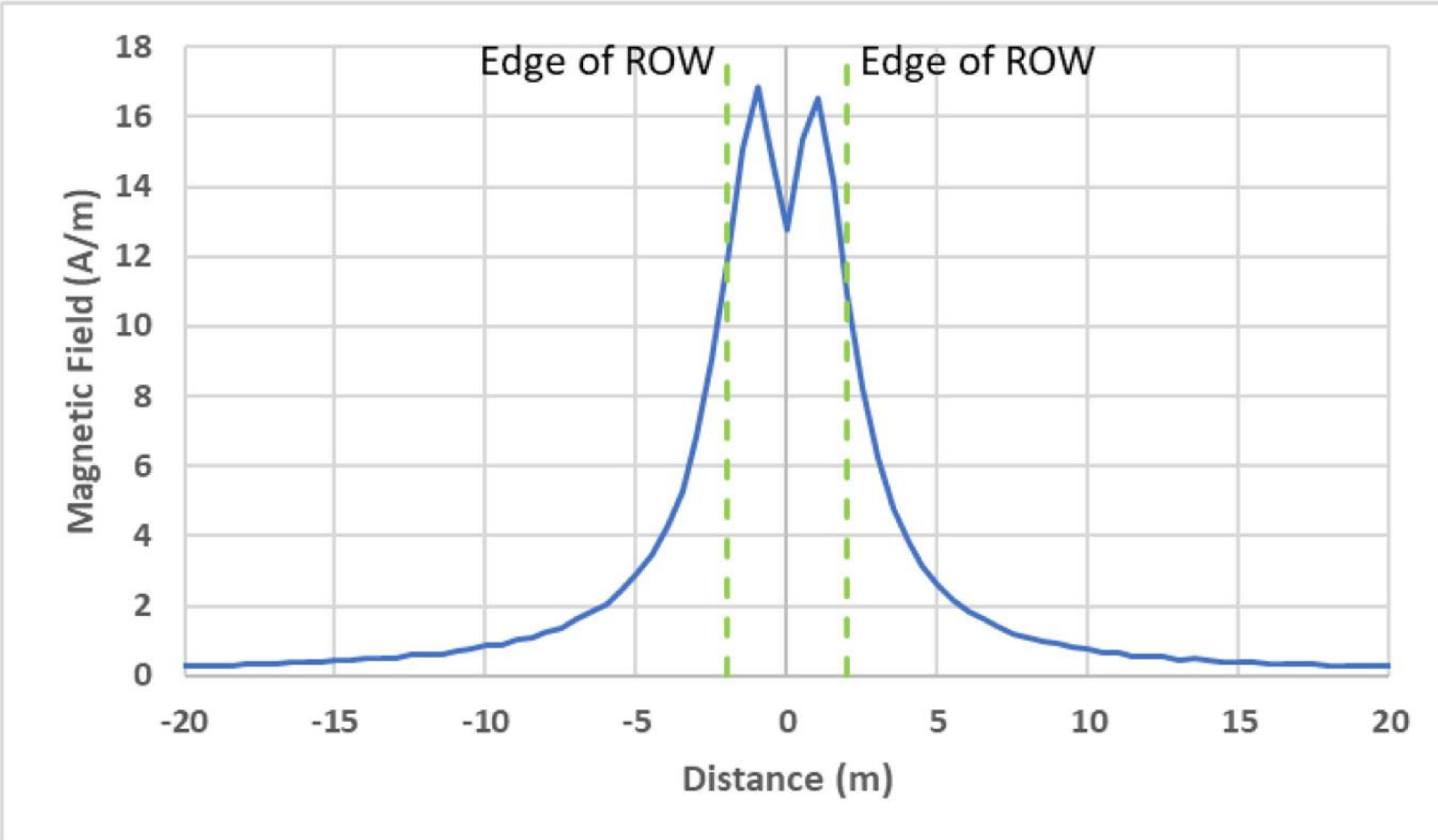
For the purposes of assessing potential risks to human health from the onshore substation and/or converter station, the National Institutes of Environmental Health Sciences (NIESH) has stated:

> *The strength of the EMF from equipment within substations, such as transformers, reactors, and capacitor banks, decreases rapidly with increasing distance. Beyond the substation fence or wall, the EMF produced by the substation equipment is typically indistinguishable from background levels (NIESH 2002).*

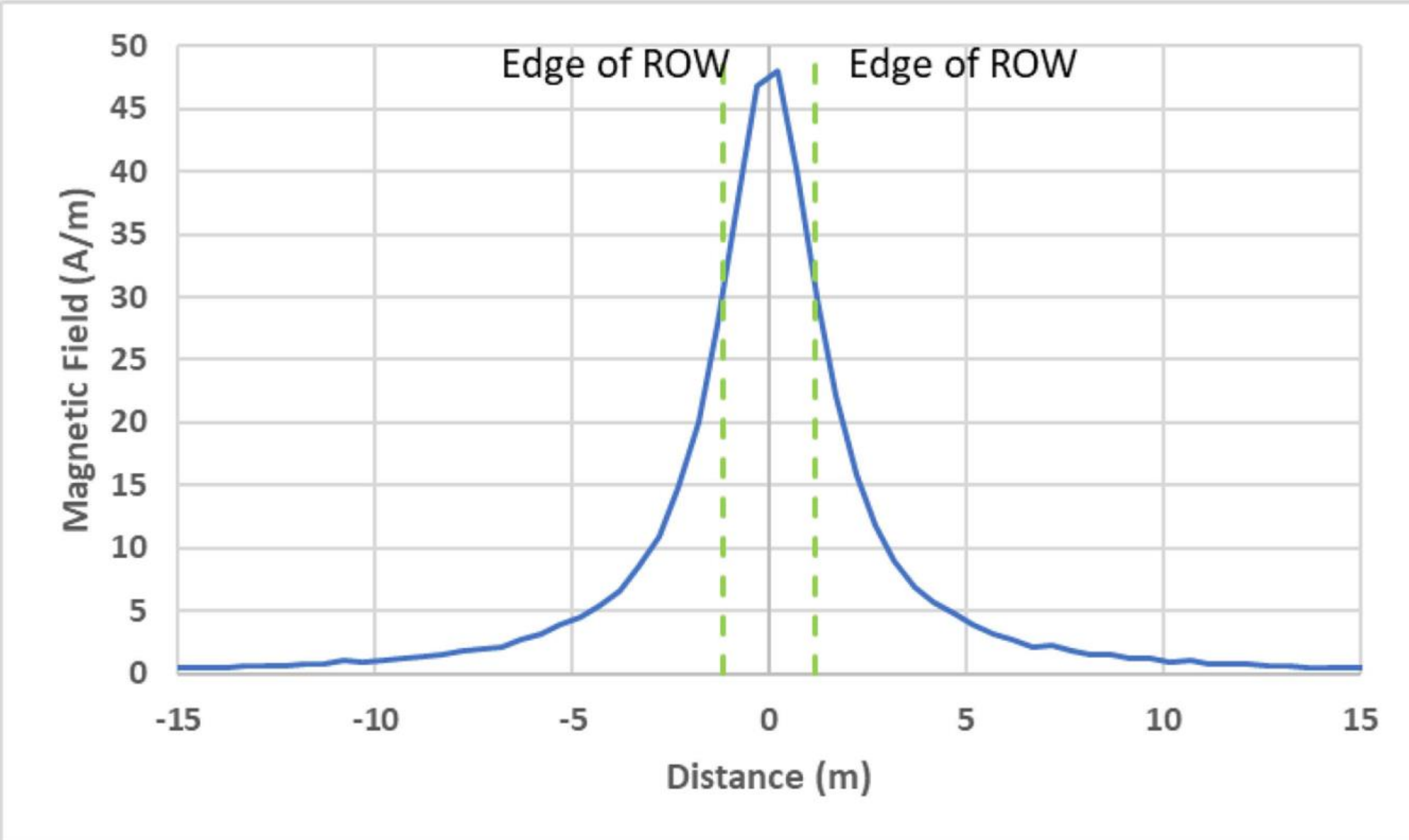
Therefore, no risk to human health for the public outside the onshore substation fence is expected.



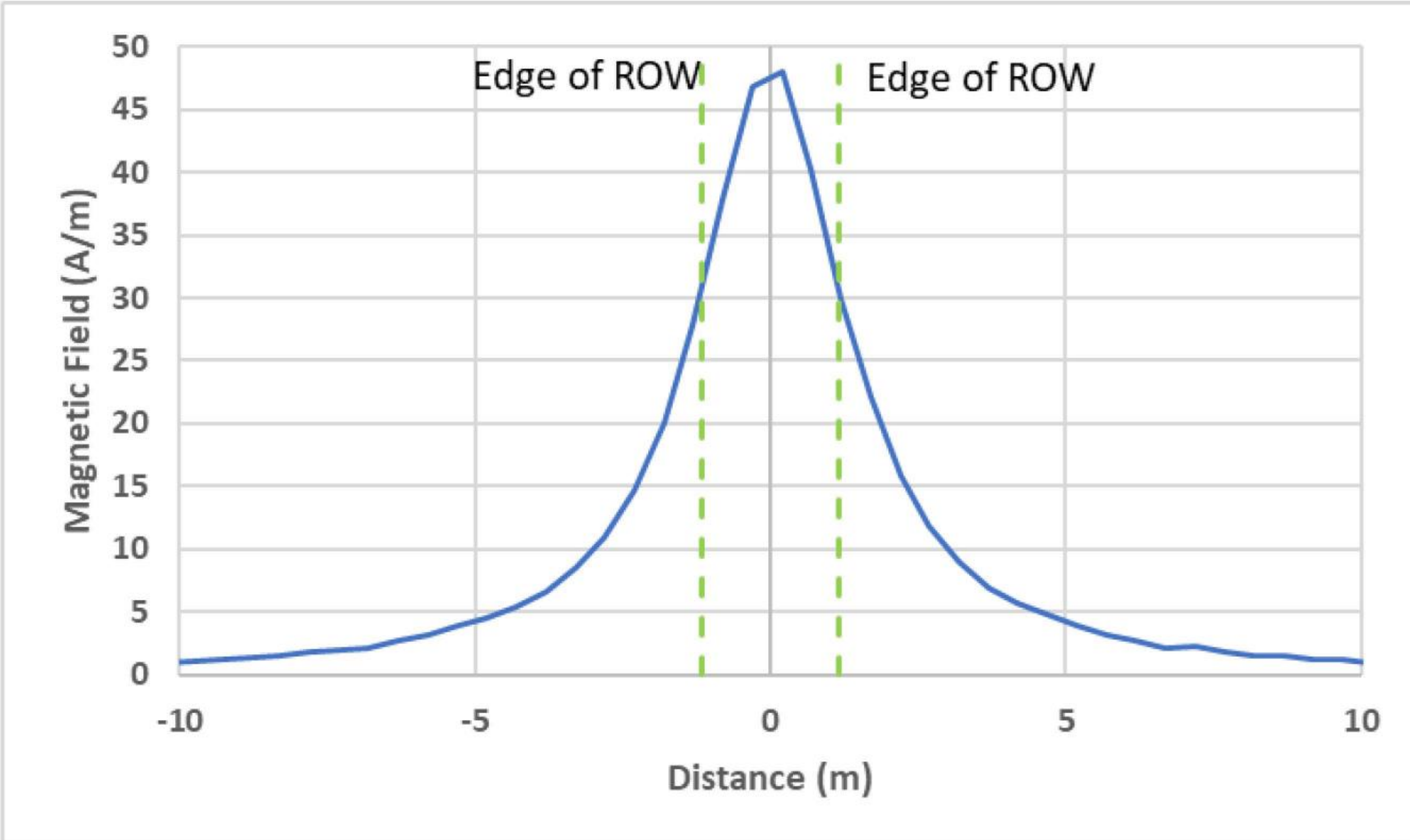
Electromagnetic Field (EMF) Assessment, Case 29: Magnetic field results at the seabed for four 230 kV high voltage alternating current (HVAC) export cables (2,000 mm^2 Cu) installed via horizontal directional drilling at the landfall sites.



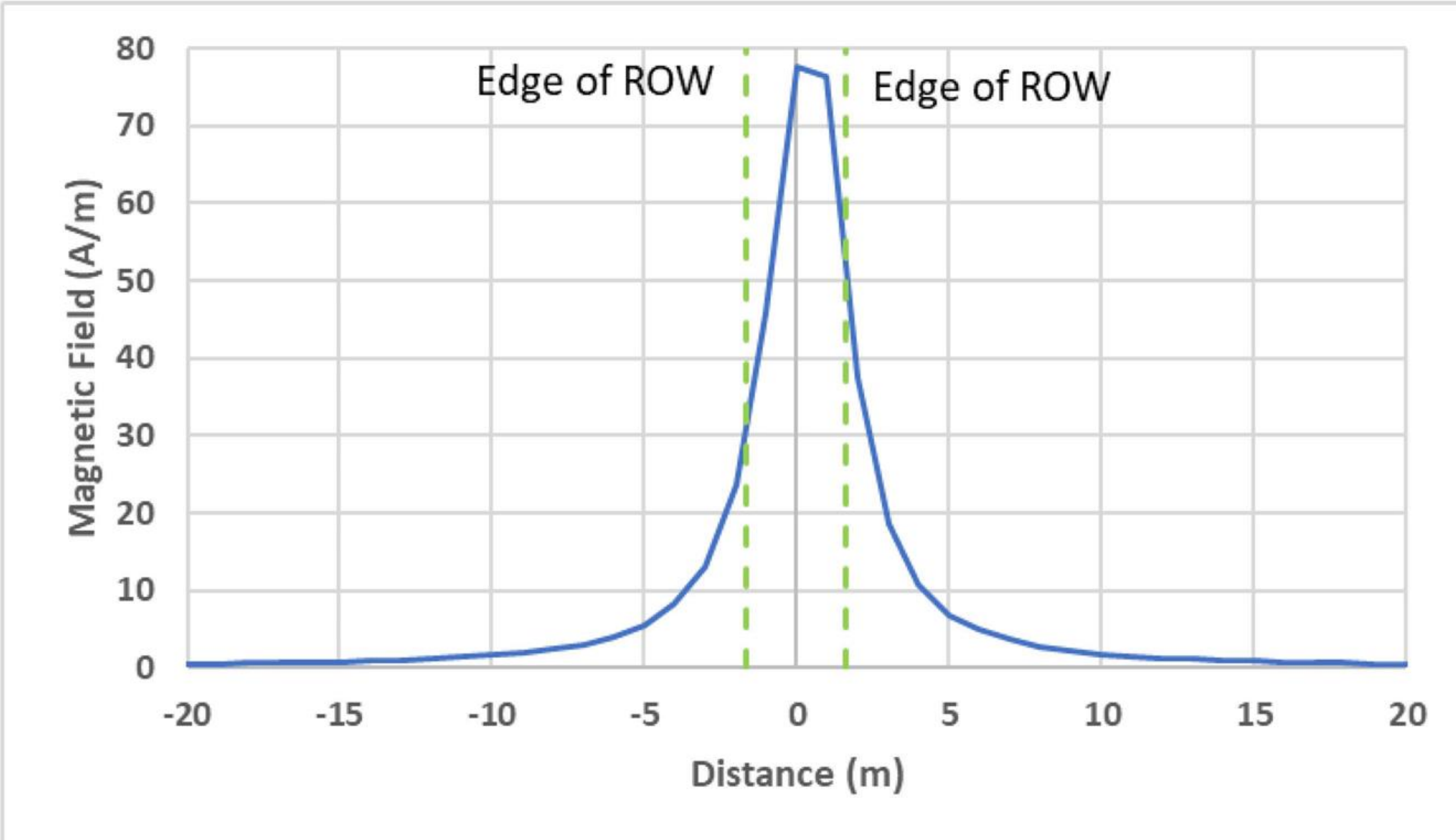
Electromagnetic Field (EMF) Assessment, Case 43: Magnetic field results at the surface for 230 kV high voltage alternating current (HVAC) onshore interconnection cables (four circuits, 3,000 mm^2 Cu single core) installed underground in a narrow right-of-way corridor.



Electromagnetic Field (EMF) Assessment, Case 48: Magnetic field results at the surface for 320 kV high voltage direct current (HVDC) onshore interconnection cables (one circuit, 2,500 mm² Cu) installed underground.



Electromagnetic Field (EMF) Assessment, Case 52: Magnetic field results at the surface for 525 kV high voltage direct current (HVDC) onshore interconnection cables (2,500 mm^2 Cu) installed underground and operating in monopole mode.



Electromagnetic Field (EMF) Assessment, Case 46: Magnetic field results at the surface for 275 kV HVAC Onshore interconnection transmission cables (3000 mm^2 Cu Single Core) and 525 kV HVDC Onshore interconnection transmission cables (2500 mm^2 Cu) installed underground and operating in monopole mode.

Figure 9.3-5
EMF Results for 275 kV HVAC and 525 kV HVDC Onshore Interconnection Cables

9.4 Summary of Proposed Health, Safety, and Environmental Protection Measures

HSSE are critical components of all Atlantic Shores planning and activities. Given their importance, Atlantic Shores has prepared HSSE plans and systems to mitigate risk and plan effective responses. Atlantic Shores is implementing multiple measures to protect HSSE.

Offshore

- An NSRA was prepared to assess navigation safety risks. The WTG orientation and uniform grid layout was selected to avoid and minimize the risk of collision and allision. An ERP will be developed in part to address the unlikely events of collisions, allisions, vessels in distress, man overboard, and SAR.

- An extensive EMF modeling assessment was conducted for the offshore cables and OSSs to assess potential effects to marine life.

- To facilitate safe navigation, all offshore structures will include marine navigation lighting and marking in accordance with USCG and BOEM guidance. Atlantic Shores will continue to work with the USCG and BOEM to determine the appropriate marine lighting and marking schemes for the proposed offshore facilities.

- Each permanent structure (including WTGs, OSSs, and the met tower) will include unique alphanumeric identification and lights that are visible in all directions. Sound signals will be installed on select foundations in accordance with the Marking and Lighting Plan that will be developed in consultation with the USCG.

- Atlantic Shores will have the capability to mark each WTG, OSS, and met tower position (virtually or using physical transponders) with AIS. The number, location, and type of AIS transponders will be determined in consultation with USCG.

- The Project facilities are designed to withstand maximum scenario severe weather events based on site-specific meteorological, oceanographic, and geological conditions and will conform to all applicable standards.

- The Projects will undergo a thorough and well-vetted structural design process in accordance with applicable standards and based on site-specific conditions. The Project design will be reviewed by BOEM and the BSEE and will also be verified by an independent CVA pursuant to 30 CFR Parts 585.705-585.714 as part of the FDR and FIR.

- A Site Manager will be employed to control access to offshore facilities, only allowing personnel with proper training, certificates, and medical fitness. Proper signage restricting access will be installed on the WTG, OSS, and met tower foundations.

- Temporary safety buffer zones will be established around offshore working areas to reduce hazards.

- Solid and liquid wastes will be managed in accordance with applicable regulations to reduce the risk of spills, discharges, and accidental releases.

- Mitigation measures will be implemented to assist with SAR including implementation of WTG rotor emergency braking systems during a SAR event, measures to assist in search detection (e.g., installation of VHF direction finding equipment and high-resolution infrared detection systems), and access ladders to open refuge areas on foundations for distressed mariners.

- The Projects will be monitored 24 hours per day and will be equipped with a SCADA system which provides an interface between the Projects' facilities and all environmental and condition monitoring sensors and allows the operator to control the Projects' equipment remotely.

- Offshore cables will be equipped with DTS, DAS, and/or OLPD to constantly assess and monitor the status of the offshore cables.

Onshore

- An extensive EMF modeling assessment was conducted to assess the landfall sites, the underground onshore interconnection cables, and the onshore substations and/or converter stations (see Appendix II-I). All modeled EMF levels are well below guidelines protective of human health.

- Once operational, onshore substations and/or converter stations will be equipped with fencing, screening barriers, camera systems, signage, and physical barriers as part of a security plan.

- Active, onshore worksites will be secured with temporary fencing and signage to prevent public access and trenches or holes will be covered in compliance with permit requirements.

- A TMP including traffic control measures (e.g., signage, police details, lane closures, detours, etc.) will be developed and implemented.

- Refueling and major equipment maintenance will be performed offsite (e.g., at commercial service stations or a contractor's yard) to the maximum extent practicable.

- A SPCC will be developed and maintained, and spill kits will be provided at all locations where hazardous materials are stored.

- Solid and liquid wastes will be managed in accordance with applicable regulations to reduce the risk of spills, discharges, and accidental releases.

Offshore and Onshore

- The Projects will result in a region-wide net decrease in harmful air pollutant emissions and GHGs that contribute to climate change.

10.0 REFERENCES

1.0 Introduction

BOEM. 2018. Draft Guidance Regarding the Use of a Project Design Envelope. [published January, 2018; accessed March 25, 2021]. https://www.boem.gov/sites/default/files/renewable-energy-program/Draft-Design-Envelope-Guidance.pdf

2.1 Geology

Atlantic City Municipal Utilities Authority. 2020. [accessed November 12, 2020]. https://www.acmua.org/.

[BOEM] Bureau of Ocean Energy Management. Office of Renewable Energy Programs. 2020. Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant to 30 CFR Part 585. [published May 27, 2020; accessed December 3, 2020]. https://www.boem.gov/sites/default/files/documents/about-boem/GG-Guidelines.pdf.

[BOEM]. Bureau of Ocean Energy Management. 2017. Munitions and Explosives of Concern Survey Methodology and In-field Testing for Wind Energy Areas on the Atlantic Outer Continental Shelf. OCS Study BOEM 2017-063. [accessed November 24, 2020]. https://www.boem.gov/Renewable-Energy-Environmental-Studies/.

Grow, JA. Klitgord, KD. Schlee, JS. 1988. Structure and Evolution of Baltimore Canyon Trough. In: Sheridan RE, Grow, JA, editors. Volumes 1-2, The Atlantic Continental Margin: U.S., Chapter 13. The Geological Society of America. [published January 1988; accessed October 9, 2020]. https://www.researchgate.net/publication/282505673_Structure_and_evolution_of_Baltimore_Canyon_Trough.

[MARCO] Mid-Atlantic Regional Council on the Ocean. Mid-Atlantic Ocean Data Portal. C2020. US Government Publishing Office; NOAA Office of Coast Survey; US Army Corps of Engineers; Mapped by MarineCadastre.gov. [accessed October 23, 2020] https://portal.midatlanticocean.org/data-catalog/maritime-industries/#layer-info-ocean-disposal-sites168.

McHugh, Cecilia M.G. Olson, Hilary Clement. 2002. Pleistocene Chronology of Continental Margin Sedimentation: New Insights Into Traditional Models, New Jersey. Marine Geology, Volume 186, Issues 3-4, July 2002, pages 389-411. [published 2002; accessed January 31, 2021]. https://www.sciencedirect.com/science/article/pii/S0025322702001986.

New Jersey American Water. c2019. 2019 Annual Water Quality Report: Coastal North System. [published 2019; accessed November 15, 2020]. https://www.amwater.com/ccr/coastalnorth.pdf.

[NJDEP] New Jersey Department of Environmental Protection. New Jersey Geological Survey. 2009. Kirkwood-Cohansey Water-table Aquifer. [published 2009; accessed November 15, 2020]. https://www.state.nj.us/dep/njgs/enviroed/infocirc/kirkwood-cohansey.pdf.

[NJDEP] New Jersey Department of Environmental Protection Office of Science. July 2010. Ocean/Wind Power Ecological Baseline Studies: Final Report. Volume I: Overview, Summary, and Application; Section 2.2.1, Marine Geology. [published July 2010; accessed October 9, 2020]. https://www.nj.gov/dep/dsr/ocean-wind/Ocean%20Wind%20Power%20Ecological%20Baseline%20Studies_Volume%20One.pdf.

[NJDEP] New Jersey Department of Environmental Protection Division of Water Supply and Geoscience. C2020. SWAP-Frequently Asked Questions. [accessed December 7, 2020]. https://www.state.nj.us/dep/watersupply/swap/faq.htm#q5.

[NJDOH] New Jersey Department of Public Health. February 6, 2020. New Jersey State Health Assessment Data: Monmouth County Public Health Profile Report. [published February 6, 2020; accessed 2020 Nov 15]. https://www-doh.state.nj.us/doh-shad/community/highlight/profile/PrivateWell.Testing/GeoCnty/13.html.

[NJWSA] New Jersey Water Supply Authority. 2017. The Manasquan System. [accessed November 15, 2020]. https://www.njwsa.org/manasquan.html.

Stockton University Coastal Research Center: New Jersey Geologic History. c2020. Galloway (NJ). [accessed November 12, 2020]. https://stockton.edu/coastal-research-center/njbpn/geologic-hist.html.

[USGS] United States Geological Survey. 2019. WaterWorlds—Continental Margin. C 2021a. [published June 17, 2019; accessed January 31, 2021]. https://www.usgs.gov/news/waterwords-continental-margin?qt-news_science_products=4#qt-news_science_products.

[USGS] United States Geological Survey. Trek Through Time. C 2021b. [accessed January 31, 2021]. https://www.usgs.gov/science-explorer-results?es=Trek+through+Time.

[USGS] United States Geological Survey. U.S. Geological Survey. 2019. Water Worlds—Methane Seep. C2021c. [published June 13, 2019; accessed February 7, 2021]. https://www.usgs.gov/news/waterwords-methane-seep?qt-news_science_products=4#qt-news_science_products.

[USGS] United States Geological Survey. U.S. Geological Survey Gas Hydrates Project. C 2021d. [accessed February 7, 2021]. https://www.usgs.gov/centers/whcmsc/science/us-geological-survey-gas-hydrates-project?qt-science_center_objects=0#qt-science_center_objects.

U.S. Committee on the Marine Transportation System. Proposed National Guidance for Industry on responding to Munitions and Explosives of Concern in U.S. Federal Waters (2023); [accessed 2024 February 20] https://www.federalregister.gov/documents/2023/08/25/2023-

18381/proposed-national-guidance-for-industry-on-responding-to-munitions-and-explosives-of-concern-in-us

2.2 Physical Oceanography and Meteorology

Ashley GM, Halsey SD, Buteux CB. 1986. New Jersey's longshore current pattern. Journal of Coastal Research. 2(4):453-463.

[BOEM] Bureau of Ocean Energy Management. 2017. Habitat mapping and assessment of northeast wind energy areas; [accessed 2020 August 5]. https://espis.boem.gov/final%20reports/5647.pdf.

[BOEM] Bureau of Ocean Energy Management. 2020. Potential earthquake, landslide, tsunami and geo-hazards for the U.S. offshore pacific wind farms; [accessed 2021 February 5]. https://www.boem.gov/sites/default/files/documents/environment/RPS-Final-Report-Geohazards_0.pdf.

Bumpus DF. 1965. Residual drift along the bottom on the continental shelf in the Middle Atlantic Bight area 1. Limnology and Oceanography, 10(suppl): R50-R53.

Buteux CB. 1982. Variations in magnitude and direction of longshore currents along the central New Jersey coast [Master's thesis] New Brunswick: Rutgers University.

Castelao R., Glenn S., Schofield O. 2010. Temperature, salinity, and density variability in the central Middle Atlantic Bight. Journal of Geophysical Research: Oceans, 115(C10).

Chen K., He R. 2010. Numerical investigation of the Middle Atlantic Bight shelfbreak frontal circulation using a high-resolution ocean hindcast model. Journal of Physical Oceanography. 40(5): 949-964.

Chen Z. 2018. Dynamics and Spatio-Temporal Variability of the Mid-Atlantic Bight Cold Pool [doctoral dissertation]. New Brunswick (NJ). Rutgers University.

Chen Z, Curchitser E, Chant R, Kang D. 2018. Seasonal variability of the cold pool over the Mid-Atlantic Bight Continental Shelf. Journal of Geophysical Research: Oceans. 123(11):8203-26.

Chen, Z., and E. N. Curchitser. 2020: Interannual Variability of the Mid-Atlantic Bight Cold Pool. J. Geophys. Res. Oceans, 125. https://doi.org/10.1029/2020JC016445.

Clare MA, Talling PJ, Challenor P, Malgesini, G, Hunt J. 2014. Distal turbidites reveal a common distribution for large (> 0.1 km3) submarine landslide recurrence: Geology.42(3): 263-266.

Ganim J. Cold Pool. 2019. MARACOOS. Newark (DE): Mid-Atlantic Regional Association Coastal Ocean Observing System; [published 2019 April 23; accessed 2020 November 30].

https://www.integratedecosystemassessment.noaa.gov/regions/northeast/components/cold-pool/.

Goldsmith KA, Lau S, Poach ME, Sakowicz GP, Trice TM, Ono CR, Nye J, Shadwick, EH, StLaurent KA, Saba GK. 2019. Scientific considerations for acidification monitoring in the US Mid-Atlantic Region. Estuarine, Coastal and Shelf Science. 225:106189.

Landsea C W, Franklin J L, 2013. Atlantic Hurricane Database Uncertainty and Presentation of a New Database Format. Mon. Wea. Rev., 141, 3576-3592.

Lentz SJ. 2017. Seasonal warming of the Middle Atlantic Bight Cold Pool. Journal of Geophysical Research: Oceans. 122(2):941-954.

Locarnini RA, Mishonov AV, Baranova OK, Boyer TP, Zweng MM, Garcia HE, Reagan JR, Seidov D, Weathers K, Paver CR, Smolyar I. 2018. World ocean atlas 2018, Volume 1: Temperature. A. Mishonov Technical Ed. NOAA Atlas NESDIS 81.

[MAROA] Mid-Atlantic Regional Ocean Assessment. 2020. Oceanographic setting and processes; [accessed 2020 August 5]. https://roa.midatlanticocean.org/ ocean-ecosystem-and-resources/characterizing-the-mid-atlantic-ocean-ecosystem/oceanographic-setting-and-processes/.

Miles, J., T. Martin, and L. Goddard, 2017: Current and wave effects around windfarm monopile foundations. Coastal engineering (Amsterdam), 121, 167-178.

Miles, Travis, Sarah Murphy, Josh Kohut, Sarah Borsetti, and Daphne Munroe, 2020. Could federal wind farms influence continental shelf oceanography and alter associated ecological processes? A literature review. Science Center for Marine Fisheries, Rutgers University. Available from https://scemfis.org/wp-content/uploads/2021/01/ColdPoolReview.pdf (February 2021).

Miller KG, Browning JV, Mountain GS, Sheridan RE, Sugarman PJ, Glenn S, Christensen BA. 2014. History of continental shelf and slope sedimentation on the US middle Atlantic margin. Geological Society. London. Memoirs. 41(1):21-34.

[NEIEA] Northeast Integrated Ecosystem Assessment. n.d. Cold Pool; [accessed 2020 October 22]. https://www.integratedecosystemassessment.noaa.gov/regions/northeas t/components/cold-pool/

[NFHL] National Flood Hazard Layer. 2020. Examining Flood Map Changes in New Jersey; [accessed 2021 March 9]. https://hazards-fema.maps.arcgis.com/apps/webappv iewer/index.html?.

[ONJSC] Office of the New Jersey State Climatologist – Rutgers University. 2020. Monthly climate tables; [accessed 2020 August 5]. http://climate.rutgers.edu/stateclim_v1/nclimdiv/index.php?stn=NJ03&elem=pcpn.

[PNNL] Pacific Northwest National Laboratory. 2020. Mid-Atlantic Bight Wave Hindcast to Support DOE Lidar Buoy Deployments: Model Validation; [accessed 2021 February 5].

Saunders PM. 1977. Wind stress on the ocean over the eastern continental shelf of North America. Journal of Physical Oceanography. 7(4):555-566.https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-29814. pdf.

Schultze, L. K. P., L. M. Merckelbach, J. Horstmann, S. Raasch, and J. R. Carpenter, 2020: Increased Mixing and Turbulence in the Wake of Offshore Wind Farm Foundations. Journal of Geophysical Research: Oceans, 125

Tides and Currents. 2020a. Atlantic City, NJ . Station ID: 8534720; [accessed 2020 August 5].https://tidesandcurrents.noaa.gov/stationhome.html?id=8534720.

Tides and Currents. 2020b. Sandy Hook, NJ . Station ID: 8531680; [accessed 2020 August 5]. https://tidesandcurrents.noaa.gov/stationhome.html?id=85316 80.

[USDOI] United States Department of the Interior. 1982. Final environmental impact statement OCS SALE No.76 Outer continental shelf oil and gas lease sale offshore the Mid-Atlantic States.

Voynova, Y. G., M. J. Oliver, and J. H. Sharp, 2013: Wind to zooplankton: Ecosystem-wide influence of seasonal wind-driven upwelling in and around the Delaware Bay. Journal of Geophysical Research. Oceans, 118, 6437-6450.

Zweng MM, Reagan JR, Seidov D, Boyer TP, Locarnini RA, Garcia HE, Mishonov AV, Baranova OK, Weathers K, Paver CR, Smolyar I. 2018. World Ocean Atlas 2018. Volume 2: Salinity. A. Mishonov Technical Ed. NOAA Atlas NESDIS 82.

3.1 Air Quality

[NOAA 2020] National Oceanic & Atmospheric Administration Global Monitoring Laboratory. Trends in Atmospheric Carbon Dioxide; [accessed October 30, 2020]. https://www.esrl.noaa.gov/gmd/ccgg/trends/global.html#global

[NPS 2020] National Park Service. 2020. Class I Areas. [published May 18, 2020; accessed October 29, 2020]. https://www.nps.gov/subjects/air/class1.htm.

[BOEM 2012] Bureau of Ocean Energy Management Office of Renewable Energy Programs. 2012. Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New Jersey, Delaware, Maryland, and Virginia Final Environmental Assessment: OCS EIS/EA BOEM 2012-003.

[IEA 2020] International Energy Agency. 2020. Global CO2 emissions in 2019. [Published February 11, 2020; accessed October 30, 2020]. https://www.iea.org/articles/global-co2-emissions-in-2019.

[NJDEP 2020a] New Jersey Department of Environmental Protection. 2020. Greenhouse Gas Emissions in New Jersey; [updated August 2020; accessed February 18, 2021]

[NPS 2010] National Park Service. 2010. Federal Land Managers' Air Quality Related Values Work Group (FLAG) Phase I Report—Revised: Natural Resource Report NPS/NRPC/NRR—2010/232https://www.nj.gov/dep/dsr/trends/ghg.pdf.

[EPA 2020a] Environmental Protection Agency Emissions & Generation Resource Integrated Database (eGRID). 2018. eGRID Summary Tables 2018; [published March 9, 2020, accessed October 30, 2020]. https://www.epa.gov/sites/production/files/2020-01/documents/egrid2018_summary_tables.pdf.

[EPA 2020b] Environmental Protection Agency. eGRID Related Materials. [accessed October 30, 2020]. https://www.epa.gov/egrid/egrid-related-materials.

[NJDEP 2020c] New Jersey Department of Environmental Protection. 2020. 2019 New Jersey Air Quality Report.

[EPA 2020c] Environmental Protection Agency AirData Air Quality Monitors. [accessed October 30, 2020]. https://epa.maps.arcgis.com/apps/webappviewer/index.html?id=5f239fd3e72f424f98ef3d5def547eb5.

[NJDEP 2020] State of New Jersey Department of Environmental Protection Bureau of Evaluation and Planning. 2020. New Jersey Air Emission Inventories; [published 2020; accessed November 3, 2020]. https://www.nj.gov/dep/baqp/inventory.html.

[NJDEP 2020b] Barr A, Orlando P, Kettig R, Barry R, Karmarkar-Deshmukh R, Kamel M. New Jersey's Global Warming Response Act 80x50 Report. Trenton (NJ): New Jersey Department of Environmental Protection.

[EPA 2020b] Environmental Protection Agency CO-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool; [published June 2020; accessed February 18, 2021] https://www.epa.gov/statelocalenergy/co-benefits-risk-assessment-cobra-health-impacts-screening-and-mapping-tool

[USACE 2017] Department of the Army Corps of Engineers. 2017. Waterborne Commerce of the United States, Calendar Year 2016, Part 1– Waterways and Harbors, Atlantic Coast. IWR-WCUS-16-1.

3.2 Water Quality

[ASA] Applied Science Associates, Inc. 2008. Results from Modeling of Sediment Dispersion during Installation of the Proposed Bayonne Energy Center Submarine Cable. Narragansett (RI):

ASA Project 2007-025.
http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterSeq=28172.

Atlantic City Municipal Utilities Authority. 2020. Annual Water Quality Report- Reporting Year 2020. Atlantic City (NJ): Atlantic City Municipal Utilities Authority; [accessed 12 November 2020]. https://www.acmua.org/.

Balthis WL, Hyland JL, Fulton MH, Wirth EF, Kiddon JA, Macauley J. 2009. Ecological Condition of Coastal Ocean Waters Along the U.S. Mid-Atlantic Bight: 2006. NOAA Technical Memorandum NOS NCCOS 109, NOAA National Ocean Service: Charleston (SC); 29412-9110.

[BOEM] Bureau of Ocean Energy Management. 2012. Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New Jersey, Delaware, Maryland, and Virginia: Final Environmental Assessment. US Department of Interior, Bureau of Ocean Energy Management.

BOEM 2021. South Fork Wind Farm and South Fork Export Cable Project Draft Environmental Impact Statement. Sterling (VA): BOEM; OCS EIS/EA BOEM 2020-057.

Bricker SB, Clement CG, Pirhalla DE, Orlando SP, Farrow DRG. 1999. National Estuarine Eutrophication Assessment: Effects of Nutrient Enrichment in the Nation's Estuaries. Silver Springs (MD): NOAA, National Ocean Service, Special Projects Office and the National Centers for Coastal Ocean Science.

Castelao, R., S. Glenn, and O. Schofield, 2010: Temperature, salinity, and density variability in the central Middle Atlantic Bight. Journal of Geophysical Research: Oceans, 115, C10005.

Chen Z, Curchitser E, Chant R, Kang D. 2018. Seasonal Variability of the Cold Pool Over the Mid-Atlantic Bight Continental Shelf. Journal of Geophysical Research: Oceans. 123: 8203-8226.

Chen, Z., and E. N. Curchitser, 2020: Interannual Variability of the Mid-Atlantic Bight Cold Pool. Journal of geophysical research. Oceans, 125.

Elliott J, Smith K, Gallien DR, and Khan A. 2017. Observing Cable Laying and Particle Settlement During the Construction of the Block Island Wind Farm. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2017-027. 225 pp.

[EPA] Environmental Protection Agency. 2010 NCCA 2010 Water Quality Indicator Status [dataset]. Washington D.C.: EPA Office of Wetlands, Oceans, and Watersheds; [accessed 30 November 2020]. https://www.epa.gov/national-aquatic-resource-surveys/data-national-aquatic-resource-surveys.

EPA. 2012. National Coastal Condition Report IV. Washington DC: EPA, Office of Water and Office of Research and Development Report No. EPA-842-R-10-003.

EPA. 2015. National Coastal Condition Assessment 2010. Washington, DC: Office of Water and Office of Research and Development. Report No. EPA 841-R-15-006.

EPA. 2016a. National Aquatic Resources Surveys-Indicators: Dissolved Oxygen; Washington D.C.: EPA Office of Wetlands, Oceans, and Watersheds; [accessed 30 November 2020].https://www.epa.gov/national-aquatic-resource-surveys/indicators-dissolved-oxygen.

EPA. 2016b. National Aquatic Resources Surveys-Indicators: Chlorophyll a; Washington D.C.: EPA Office of Wetlands, Oceans, and Watersheds; [accessed 30 November 2020].https://www.epa.gov/national-aquatic-resource-surveys/indicators-chlorophyll.

EPA. 2017. The Effects: Dead Zones and Harmful Algal Blooms; Washington D.C.: EPA Office of Water; [accessed 30 November 2020]. https://www.epa.gov/nutrientpollution/effects-dead-zones-and-harmful-algal-blooms.

Ganim J. Cold Pool. 2019. MARACOOS. Newark (DE): Mid-Atlantic Regional Association Coastal Ocean Observing System; [published 2019 April 23; accessed 30 November 2020]. https://www.integratedecosystemassessment.noaa.gov/regions/northeast/components/cold-pool/

Green L, Addy K, Sanbe N. 1996. Natural Resources Fact Sheet: Measuring Water Clarity. University of Rhode Island, Department of Natural Resources Science, Cooperative Extension. Report No. 96-1.

Johnson A. 2018. The Effects of Turbidity and Suspended Sediments on ESA-Listed Species from Projects Occurring in the Greater Atlantic Region. Greater Atlantic Region Policy Series 18-02. NOAA Fisheries Greater Atlantic Regional Fisheries Office.

Kohut J, Haldeman C, Kerfoot J. 2014. Monitoring Dissolved Oxygen in New Jersey Coastal Waters Using Autonomous Gliders. Edison (NJ): EPA Office of Research and Development National Risk Management Laboratory. Report No. EPA/600/R-13/180.

Lentz SJ. 2017. Seasonal warming of the Middle Atlantic Bight Cold Pool. Journal of Geophysical Research: Oceans. 122: 941–954.

Mallin M, Johnson V, Ensign S. 2008. Comparative impacts of stormwater runoff on water quality of an urban, a suburban, and a rural stream. Environmental Monitoring and Assessment. 159: 475–491.

Miles, Travis, Sarah Murphy, Josh Kohut, Sarah Borsetti, and Daphne Munroe, 2020. Could federal wind farms influence continental shelf oceanography and alter associated ecological processes? A literature review. Science Center for Marine Fisheries, Rutgers University. Available from https://scemfis.org/wp-content/uploads/2021/01/ColdPoolReview.pdf%20(February%202021).

Miles, J., T. Martin, and L. Goddard, 2017: Current and wave effects around windfarm monopile foundations. Coastal engineering (Amsterdam), 121, 167-178.

NASA Earth Observatory. Phytoplankton Bloom off New Jersey [date unknown]. [published 2016 July 6; accessed September 2020]. https://earthobservatory.nasa.gov/images/88340/phytoplankton-bloom-off-new-jersey.

[NJDEP] New Jersey Department of Environmental Protection. 2015a. New Jersey's Marine HAB Monitoring. Presentation by NJDEP Bureau of Marine Water Monitoring to the New Jersey Water Monitoring Council. [published 2015 September 23; accessed September 2020]. https://www.nj.gov/dep/wms/Schuster_NJDEPMarineHabmon.pdf.

NJDEP. 2015b. Sanitary Survey Report for Shellfish Growing Area AONorthCent (Bayhead to Monmouth Beach). NJDEP Water Monitoring and Standards.

NJDEP. 2018. NJDEP NSSP Monitoring Network [dataset]. Trenton (NJ): NJDEP Bureau of GIS; [last modified 2018 December 27; accessed 30 November 2020].

NJDEP. 2019a. 2016 New Jersey Integrated Water Quality Assessment Report. NJDEP Division of Water Monitoring and Standards, Bureau of Environmental Analysis, Restoration and Standards. https://www.arcgis.com/home/webmap/viewer.html?webmap=5f6e08fc9e354467a2fd455790ef114a&extent=-76.286,38.8572,-73.0505,40.5141

NJDEP. 2019b. CyanoHAB Events 2017. Trenton (NJ): NJDEP Bureau of Freshwater and Biological Monitoring; [last updated 2019 November 18; accessed 30 November 2020]. https://www.nj.gov/dep/wms/bfbm/2017cyanoHABevents.html.

NJDEP. 2019c. CyanoHAB Events 2018. Trenton (NJ): NJDEP Bureau of Freshwater and Biological Monitoring; [last updated 2019 November 18; accessed 30 November 2020]. https://www.nj.gov/dep/wms/bfbm/2018cyanoHABevents.html.

NJDEP. 2019d. NJPDES Surface Water Discharges in New Jersey, (1:12,000) [dataset]. Trenton (NJ): NJDEP Bureau of GIS; [last updated 2019 December 26; accessed 30 November 2020]. https://gisdata-njdep.opendata.arcgis.com/datasets/njpdes-surface-water-discharges-in-new-jersey-112000?geometry=-79.673%2C38.921%2C-70.286%2C40.401.

NJDEP. 2020a. Chlorophyll Remote Sensing [dataset]. Leeds Point (NJ): NJDEP Bureau of Marine Water Monitoring; [last updated 2020 February 3; accessed 30 November 2020]. http://njdep.rutgers.edu/aircraft/.

NJDEP. 2020b. NJDEP Harmful Algal Bloom (HAB) Interactive Mapping and Reporting System. Trenton (NJ): NJDEP Bureau of Freshwater and Biological Monitoring; [accessed 30 November 2020]. https://njdep.maps.arcgis.com/apps/opsdashboard/index.html#/49190166531d4e5a811c9a91e4a41677.

NJDEP. 2020c. CyanoHAB Events 2019. Trenton (NJ): NJDEP Bureau of Freshwater and Biological Monitoring; [last updated 2020 March; accessed 30 November 2020]. https://www.nj.gov/dep/wms/bfbm/2019cyanoHABevents.html.

NJDEP. 2020d. Bureau of Marine Water Monitoring Laboratory Facilities. Leeds Point (NJ): NJDEP Bureau of Marine Water Monitoring; [last updated 2020 June; accessed 30 November 2020]. https://www.nj.gov/dep/bmw/labfacility.htm.

NJDEP. 2020e. Nutrient Monitoring Networks. Leeds Point (NJ): NJDEP Bureau of Marine Water Monitoring; [accessed 2020 30 November 2020]. https://www.state.nj.us/dep/bmw/coastalwaterquality.htm.

NJDEP. 2020f. Stormwater Utilities. Trenton (NJ): NJDEP; [last updated 2020 September 16; accessed September 2020]. https://www.nj.gov/dep/dwq/stormwaterutility.html.

[NOAA] National Oceanic and Atmospheric Administration. Summertime Dissolved Oxygen Levels—What Do They Mean for Fish…and Fishermen? [date unknown(a)]. Chesapeake Bay Interpretive Buoy System; [accessed 30 November 2020]. https://buoybay.noaa.gov/news/summertime-dissolved-oxygen-levels-what-do-they-mean-for-fish-and-fishermen.

NOAA. Nutrient Biogeochemistry [date unknown(b)]. Miami (FL): NOAA Atlantic Oceanographic and Meteorological Laboratory's Ocean Chemistry and Ecosystem Division; [accessed 30 November 2020]. https://www.aoml.noaa.gov/ocd/ocdweb/nutrients.html.

NOAA. What is Upwelling? [date unknown(c)]. Silver Springs (MD): NOAA National Ocean Service; [last updated 2020 April 9; accessed 30 November 2020]. https://oceanservice.noaa.gov/facts/upwelling.html.

NOAA. 2018. Ocean Disposal Sites [dataset]. North Charleston (SC): Office for Coastal Management; [published 2018 October 31; accessed 30 November 2020]. https://www.fisheries.noaa.gov/inport/item/54193.

[MDMR] State of Maine Department of Marine Resources. 2016. The Scoop on Fecal Coliform. Augusta (ME): MDMR; [accessed 30 November 2020]. https://www.maine.gov/dmr/shellfish-sanitation-management/programs/growingareas/coliform.html.

Schultze, L. K. P., L. M. Merckelbach, J. Horstmann, S. Raasch, and J. R. Carpenter, 2020: Increased Mixing and Turbulence in the Wake of Offshore Wind Farm Foundations. Journal of Geophysical Research: Oceans, 125.

[VDH] Virginia Department of Health. 2020. Classification of Shellfish Growing Areas. Richmond (VA): VDH; [accessed 30 November 2020]. https://www.vdh.virginia.gov/environmental-health/environmental-health-services/shellfish-safety/classification-of-shellfish-growing-areas/.

Voynova, Y. G., M. J. Oliver, and J. H. Sharp, 2013: Wind to zooplankton: Ecosystem-wide influence of seasonal wind-driven upwelling in and around the Delaware Bay. Journal of Geophysical Research. Oceans, 118, 6437-6450.

West Point Partners, LLC. 2013. Application to the United States Army Corps of Engineers (New York District) for a Department of the Army Individual Permit. Volume 1 of 2. Fairfield (CT): West Point Partners, LLC. http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7BC191AEEA-9CFF-4D39-9654-E21B59A3629A%7D.

4.1 Wetlands and Other Waters of the United States

Franklin Township Public Schools. 2021. The four regions of New Jersey. Somerset (NJ): Franklin Township Public Schools; [accessed 22 January 2021]. https://www.franklinboe.org/cms/lib/NJ01000817/Centricity/Domain/1362/four%20regions%20of%20nj-unit%201%20lesson%202-1.pptx.

Citizens United to Protect the Maurice River and its Tributaries, Inc. (CUPMR). 2008. Plants of Southern New Jersey. Millville (NJ): CUPMR; [accessed 22 January 2021]. https://www.cumauriceriver.org/botany/mariveg.html

Natural Resources Conservation Service (NRCS). 2020. Soil Data Access (SDA) Hydric Soils List. Washington D.C.: USDA NRCS; [accessed 22 January 2021]. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcseprd1316620.html

New Jersey Department of Military and Veteran Affairs (DMAVA). 2020. Field Guide to the Beach Habitats of the National Guard Training Center. Sea Girt (NJ): New Jersey Army National Guard; [accessed 22 January 2021]. https://www.nj.gov/military/construction-facilities-management/environmental-management/documents/3307-booklet-FINAL.pdf

New Jersey Department of Environmental Protection (NJDEP). 2020. New Jersey Coastal Management Program. Trenton (NJ): NJDEP, Bureau of Climate Resilience Planning; [updated October 21, 2020; accessed 22 January 2021]. https://www.state.nj.us/dep/cmp/

New Jersey Department of Environmental Protection and Energy (NJDEPE) and United States Army Corps of Engineers (USACE). 1993. *Memorandum of Agreement Between the State of New Jersey and the Department of the Army.* [accessed 22 January 2021]. http://www2.law.mercer.edu/elaw/wetlands/new%20jersey%20corps%20assumption%20moa.pdf

New Jersey Department of Environmental Protection (NJDEP). 2017. Background Information: Coastal Resiliency and Building Ecological Solutions. Trenton (NJ): State of New Jersey; [updated October 18, 2017; accessed 22 January 2021]. https://www.nj.gov/dep/seeds/bescch/2_bkgrdinfo.htm.

Soil Survey Staff. 2020. Web Soil Survey. Washington D.C.: Natural Resources Conservation Service, United States Department of Agriculture; [accessed 22 January 2021]. https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx.

Stockton University. 2021. New Jersey Geologic History: New Jersey Coastal Composition. Galloway (NJ): Stockton University; [accessed 22 January 2021]. https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx.

Stockton University. 2021. New Jersey geologic history. Galloway (NJ): Stockton University; [accessed 22 January 2021]. https://stockton.edu/coastal-research-center/njbpn/geologic-hist.html.

U. S. Fish and Wildlife Service (USFWS). 2021. National Wetlands Inventory. Washington D.C.: U.S. Department of the Interior, Fish and Wildlife Service; [updated October 1, 2019; accessed 22 January 2021]. http://www.fws.gov/wetlands/.

Yang L, Jin S, Danielson P, Homer CG, Gass L, Bender SM, Case A, Costello C, Dewitz JA, Fry JA, Funk M, Granneman BJ, Liknes GC, Rigge MB, and Xian G. 2018. A New Generation of the United States National Land Cover Database—Requirements, Research Priorities, Design, and Implementation Strategies. Journal of Photogrammetry and Remote Sensing. 146: 108-123. https://doi.org/10.1016/j.isprsjprs.2018.09.006.

4.2 Coastal and Terrestrial Habitat and Fauna

Middletown Township Environmental Commission (MTEC). 1995. Coastal Habitats of the Middletown Bayshore: A Natural Resource Inventory of the Bayshore Region: Middletown, Monmouth County, New Jersey. Middletown (NJ): Middletown Township Environmental Commission. [accessed 25 January 2021]. https://rucore.libraries.rutgers.edu/rutgers-lib/29668/PDF/1/play/.

New Jersey Department of Environmental Protection (NJDEP). 2020. New Jersey Coastal Management Program. Trenton (NJ): NJDEP, Bureau of Climate Resilience Planning; [updated October 21, 2020; accessed 25 January 2021]. https://www.state.nj.us/dep/cmp/.

New Jersey Department of Environmental Protection (NJDEP). 2018. New Jersey's Endangered and Threatened Wildlife. Trenton (NJ); Department of Environmental Protection; [updated March 20, 2018; [accessed 25 January 2021]. https://www.nj.gov/dep/fgw/tandespp.htm.

New Jersey Fish and Wildlife (NJFW). 2021. Central New Jersey Warmwater Game Fish. Trenton (NJ); New Jersey Department of Environmental Protection; [accessed 25 January 2021]. https://www.njfishandwildlife.com/pdf/fishbrochurecentral.pdf.

Neuman M, Guillermo R, Able K. 2004. Species Composition and Food Habits of Dominant Fish Predators in Salt Marshes of an Urbanized Estuary, The Hackensack Meadowlands, New Jersey. Tuckerton (NJ); Urban Habitats Scientific Journal; [2004 Dec; accessed 25 January 2021].

http://www.urbanhabitats.org/v02n01/saltmarsh_full.html#:~:text=The%20dominant%20fish%20species%20(white,Kraus%20%26%20Bragin%2C%201989).

State of New Jersey. 2021a. Pinelands National Reserve, Plants. New Lisbon (NJ); Pinelands Commission; [accessed 25 January 2021]. https://nj.gov/pinelands/reserve/plants/.

State of New Jersey. 2021b. Pinelands National Reserve, Animals. New Lisbon (NJ); Pinelands Commission; [accessed 25 January 2021]. https://nj.gov/pinelands/reserve/anim/.

Pinelands Preservation Alliance. 2021. Pine Barrens Wildlife. Southampton (NJ); Pinelands Preservation Alliance; [accessed 25 January 2021]. https://pinelandsalliance.org/learn-about-the-pinelands/ecosystem/wildlife/.

New Jersey Pinelands Commission. 2015. Threatened & Endangered Animals of the New Jersey Pinelands. New Lisbon (NJ); Pinelands Commission; [updated 2015 Jun; accessed 25 January 2021]. https://www.nj.gov/pinelands/infor/fact/T&Efacts.pdf.

USDA Forest Service. 2004. Forests of the Garden State. Newtown Square (PA): USDA Forest Service; [updated October 04, 2004; accessed 25 January 2021]. https://www.fs.fed.us/ne/newtown_square/publications/resource_bulletins/pdfs/2005/ne_rb163.pdf.

U.S. Fish & Wildlife Service (USFWS). 2021. Endangered Species. New Jersey Field Office: Northeast Region Ecological Services; [updated January 12, 2021; accessed 25 January 2021]. https://www.fws.gov/northeast/njfieldoffice/endangered/index.html.

Wootton L, Miller J, Miller C, Peek M, Williams A, Rowe P. 2016. Sea Grant Consortium Dune Manual. New Jersey (US): New Jersey Sea Grant Consortium; [accessed 25 January 2021]. http://njseagrant.org/wp-content/uploads/2016/07/Dune-Manual-Pgs-compressed.pdf.

4.3 Birds

Atlantic Seabirds. 2019. Interactive map of the ten Black-capped Petrels captured at sea offshore Cape Hatteras, NC, and tracked by satellite. Available at https://www.atlanticseabirds.org/bcpe-2019.

Baker, A., P. Gonzalez, R. I. G. Morrison, & B. A. Harrington. 2020. Red Knot (Calidris canutus), version 1.0. *in* Billerman, S. M. (ed). Birds of the World. Cornell Lab of Ornithology, Ithaca, NY, USA Available at https://doi-org.uri.idm.oclc.org/10.2173/bow.redkno.01.

BOEM. 2021. Vineyard Wind 1 Offshore Wind Energy Project Final Environmental Impact Statement Volume II. OCS EIS/EA BOEM 2021-0012. https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Vineyard-Wind-1-FEIS-Volume-2.pdf.

Burger, J., C. Gordon, J. Lawrence, J. Newman, G. Forcey, & L. Vlietstra. 2011. Risk evaluation for federally listed (roseate tern, piping plover) or candidate (red knot) bird species in offshore waters: A first step for managing the potential impacts of wind facility development on the Atlantic Outer Continental Shelf. Renew. Energy 36: 338–351.

Bierregaard, R. 2019. Osprey Research - Overview. ospreytrax.com. Available at http://ospreytrax.com/index.html.

Bierregaard, R. O., F. A. Poole, M. S. Martell, P. Pyle, & M. A. Patten. 2020. Osprey (Pandion haliaetus), version 1.0. In Birds of the World (P.G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.

Cochran, W. W. 1985. Ocean migration of Peregrine Falcons: is the adult male pelagic? Pp. 223–237 *in* Harwood, M. (ed). Proceedings of Hawk Migration Conference IV. Hawk Migration Association of North America, Rochester, NY

Cook, A. S. C. P., A. Johnston, L. J. Wright, & N. H. K. Burton. 2012. A Review of Flight Heights and Avoidance Rates of Birds in Relation to Offshore Wind Farms. BTO Research Report Number 618. British Trust for Ornithology, Thetford, UK. 61 pp. Available at http://www.bto.org/sites/default/files/u28/downloads/Projects/Final_Report_SOSS02_BTOReview.pdf.

Curtice, C., J. Cleary, E. Shumchenia, & P. Halpin. 2016. Marine-life Data and Analysis Team (MDAT) technical report on the methods and development of marine-life data to support regional ocean planning and management. Prepared on behalf of the Marine-life Data and Analysis Team (MDAT). Available at http://seamap.env.duke.edu/models/MDAT/MDAT-Technical-Report.pdf.

DeSorbo, C. R., C. Persico, & L. Gilpatrick. 2018. Studying migrant raptors using the Atlantic Flyway. Block Island Raptor Research Station, Block Island, RI: 2017 season. BRI Report # 2018-12 submitted to The Nature Conservancy, Block Island, Rhode Island, and The Bailey Wildlife Foundation, Cambridge, Massachusetts. Biodiversity Research Institute, Portland, Maine. 35 pp.

DeSorbo, C. R., C. P. Persico, L. Gilpatrick, A. Gilbert, A. Dalton, & M. Burton. 2019. Studying migrant raptors using the Atlantic Flyway: Block Island Raptor Research Station, Block Island, RI: 2018 season. BRI Report # 2019-10 submitted to The Nature Conservancy, Block Island, Rhode Island, and The Bailey Wildlife Foundation, Cambridge, Massachusetts. Biodiversity Research Institute, Portland, Maine. 33 pp plus appendices.

DeSorbo, C. R., K. G. Wright, & R. Gray. 2012. Bird migration stopover sites: ecology of nocturnal and diurnal raptors at Monhegan Island. Report BRI 2012-09 submitted to the Maine Outdoor Heritage Fund, Pittston, Maine, and the Davis Conservation Foundation, Yarmouth, Maine. Biodiversity Research Institute, Gorham, Maine. 43 pp. Available at http://www.briloon.org/raptors/monhegan.

Dierschke, V., R. W. Furness, & S. Garthe. 2016. Seabirds and offshore wind farms in European waters: Avoidance and attraction. Biol. Conserv. 202: 59–68.

Drewitt, A. L., & R. H. W. Langston. 2006. Assessing the Impacts of Wind Farms on Birds. Ibis (Lond. 1859). 148: 29–42.

Fliessbach, K. L., K. Borkenhagen, N. Guse, N. Markones, P. Schwemmer, & S. Garthe. 2019. A ship traffic disturbance vulnerability index for Northwest European seabirds as a tool for marine spatial planning. Front. Mar. Sci. 6: 192.

Fox, A. D., M. Desholm, J. Kahlert, T. K. Christensen, & I. Krag Petersen. 2006. Information needs to support environmental impact assessment of the effects of European marine offshore wind farms on birds. Ibis (Lond. 1859). 148: 129–144.

Fox, A. D., M. Desholm, J. Kahlert, T. K. Christensen, & I. K. Petersen. 2006. Information needs to support environmental impact assessment of the effects of European marine offshore wind farms on birds. Ibis (Lond. 1859). 148: 129–144.

Fox, A. D., & I. K. Petersen. 2019. Offshore wind farms and their effects on birds. Dansk Orn. Foren. Tidsskr. 113: 86–101.

Furness, R. W., H. M. Wade, & E. A. Masden. 2013. Assessing vulnerability of marine bird populations to offshore wind farms. J. Environ. Manage. 119: 56–66.

Garthe, S., & O. Hüppop. 2004. Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. J. Appl. Ecol. 41: 724–734.

Garthe, S., N. Markones, & A.-M. Corman. 2017. Possible impacts of offshore wind farms on seabirds: a pilot study in Northern Gannets in the southern North Sea. J. Ornithol. 158: 345–349.

Gochfeld, M., & J. Burger. 2020. Roseate Tern (*Sterna dougallii*), version 1.0. *in* Billerman, S. M. (ed). Birds of the World. Cornell Lab of Ornithology, Ithaca, NY, USA Available at https://doi-org.uri.idm.oclc.org/10.2173/bow.roster.01.

Goodale, M. W., & A. Milman. 2016. Cumulative adverse effects of offshore wind energy development on wildlife. J. Environ. Plan. Manag. 59: 1–21.

Goodale, M. W., & I. J. Stenhouse. 2016. A conceptual model for determining the vulnerability of wildlife populations to offshore wind energy development. Human-Wildlife Interact. 10: 53–61.

Haney, J. C. 1987. Aspects of the pelagic ecology and behavior of the Black-capped Petrel (*Pterodroma hasitata*). Wilson Bull. 99: 153–168.

Hartman, J. C., K. L. Krijgsveld, M. J. M. Poot, R. C. Fijn, M. F. Leopold, & S. Dirksen. 2012. Effects on birds of Offshore Wind farm Egmond aan Zee (OWEZ). An overview and integration of insights obtained. Report 12-005. Bureau Waardenburg, Culemborg, Netherlands.

Hill, R., K. Hill, R. Aumuller, A. Schulz, T. Dittmann, C. Kulemeyer, & T. Coppack. 2014. Of birds, blades, and barriers: Detecting and analysing mass migration events at alpha ventus. Pp. 111–132 *in* Federal Maritime and Hydrographic Agency & Federal Ministry of the Environment Nature Conservation and Nuclear Safety (eds). Ecological Research at the Offshore Windfarm alpha ventus. Springer Spektrum, Berlin, Germany

Hüppop, O., J. Dierschke, K.-M. Exo, E. Fredrich, & R. Hill. 2006. Bird migration studies and potential collision risk with offshore wind turbines. Ibis (Lond. 1859). 148: 90–109.

Jodice, P. G. R., R. A. Ronconi, E. Rupp, G. E. Wallace, & Y. Satgé. 2015. First satellite tracks of the Endangered Black-capped Petrel. Endangered Species Research 29: 23–33.

Johnston, A., A. S. C. P. Cook, L. J. Wright, E. M. Humphreys, & N. H. K. Burton. 2014. Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. J. Appl. Ecol. 51: 31–41.

Katzner, T., B. W. Smith, T. A. Miller, D. Brandes, J. Cooper, M. Lanzone, D. Brauning, C. Farmer, S. Harding, D. E. Kramar, C. Koppie, C. Maisonneuve, M. Martell, E. K. Mojica, C. Todd, J. A. Tremblay, M. Wheeler, D. F. Brinker, T. E. Chubbs, R. Gubler, K. O'Malley, S. Mehus, B. Porter, R. P. Brooks, B. D. Watts, & K. L. Bildstein. 2012. Status, biology, and conservation priorities for North America's eastern Golden Eagle (Aquila chrysaetos) population. Auk 129: 168–176.

Kerlinger, P. 1985. Water-crossing behavior of raptors during migration. Wilson Bull. 97: 109–113.

Krijgsveld, K. L., R. C. Fljn, M. Japink, P. W. van Horssen, C. Heunks, M. P. Collier, M. J. M. Poot, D. Beuker, & S. Birksen. 2011. Effect Studies Offshore Wind Farm Egmond aan Zee: Final Report on Fluxes, Flight Altitudes and Behaviour of Flying Birds. Bureau Waardenburg report no. 10-219. Institute for Marine Resources & Ecosystem Studies, Wageningen UR, Netherlands.

Langston, R. H. W. 2013. Birds and wind projects across the pond: A UK perspective. Wildl. Soc. Bull. 37: 5–18.

Lee, D. S. 2000. Status and Conservation Priorities for Black-capped Petrels in the West Indies. Pp. 11–18 *in* Schreiber, E. A. & D. S. Lee (eds). Status and Conservation of West Indian Seabirds. Society of Caribbean Ornithology, Ruston, LA

Leonhard, S. B., J. Pedersen, P. N. Grøn, H. Skov, J. Jansen, C. J. Topping, & I. K. Petersen. 2013. Wind farms affect Common Scoter and Red-throated Diver behaviour. In Danish Offshore Wind: Key Environmental Issues – A Follow-up. The Environment Group: The Danish Energy Agency, The Danish Nature Agency, DONG Energy and Vattenfall, pp. 70–93 (Chapter 5).

Lindeboom, H. J., H. J. Kouwenhoven, M. J. N. Bergman, S. Bouma, S. Brasseur, R. Daan, R. C. Fijn, D. de Haan, S. Dirksen, R. van Hal, R. Hille Ris Lambers, R. ter Hofstede, K. L. Krijgsveld, M. Leopold, & M. Scheidat. 2011. Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. Environ. Res. Lett. 6: 035101.

Loring, P. H., J. D. McLaren, P. A. Smith, L. J. Niles, S. L. Koch, H. F. Goyert, & H. Bai. 2018. Tracking Movements of Threatened Migratory rufa Red Knots in U.S. Atlantic Outer Continental Shelf Waters. OCS Study BOEM 2018-046. US Department of the Interior, Bureau of Ocean Energy Management, Sterling (VA) 145 pp. OCS Study BOEM 2018-046. U.S. Department of the Interior, Bureau of Ocean Energy Management, Sterling, VA. 145 pp.

Loring, P. H., P. W. C. Paton, J. D. McLaren, H. Bai, R. Janaswamy, H. F. Goyert, C. R. Griffin, & P. R. Sievert. 2019. Tracking offshore occurrence of Common Terns, endangered Roseate Terns, and threatened Piping Plovers with VHF arrays. OCS Study BOEM 2019-017. US Department of the Interior, Bureau of Ocean Energy Management, Sterling, VA. 140 pp. Available at https://espis.boem.gov/final reports/BOEM_2019-017.pdf.

Loring, P., A. Lenske, J. McLaren, M. Aikens, A. Anderson, Y. Aubrey, E. Dalton, A. Dey, C. Friis, D. Hamilton, B. Holberton, D. Kriensky, D. Mizrahi, L. Niles, K. L. Parkins, J. Paquet, F. Sanders, A. Smith, Y. Turcotte, A. Vitz, & P. Smith. 2021. Tracking Movements of Migratory Shorebirds in the US Atlantic Outer Continental Shelf Region. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-008. 104 p.

Masden, E. A., D. T. Haydon, A. D. Fox, R. W. Furness, R. Bullman, & M. Desholm. 2009. Barriers to movement: impacts of wind farms on migrating birds. ICES J. Mar. Sci. 66: 746–753. Available at http://icesjms.oxfordjournals.org/cgi/doi/10.1093/icesjms/fsp031.

Mendel, B., P. Schwemmer, V. Peschko, S. Müller, H. Schwemmer, M. Mercker, & S. Garthe. 2019. Operational offshore wind farms and associated ship traffic cause profound changes in distribution patterns of Loons (Gavia spp.). J. Environ. Manage. 231: 429–438.

MMO. 2018. Displacement and habituation of seabirds in response to marine activities. A report produced for the Marine Management Organisation,. MMO Project No: 1139, May 2018, 69 pp. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/715604/Displacement_and_habituation_of_seabirds_in_response_to_marine_activities.pdf.

O'Connell, A. F., A. T. Gardner, A. T. Gilbert, & K. Laurent. 2009. Compendium of Avian Occurrence Information for the Continental Shelf Waters along the Atlantic Coast of the United States, Final Report (Database Section - Seabirds). OCS Study BOEM 2012-076. Prepared by the USGS Patuxent Wildlife Research Center, Beltsville, MD. U.S. Department of the Interior, Geological Survey, and Bureau of Ocean Energy Management Headquarters. 362 pp. Available at http://www.gomr.boemre.gov/homepg/espis/espismaster.asp?appid=1.

Percival, S. M. 2010. Kentish Flats Offshore Wind Farm: Diver Surveys 2009-10. Durham, UK.

Peschko, V., B. Mendel, M. Mercker, J. Dierschke, & S. Garthe. 2021. Northern gannets (*Morus bassanus*) are strongly affected by operating offshore wind farms during the breeding season. J. Environ. Manage.: 1–12. Available at https://doi.org/10.1016/j.jenvman.2020.111509.

Petersen, I. K., T. K. Christensen, J. Kahlert, M. Desholm, & A. D. Fox. 2006. Final results of bird studies at the offshore wind farms at Nysted and Horns Rev, Denmark. Report by The National Environmental Research Institute to DONG energy and Vattenfall A/S. 161 pp.

Petersen, I. K., & A. D. Fox. 2007. Changes in bird habitat utilisation around the Horns Rev 1 offshore wind project, with particular emphasis on Common Scoter. Report commissioned by Vattenfall A/S by National Environmental Research Institute, University of Aarhus, Denmark.

Simons, T. R., D. S. Lee, & J. C. Hanley. 2013. Diablotin (*Pterodroma hasitata*): A biography of the endangered Black-capped Petrel. Marine Ornithology 41: S3–S43.

Skov, H., M. Desholm, S. Heinänen, J. A. Kahlert, B. Laubek, N. E. Jensen, R. Žydelis, & B. P. Jensen. 2016. Patterns of migrating soaring migrants indicate attraction to marine wind farms. Biol. Lett. 12: 20160804.

Skov, H., S. Heinanen, T. Norman, R. M. Ward, S. Mendez-Roldan, & I. Ellis. 2018. ORJIP Bird Collision and Avoidance Study. Final Report - April 2018. Report by NIRAS and DHI to The Cabon Trust, U.K. 247 pp.

Stenhouse, I. J., A. M. Berlin, A. T. Gilbert, M. W. Goodale, C. E. Gray, W. A. Montevecchi, L. Savoy, & C. S. Spiegel. 2020. Assessing the exposure of three diving bird species to offshore wind areas on the U.S. Atlantic Outer Continental Shelf using satellite telemetry. Divers. Distrib. n/a. Available at https://doi.org/10.1111/ddi.13168.

U.S. Fish and Wildlife Service. 2018. Threatened Species Status for Black-Capped Petrel with a Section 4(d) Rule. Federal Register 83: 50560–50574.

U.S. Fish and Wildlife Service. 2021. Birds of Conservation Concern 2021. Department of the Interior, Falls Church, VA. 48 pp.

Vanermen, N., T. Onkelinx, W. Courtens, M. Van de walle, H. Verstraete, & E. W. M. Stienen. 2015. Seabird avoidance and attraction at an offshore wind farm in the Belgian part of the North Sea. Hydrobiologia 756: 51–61.

Wade, H. M., E. A. Masden, A. C. Jackson, & R. W. Furness. 2016. Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments. Mar. Policy 70: 108–113.

Williams, K. A., I. J. Stenhouse, E. E. Connelly, & S. M. Johnson. 2015. Mid-Atlantic Wildlife Studies: Distribution and Abundance of Wildlife along the Eastern Seaboard 2012-2014. Biodiversity Research Institute. Portland, Maine. Science Communications Series BRI 2015-19. 32 pp.

Willmott, J. R., G. Forcey, & A. Kent. 2013. The relative vulnerability of migratory bird species to offshore wind energy projects on the Atlantic Outer Continental Shelf: An assessment method and database. OCS Study BOEM 2013-207. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Herndon, VA. 275 pp.

4.4 Bats

Alerstam T. 2000. Bird migration performance on the basis of flight mechanics and trigonometry. In: Domenici P, Blake RW, editors. Biomechanics in Animal Behaviour. Oxford: BIOS Scientific Publishers. p 105-124

Alerstam T. 2008. Great-circle migration of arctic birds. Proceedings conf. RIN08– Animal Navigation, paper no 23, 9 pp (CD). Royal Institute of Navigation, London

Allen GM. 1923. The red bat in Bermuda. Journal of Mammalogy 4(1):61–61.

Arnett EB, Brown WK, Erickson WP, Fiedler JK, Hamilton BL, Henry TH, Jain A, Johnson GD, Kerns J, Koford RR, Nicholson CP, O'Connell TJ, Piorkowski MD, Tankersley RD Jr. 2008. Patterns of bat fatalities at wind energy facilities in North America. Journal of Wildlife Management 72:61–78.

Arnett EB, Baerwald EF. 2013. Impacts of wind energy development on bats: implications for conservation. In: Adams RA, Scott SC, editors. Bat Evolution, Ecology, and Conservation. New York (NY): Springer. p. 435–456.

Arnett EB, Baerwald EF, Mathews F, Rodrigues L, Rodríguez-Durán A, Rydell J, Villegas-Patraca R, Voigt CC. 2016. Impacts of wind energy development on bats: a global perspective. In: Voight C, Kingston T, editors. Bats in the Anthropocene: conservation of bats in a changing world. Springer, Cham. p. 295-323.

Ahlén I, Baagøe H J, Bach L. 2009. Behavior of Scandinavian bats during migration and foraging at sea. Journal of Mammalogy 90(6):1318–1323.

Bailey LA, Brigham RM, Bohn SJ, Boyles JG, Smit B. 2019. An experimental test of the allotonic frequency hypothesis to isolate the effects of light pollution on bat prey selection. Oecologia 190(2):367–74.

Bauer S, Ens BJ, Klaassen M. 2010. Many routes lead to Rome: potential causes for the multi-route migration system of red knots, *Calidris canutus islandica*. Ecology 91:1822–1831.

Bennett VJ, Hale AM. 2014. Red Aviation Lights on Wind Turbines Do Not Increase Bat–Turbine Collisions. Animal Conservation. 17. 10.1111/acv.12102

Boyles JG, Cryan PM, McCracken GF, Kunz TH. 2011. Economic importance of bats in agriculture. Science 332(6025):41–42.

Brabant, R., Y. Laurent, & B. Jonge Poerink. 2018. First ever detections of bats made by an acoustic recorder installed on the nacelle of offshore wind turbines in the North Sea. 2018

WinMon report 2018. Royal Belgian Institute of Natural Sciences. Available at http://www.vliz.be/imisdocs/publications/320069.pdf.

Bunkley JP, Barber JR. 2015. Noise reduces foraging efficiency in pallid bats (*Antrozous pallidus*). Ethology 121(11):1116–21.

Bunkley JP, McClure CJ, Kleist NJ, Francis CD, Barber JR. 2015. Anthropogenic noise alters bat activity levels and echolocation calls. Global Ecology and Conservation 3:62–71.

Caceres MC, Barclay RM. 2000. *Myotis septentrionalis*. Mammalian species (634):1-4.

Carter TC, Feldhamer GA. 2005. Roost tree use by maternity colonies of Indiana bats and northern long-eared bats in southern Illinois. Forest Ecology and Management 219(2-3):259–68.

Cryan PM. 2008. Mating behavior as a possible cause of bat fatalities at wind turbines. The Journal of Wildlife Management 72(3):845–849.

Cryan PM, Brown AC. 2007. Migration of bats past a remote island offers clues toward the problem of bat fatalities at wind turbines. Biological Conservation139(1-2):1–11.

Cryan PM, Barclay RM. 2009. Causes of bat fatalities at wind turbines: hypotheses and predictions. Journal of Mammalogy 90(6):1330–1340.

Cryan PM, Jameson JW, Baerwald EF, Willis CK, Barclay RM, Snider EA, Crichton EG. 2012. Evidence of late-summer mating readiness and early sexual maturation in migratory tree-roosting bats found dead at wind turbines PLoS One 7(10): e47586.

Cryan PM, Gorresen PM, Hein CD, Schirmacher MR, Diehl RH, Huso MM, Hayman DTS, Fricker PD, Bonaccorso FJ, Johnson DH, Heist K, Dalton DC. 2014. Behavior of bats at wind turbines. Proceedings of the National Academy of Sciences 111(42):15126–15131.

Cravens ZM, Boyles JG. 2019. Illuminating the physiological implications of artificial light on an insectivorous bat community. Oecologia 189(1):69–77.

Cravens ZM, Brown VA, Divoll TJ, Boyles JG. 2018. Illuminating prey selection in an insectivorous bat community exposed to artificial light at night. Journal of Applied Ecology 55(2):705–13.

Cravens ZM, Boyles JG. 2019. Illuminating the physiological implications of artificial light on an insectivorous bat community. Oecologia 189(1):69–77.

Davies TW, Bennie J, Gaston KJ. 2012. Street lighting changes the composition of invertebrate communities. Biology Letters 8(5):764–7.

Dowling Z, Sievert PR, Baldwin E, Johnson L, von Oettingen S, Reichard J. 2017. Flight Activity and Offshore Movements of Nano-Tagged Bats on Martha's Vineyard, MA. Sterling (VA): U.S. Department of the Interior, BOEM, Office of Renewable Energy Programs. OCS Study BOEM

2017-054. [published June 2017; accessed 30 October 2020]. https://www.boem.gov/Flight-Activity-and-Offshore-Movements-of-Nano-Tagged-Bats-on-Marthas-Vineyard/

Dowling ZR, O'Dell DI. 2018. Bat Use of an Island off the Coast of Massachusetts. Northeastern Naturalist. 25(3):362-82.

Druecker JD. 1972. Aspects of reproduction in *Myotis volans*, *Lasionycteris noctivagans*, and *Lasiurus cinereus*. Unpublished Ph.D. dissertation, Albuquerque (NM): Department of Biology. University of New Mexico.

Fleming TH, Eby P. 2003. Ecology of bat migration. In: Kunz TH, Fenton MB, editors. Bat Ecology. Chicago (IL): The University of Chicago Press. p. 156–208.

Frick WF, Baerwald EF, Pollock JF, Barclay RM, Szymanski JA, Weller TJ, Russell AL, Loeb SC, Medellin RA, McGuire LP. 2017. Fatalities at wind turbines may threaten population viability of a migratory bat. Biological Conservation 209:172–7.

Geo-Marine, Inc. 2010. New Jersey Department of Environmental Protection Baseline Studies. Final Report Volume II: Avian Studies. [published July 2010; accessed 2020 November]. https://www.nj.gov/dep/dsr/ocean-wind/Ocean%20Wind%20Power%20Ecological%20Baseline%20Studies_Volume%20Two.pdf.

Gill Jr RE, Tibbitts TL, Douglas DC, Handel CM, Mulcahy DM, Gottschalck JC, Warnock N, McCaffery BJ, Battley PF, Piersma T. 2009. Extreme endurance flights by landbirds crossing the Pacific Ocean: ecological corridor rather than barrier Proceedings of the Royal Society B: Biological Sciences 276(1656):447–57.

Griffin DR. 1940. Notes on the life histories of New England cave bats. Journal of Mammalogy 21(2):181–7.

Griffin DR. 1945. Travels of banded cave bats. Journal of Mammalogy 26(1):15–23.

Haddock JK, Threlfall CG, Law B, Hochuli DF. 2019. Light pollution at the urban forest edge negatively impacts insectivorous bats. Biological Conservation 236:17–28.

Hatch SK, Connelly EE, Divoll TJ, Stenhouse IJ, Williams KA. 2013. Offshore Observations of Eastern Red Bats (*Lasiurus borealis*) in the Mid-Atlantic United States Using Multiple Survey Methods. PLoS ONE 8(12): e83803. doi:10.1371/journal.pone.0083803

Hayes MA, Hooton LA, Gilland KL, Grandgent C, Smith RL, Lindsay SR, Collins JD, Schumacher SM, Rabie PA, Gruver JC. 2019. A smart curtailment approach for reducing bat fatalities and curtailment time at wind energy facilities. Ecological Applications 29(4):e01881.

Hedenström A. 2009. Optimal migration strategies in bats. Journal of Mammalogy 90:1298–1309.

Henderson LE, Broders HG. 2008. Movements and resource selection of the northern long-eared myotis *(Myotis septentrionalis)* in a forest—agriculture landscape. Journal of Mammalogy. 15;89(4):952-63.

Hüppop O, Hill R. 2016. Migration phenology and behaviour of bats at a research platform in the south-eastern North Sea. Lutra 59(1-2):5–22.

Jansson S, Malmqvist E, Brydegaard M, Åkesson S, Rydell J. 2020. A Scheimpflug lidar used to observe insect swarming at a wind turbine. Ecological Indicators 117:106578.

Johnson JB, Gates JE, Zegre NP. 2011. Monitoring seasonal bat activity on a coastal barrier island in Maryland, USA. Environmental Monitoring and Assessment 173:685–699.

Jonasson KA, Willis CK. 2012. Hibernation energetics of free-ranging little brown bats. Journal of Experimental Biology 215(12):2141–9.

Lacoeuilhe A, Machon N, Julien JF, Le Bocq A, Kerbiriou C. 2014. The influence of low intensities of light pollution on bat communities in a semi-natural context. PLoS ONE 9(10):e103042. https://doi.org/10.1371/journal.pone.0103042.

Lagerveld S, Poerink BJ, de Vries P. 2015. Monitoring bat activity at the Dutch EEZ in 2014. Report no. C094/15. Wageningen (UR): IMARES.

Lagerveld S, Gerla D, van der Wal J, de Vries P, Brabant R, Stienen E, Deneudt K, Manshanden J, Scholl M. 2017. Spatial and temporal occurrence of bats in the southern North Sea area. Report no. Wageningen University & Research Report C090/17). Wageningen (UR): Wageningen University & Research Centre.

Lagerveld S, Noort CA, Meesters L, Bach L, Bach P, Geelhoed S. 2020. Assessing fatality risk of bats at offshore wind turbines. Report no. C025/20. Wageningen (UR): Wageningen Marine Research. [published March 2020; accessed 2020 November]. https://doi.org/10.18174/518591

Mackiewicz J, Backus RH. 1956. Oceanic records of *Lasionycteris noctivagans* and *Lasiurus borealis*. Journal of Mammalogy 37(3):442–3.

May ML. 2013. A critical overview of progress in studies of migration of dragonflies (Odonata: Anisoptera) with emphasis on North America. Journal of Insect Conservation 17(1):1–5.

Merriam CH. 1887. Do any Canadian bats migrate? Evidence in the affirmative. Transactions of the Royal Society of Canada 4:85–87.

Menzel MA, Owen SF, Ford WM, Edwards JW, Wood PB, Chapman BR, Miller KV. 2002. Roost tree selection by northern long-eared bat (*Myotis septentrionalis*) maternity colonies in an industrial forest of the central Appalachian Mountains. Forest Ecology and Management 155(1-3):107–14.

[NJDEP] New Jersey Department of Environmental Protection. 2018. New Jersey's Wildlife Action Plan. Trenton (NJ): NJDEP Division of Fish and Wildlife.

[NJDFW] New Jersey Division of Fish and Wildlife. 2017. New Jersey Landscape Project, Version 3.3. New Jersey Department of Environmental Protection, Division of Fish and Wildlife, Endangered and Nongame Species Program. 33 pp.

NYSERDA Metocean Buoys Wildlife Sensors Deployed in Support of Offshore Wind Energy. [published 2021; accessed 15 November 2020]. https://remote.normandeau.com/nys_buoy_overview.php.

Pelletier SK, Omland K, Watrous KS, Peterson TS. 2013. Information Synthesis on the Potential for Bat Interactions with Offshore Wind Facilities, Final Report. Herndon (VA): U.S. Dept of the Interior, Bureau of Ocean Energy Management, Headquarters. OCS Study BOEM 2013-01163. 119 pp.

Pelletier S, Peterson T. 2013. Wind Power and Bats Offshore: What are the Risks? A Current Understanding of Offshore Bat Activity. Providence (RI): Presentation to the American Wind Power Association Offshore Wind Power, October 2013.

Peterson TS, Pelletier SK, Boyden SA, Watrous KS. 2014. Offshore acoustic monitoring of bats in the Gulf of Maine. Northeastern Naturalist 21(1):86–107.

Peterson T. 2016. Long-term Bat Monitoring on Islands, Offshore Structures, and Coastal Sites in the Gulf of Maine, Mid-Atlantic, and Great Lakes. Report by Stantec Consulting. Report for US Department of Energy (DOE).

Peurach SC. 2003. High-altitude collision between an airplane and a hoary bat, *Lasiurus cinereus*. Bat Research News 44(1):2–3.

Roby PL, Gumbert MW, Lacki MJ. 2019. Nine years of Indiana bat (*Myotis sodalis*) spring migration behavior. Journal of Mammalogy 100(5):1501–1511.

Russell RW, May ML, Soltesz KL, Fitzpatrick JW. 1998. Massive swarm migrations of dragonflies (Odonata) in eastern North America. The American Midland Naturalist 140(2):325–342.

Russo D, Cosentino F, Festa F, De Benedetta F, Pejic B, Cerretti P, Ancillotto L. 2019. Artificial illumination near rivers may alter bat-insect trophic interactions. Environmental Pollution 252:1671–7.

Rydell J, Entwistle A, Racey PA. 1996. Timing of foraging flights of three species of bats in relation to insect activity and predation risk. Oikos 1:243–52.

Rydell J, Bach L, Dubourg-Savage MJ, Green M, Rodrigues L, Hedenström A. 2010a. Mortality of bats at wind turbines links to nocturnal insect migration. European Journal of Wildlife Research 56(6): 823–827.

Rydell J, Bach L, Dubourg-Savage MJ, Green M, Rodrigues L, Hedenström A. 2010b. Bat mortality at wind turbines in northwestern Europe. Acta Chiropterologica 12(2):261–274.

Shannon HJ. 1916. Insect migrations as related to those of birds. The Scientific Monthly 3(3):227–40.

Schaub A, Ostwald J, Siemers BM. 2008. Foraging bats avoid noise. The Journal of Experimental Biology 211:3174–3180.

Schimpp SA, Li H, Kalcounis-Rueppell MC. 2018. Determining species specific nightly bat activity in sites with varying urban intensity. Urban Ecosystems 21(3):541–550.

Sjollema AL, Gates JE, Hilderbrand RH, Sherwell J. 2014. Offshore activity of bats along the Mid-Atlantic Coast. Northeastern Naturalist 21(2):154–163.

Stone EL, Harris S, Jones G. 2015. Impacts of artificial lighting on bats: a review of challenges and solutions. Mammalian Biology 80(3):213–9.

Stone EL, Jones G, Harris S. 2009. Street lighting disturbs commuting bats. Current Biology 19:1123–1127.

Stone EL, Jones G, Harris S. 2012. Conserving energy at a cost to biodiversity? Impacts of LED lighting on bats. Global Change Biology 18(8):2458–65.

Stone EL, Wakefield A, Harris S, Jones G. 2015. The impacts of new street light technologies: experimentally testing the effects on bats of changing from low-pressure sodium to white metal halide. Philosophical Transactions of the Royal Society B: Biological Sciences 370(1667):20140127

Šuba, J., Petersons, G., & Rydell, J. 2012. Fly-and-forage strategy in the bat Pipistrellus nathusii during autumn migration. Acta Chiropterologica,14(2), 379-385.

Szewczak JM. 2018. Echolocation call characteristics of eastern US bats. Arcata (CA): Humboldt State University Bat Lab and SonoBat, USA.

Thomas O. 1921. Bats on migration. Journal of Mammalogy 2:167.

Thompson M, Beston JA, Etterson M, Diffendorfer JE, Loss SR. 2017. Factors associated with bat mortality at wind energy facilities in the United States. Biological Conservation 215:241–245.

Thompson RH, Thompson AR, Brigham RM. 2015. A flock of Myotis bats at sea. Northeastern Naturalist. 22(4).

[USFWS] U.S. Fish and Wildlife Service. 2016. Endangered and threatened wildlife and plants; 4(d) rule for the northern long-eared bats. Washington (DC): Department of the Interior, Fish and Wildlife Service. CFR81:9 1900-1922.

[USFWS] U.S. Fish and Wildlife Service. 2019. National Listing Workplan 5-year Workplan (May 2019 Version). Washington (DC): Department of the Interior, Fish and Wildlife Service.

Valdez EW, Cryan PM. 2009. Food habits of the hoary bat (*Lasiurus cinereus*) during spring migration through New Mexico. The Southwestern Naturalist 54(2):195–200.

Van Gelder RG, Wingate DB. 1961. The taxonomy and status of bats in Bermuda. American Museum Novitates No. 2029.

Voigt CC, Sörgel K, Šuba J, Keišs O, Pētersons G. 2012. The insectivorous bat *Pipistrellus nathusii* uses a mixed-fuel strategy to power autumn migration. Proceedings of the Royal Society B: Biological Sciences 279(1743):3772–3778.

Voigt CC, Roeleke M, Marggraf L, Pētersons G, Voigt-Heucke SL. 2017. Migratory bats respond to artificial green light with positive phototaxis. PLoS ONE 12(5):e0177748.

Voigt CC, Rehnig K, Lindecke O, Pētersons G. 2018. Migratory bats are attracted by red light but not by warm-white light: Implications for the protection of nocturnal migrants. Ecology and Evolution 8(18):9353–61.

Weaver SP, Hein CD, Simpson TR, Evans JW, Castro-Arellano I. 2020. Ultrasonic acoustic deterrents significantly reduce bat fatalities at wind turbines. Global Ecology and Conservation 8:e01099.

Westbrook JK, Nagoshi RN, Meagher RL, Fleischer SJ, Jairam S. 2016. Modeling seasonal migration of fall armyworm moths. International Journal of Biometeorology 60(2):255–67.

Wikelski M, Moskowitz D, Adelman JS, Cochran J, Wilcove DS, May ML. 2006. Simple rules guide dragonfly migration. Biology Letters 2(3):325–329.

Whitaker JO Jr. 1998. Life history and roost switching in six summer colonies of eastern pipistrelles in buildings. Journal of Mammalogy 79(2):651–9.

Zimmerling JR, Francis CM. 2016. Bat mortality due to wind turbines in Canada. The Journal of Wildlife Management 80(8):1360–9.

4.5 Benthic Resources

Afsharian, S., Taylor, P.A. 2019: On the potential impact of Lake Erie wind farms on water temperatures and mixed-layer depths: Some preliminary 1-D modeling using COHERENS. J. of Geophy. Res.: Oceans, 124, 1736–1749.

[ASA] Applied Science Associates, Inc. 2008. Results from Modeling of Sediment Dispersion during Installation of the Proposed Bayonne Energy Center Submarine Cable. Narragansett (RI): ASA Project 2007-025. http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterSeq=28172.

[ASMFC] Atlantic States Marine Fisheries Commission. 2015. Horseshoe Crab (Limulus polyphemus). [published 2015 December; accessed 12 November 2020]. http://www.asmfc.org/uploads/file/5dfd4c1aHorsehoeCrab.pdf.

ASMFC. 2018. Jonah Crab (Cancer borealis). [published 2018 January; accessed 12 November 2020]. http://www.asmfc.org/uploads/file/5dfd4c3cJonahCrab.pdf.

Bailey H, Senior B, Simmons D, Rusin J, Picken G, Thompson PM. 2010. Assessing underwater noise levels during pile-driving at an offshore windfarm and its potential effects on marine mammals. Marine Pollution Bulletin. 60:888-897.

Barnegat Bay Partnership. 2020. Knobbed Whelk (*Busycon carica*). [accessed 12 November 2020). https://www.barnegatbaypartnership.org/species/knobbed-whelk/.

Berry WJ, Rubinstein NI, Hinchey EK, Klein-MacPhee G, Clarke DG (2011). Assessment of Dredging-Induced Sedimentation Effects on Winter Flounder (Pseudopleuronectes americanus) Hatching Success: Results of Laboratory Investigations, Proceedings of the Western Dredging Association Technical Conference and Texas A&M Dredging Seminar, Nashville, Tennessee, June 5-8, 2011.

[BOEM] Bureau of Ocean Energy Management. 2012. Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New Jersey, Delaware, Maryland, and Virginia Final Environmental Assessment.

BOEM. 2020. Vineyard Wind 1 Offshore Wind Energy Project Supplement to the Draft Environmental Impact Statement. Sterling (VA): BOEM; OCS EIS/EA BOEM 2020-025.

BOEM 2021. South Fork Wind Farm and South Fork Export Cable Project Draft Environmental Impact Statement. Sterling (VA): BOEM; OCS EIS/EA BOEM 2020-057.

Brooks RA, Bell SS, Purdy CN, Sulak KJ. 2004. The benthic community of offshore sand banks: a literature synopsis of the benthic fauna resources in potential MMS OCS sand mining areas. Gainesville (FL): USGS Florida Integrated Science Center, Center for Aquatic Resource Studies. USGS Scientific Investigation Report No. 2004-5198.

Brooks RA, Purdy CN, Bell SS, Sulak KJ. 2006. The benthic community of the eastern U.S. continental shelf: A literature synopsis of benthic faunal resources. *Continental Shelf Research* 26:804-818.

Cargnelli LM, Griesbach SJ, Packer DB, Weissberger E. Essential Fish Habitat Source Document: Atlantic Surfclam, *Spinsula solidissima*, Life History and Habitat Characteristics. Woods Hole, MA. NOAA Technical Memorandum NMFS-NE-142.

Carpenter JR, Merckelbach L, Callies U, Clark S, Gaslikova L, Baschek B. 2016. Potential Impacts of Offshore Wind Farms on North Sea Stratification. PLoS ONE 11(8). https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0160830.

Castelao, R., S. Glenn, and O. Schofield. 2010: Temperature, salinity, and density variability in the central Middle Atlantic Bight. Journal of Geophysical Research: Oceans, 115. C10005.

Cazenave PW, Torres R, Allen JI. 2016. Unstructured grid modelling of offshore wind farm impacts on seasonally stratified shelf seas. Progress in Oceanography. 145:25-41.

Chen Z. 2018. Dynamics and Spatio-Temporal Variability of the Mid-Atlantic Bight Cold Pool [doctoral dissertation]. New Brunswick (NJ). Rutgers University.

Chen, Z., and E. N. Curchitser. 2020: Interannual Variability of the Mid-Atlantic Bight Cold Pool. J. Geophys. Res. Oceans, 125. https://doi.org/10.1029/2020JC016445.

Chesapeake Bay Program. 2020. Field Guide. [accessed 12 November 2020]. https://www.chesapeakebay.net/discover/field-guide.

Colden A, Lipcius R. 2015. Lethal and Sublethal Effects of Sediment Burial on the Eastern Oyster, Crassostrea virginica. Marine Ecology Progress Series 527: 105-117. DOI: 10.3354/meps11244.

Corbett W. 2019. The Behavioural and Physiological Effects of Pile-driving Noise on Marine Species. Masters Thesis. University of Exeter.

CSA Ocean Sciences Inc. and Exponent. 2019. Evaluation of Potential EMF Effects on Fish Species of Commercial or Recreational Fishing Importance in Southern New England. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Headquarters, Sterling, VA. OCS Study BOEM 2019-049. 59 pp.

Ellers O. 1995. Discrimination among wave-generated sounds by a swash-riding clam. Biological Bulletin 189(2): 128-137.

Elliott J, Smith K, Gallien DR, and Khan A. 2017. Observing Cable Laying and Particle Settlement During the Construction of the Block Island Wind Farm. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2017-027. 225 pp.

English PA et al. 2017. Improving Efficiencies of National Environmental Policy Act Documentation for Offshore Wind Facilities Case Studies Report. Norfolk (VA): Fugro Marine GeoServices Inc. and Fugro GB Marine Ltd. OCS Study, BOEM 20147-026.

Essink K. 1999. Ecological effects of dumping of dredged sediments; options for management. Journal of Coastal Conservation 5: 69-80. DOI:10.1007/BF02802741.

Federal Geographic Data Committee (FGDC). 2012. Coastal and Marine Ecological Classification Standard, June 2012. FGDC-STD-018-2012. 353 pp.

Fisheries and Oceans Canada. 2020. Jonah Crab. [accessed 12 November 2020]. https://www.dfo-mpo.gc.ca/species-especes/profiles-profils/jonah-crab-crabe-nordique-eng.html.

Ganim J. Cold Pool. 2019. MARACOOS. Newark (DE): Mid-Atlantic Regional Association Coastal Ocean Observing System; [published 2019 April 23; accessed 12 November 2020]. https://www.integratedecosystemassessment.noaa.gov/regions/northeast/components/cold-pool/.

Greene J, Anderson M, Morse D, Shumway C, Clark M. 2010. The Northwest Atlantic Marine Ecoregional Assessment: Species, Habitats and Ecosystems. Phase One. The Nature Conservancy, Eastern U.S. Division, Boston, MA.

Guarinello M, Carey D, Read LB. 2017. Year 1 Report for 2016 Summer Post-Construction Surveys to Characterize Potential Impacts and Response of Hard Bottom Habitats to Anchor Placement at the Block Island Wind Farm (BIWF). INSPIRE Environmental prepared for Deepwater Wind Block Island LLC. May.

Guida V, Drohan A, Welch H, McHenry J, Johnson D, Kenter V, Brink J, Timmons D, Estela-Gomez E. 2017. Habitat Mapping and Assessment of Northeast Wind Energy Areas. Sterling, VA: US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2017-088. 312 p.

Hart Crowser IPE, Illingworth and Rodkin, Inc. 2009. Acoustic Monitoring and In-site Exposures of Juvenile Coho Salmon to Pile Driving Noise at the Port of Anchorage Marine Terminal Redevelopment Project, Knik Arm, Anchorage, Alaska. Report by Hart Crowser, Inc./Pentec Environmental and Illingworth and Rodkin, Inc. for URS Corporation for US Department of Transportation, Maritime Administration; Port of Anchorage; and Integrated Concepts and Research Corporation.

Hawkins AD, Pembroke AE, Popper AN. 2015. Information gaps in understanding the effects of noise on fishes and invertebrates. Reviews in Fish Biology and Fisheries 25(1): 39-64. https://doi.org/10.1007/s11160-014-9369-3.

HDR. 2019a. Benthic Monitoring during Wind Turbine Installation and Operation at the Block Island Wind Farm, Rhode Island – Year 2. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2019-019.

HDR. 2019b. Field Observations during Wind Turbine Operations at the Block Island Wind Farm, Rhode Island. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2019-028.

Houghton J, Starkes J, Stutes J, Havey M, Reyff JA, Erikson D. 2010. Acoustic monitoring of in situ exposures of juvenile coho salmon to pile driving noise at the port of Anchorage Marine Terminal redevelopment project, Knik Arm, Alaska. Paper presented at: Alaska Marine Sciences Symposium, Anchorage.

Hutchison ZL, Sigray P, He H, Gill AB, King J, and Gibson C. 2018. Electromagnetic Field (EMF) Impacts on Elasmobranch (shark, rays, and skates) and American Lobster Movement and Migration from Direct Current Cables. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2018-003.

ICF. 2020. Comparison of Environmental Effects from Different Offshore Wind Turbine Foundations. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Headquarters, Sterling, VA. OCS Study BOEM 2020-041.

JASCO Research Ltd. 2006. Vancouver Island Transmission Reinforcement Project: Atmospheric and Underwater Acoustics Assessment Report. Prepared for British Columbia Transmission Corporation 49 pp.

Johnson A. 2018. The Effects of Turbidity and Suspended Sediments on ESA-Listed Species from Projects Occurring in the Greater Atlantic Region. Greater Atlantic Region Policy Series 18-02. NOAA Fisheries Greater Atlantic Regional Fisheries Office. [accessed 28 February 2019]. http://www.greateratlantic.fisheries.noaa.gov/policyseries.

Kerckhof F, Gegraer S, Norro A, Rumes B. 2011. Offshore intertidal hard substrata: a new habitat promoting non-indigenous species in the Southern North Sea: an exploratory study. Royal Belgian Institute of Natural Sciences. Brussels, Belgium.

Kinlan B, Poti M, Dorfam D, Caldow C, Packer D, Nizinski M. 2016. Model output for deep-sea coral habitat suitability in the U.S. North and Mid-Atlantic from 2013 (NCEI Accession 0145923) [dataset]. [published 2016 April 6; accessed 2020 October]. https://data.nodc.noaa.gov/cgi-bin/iso?id=gov.noaa.nodc:145923.

Kjelland ME, Woodley CM, Swannack TM, Smith DL. 2015. A review of the potential effects of suspended sediment on fishes: potential dredging-related physiological, behavioral, and transgenerational implications. Environmental Systems and Decisions 35:334–350. DOI 10.1007/s10669-015-9557-2.

Lentz SJ. 2017. Seasonal warming of the Middle Atlantic Bight Cold Pool. Journal of Geophysical Research: Oceans, 122: 941-954.

Leonhard SB, Stenberg C, StØttrup J. 2011. Effect of the Horns Rev 1 Offshore Wind Farm on Fish Communities Follow-up Seven Years after Construction. DTU Aqua Report No 246-2011.

Lüedeke J. 2015. Review of 10 Years of Research of Offshore Wind Farms in Germany: The State of Knowledge of Ecological Impacts. Advances in Environmental and Geological Science and Engineering. 8th International Conference on Environmental and Geological Science and Engineering, 2015 June 27-29; Salerno, Italy. p. 25-37.

MacGillivray A. 2018. Underwater noise from pile driving of conductor casing at a deep-water oil platform. The Journal of the Acoustical Society of America. 143(1):450-459.

Madsen PT, Wahlberg M, Tougaard J, Lucke K, Tyack PL. 2006. Wind turbine underwater noise and marine mammals: Implications of current knowledge and data needs. Mar Ecol Prog Ser. 309:279-295.

[MAFMC] Mid-Atlantic Fishery Management Council. 2020. Ocean Quahog Fishery Information Document. [published July 2020; accessed 12 November 2020]. https://static1.squarespace.com/static/511cdc7fe4b00307a2628ac6/t/5f21a253ee0fc40b9f984c71/1596039765965/6_2020_OQ_FishInfoDoc_2020_07_27.pdf.

[MARACOOS] Mid-Atlantic Regional Association Coastal Ocean Observing System. 2019. The Mid-Atlantic Bight Cold Pool. Newark (DE): MARACOOS; [accessed 7 December 2020]. https://maracoos.org/mid-atlantic-bight-cold-pool.shtml.

McHugh R. 2005. Hydroacoustic measurements of piling operations in the North Sea, and PAMGUARD - Passive Acoustic Monitoring Guardianship open-source software. Paper presented at: National Physical Laboratory Underwater Noise Measurement Seminar Series 13th October 2005. NPL; Teddington, UK.

McPherson CR, Quijano JE, Weirathmueller MJ, Hiltz KR, Lucke K. 2019. Browse to North-West-Shelf Noise Modelling Study: Assessing Marine Fauna Sound Exposures. Technical report by JASCO Applied Sciences for Jacobs.

Meißner K, Schabelon H, Bellebaum J, Sordyl H. 2006. Impacts of submarine cables on the marine environment: A literature review. Report by the Institute of Applied Ecology Ltd for the Federal Agency of Nature Conservation, Germany.

Miles, T., Murphy, S., Kohut, J., Borsetti, S., and Munroe, D., 2020. Could federal wind farms influence continental shelf oceanography and alter associated ecological processes? A literature review. Science Center for Marine Fisheries, Rutgers University. [accessed 1 February 2021]. https://scemfis.org/wp-content/uploads/2021/01/ColdPoolReview.pdf.

Morley EL, Jones G, Radford AN. 2014. The importance of invertebrates when considering the impacts of anthropogenic noise. Proceedings of the Royal Society of London Series B. 281(1776).

Mosher J. 1972. The responses of Macoma balthica (bivalvia) to vibrations. Proceedings of the Malacological Society of London 40.

Moum JN, Smoyth WD. 2019. Upper Ocean Mixing. Encyclopedia of Ocean Sciences (3rd Edition). 1: 71-79.

Narvaez, D. A., D. M. Munroe, E. E. Hofmann, J. M. Klinck, and E. N. Powell, 2015: Long-term dynamics in Atlantic surfclam (Spisula solidissima) populations: the role of bottom water temperature. Journal of Marine Systems, 141, 136-148.

Nelson GA, Wilcox SH, Glenn R, Pugh TL. 2018. A Stock Assessment of Channeled Whelk in Nantucket Sound, Massachusetts. Massachusetts Division of Marine Fisheries, Technical Report TR-66. [published 2018 April; accessed 12 November 2020]. https://www.mass.gov/files/documents/2018/04/03/TR-66%20Final.pdf.

NMFS. 2021. Updated Recommendations for Mapping Fish Habitat. Gloucester (MA): NMFS GARFO Habitat Conservation and Ecosystem Services Division.

[NOAA] National Oceanic and Atmospheric Administration. 2017. National Database for Deep-Sea Corals and Sponges (version 20201021-0). NOAA Deep Sea Coral Research & Technology Program. https://deepseacoraldata.noaa.gov/.

NOAA. 2020. Species Directory. [accessed 12 November 2020]. https://www.fisheries.noaa.gov/species-directory.

Normandeau, Exponent, Tricas T, and Gill A. 2011. Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, CA. OCS Study BOEMRE 2011-09.

[NROC] Northeast Regional Ocean Council. 2009. Northeast Ocean Data Portal. [accessed 17 December 2020]. http://www.northeastoceandata.org.

Page HM, Dugan JE, Culver CS, Hoesterey JC. 2006. Exotic invertebrate species on offshore oil platforms. Marine Ecology Progress Series. 325: 101-107.

Page H, Dugan J, Schroder D, Love M, Nishimoto M, Love M, Hoesterey J. 2007. Trophic Links and Condition of a temperate reef fish: Comparisons among offshore oil platform and natural reefs. Marine Ecology Series. 44:245-256.

Paskyabi, M. B., 2015: Offshore Wind Farm Wake Effect on Stratification and Coastal Upwelling. Energy Procedia, 80, 131-140.

Pangerc T, Theobald PD, Wang LS, Robinson SP, Lepper PA. 2016. Measurement and characterisation of radiated underwater sound from a 3.6 MW monopile wind turbine. J Acoust Soc Am. 140(4):2913-2922.

Popper AN, Hawkins AD, Fay RR, Mann DA, Bartol S, Carlson TJ, Coombs S, Ellison WT, Gentry RL, Halvorsen MB. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. ASA Press and Springer.

Raox A, Tecchio A, Pezy JP, Lassalle G, Dregaer S, Wilhelmsson D, Cachera M, Ernande B, LeGuen C, Haraldsson M, et al. 2017. Benthic and fish aggregation inside an offshore wind farm: Which effects on the trophic web functioning? Ecological Indicators. 72:33-46.

Rausche F, Beim J. 2012. Analyzing and Interpreting Dynamic Measurements Taken During Vibratory Pile Driving. Paper presented at: International Conference on Testing and Design Methods for Deep Foundations. Kanazawa, Japan.

Roberts L, Elliott M. 2017. Good or bad vibrations? Impacts of anthropogenic vibration on the marine epibenthos. Science of The Total Environment 595: 255-268. https://doi.org/10.1016/j.scitotenv.2017.03.117.

Robinson SP, Lepper PA, Ablitt J. 2007. The measurement of the underwater radiated noise from marine piling including characterisation of a" soft start" period. Paper presented at: OCEANS 2007 - Europe. IEEE; Aberdeen, UK.

Ross SW, Rhode M, Viada ST, Mather R. 2015. Fish species associated with shipwreck and natural hard-bottom habitats from the middle to outer continental shelf of the Middle Atlantic Bight near Norfolk Canyon. NOAA National Marine Fisheries Service. [accessed 30 August 2020] https://spo.nmfs.noaa.gov/sites/default/files/ross.pdf.

Spiga I, Caldwell GS, Bruintjes R. 2016. Influence of Pile Driving on the Clearance Rate of the Blue Mussel, Mytilus edulis (L.). Meetings on Acoustics: Fourth International Conference on the Effects of Noise on Aquatic Life. Volume 27(1), 10–16 Jul 2016, Dublin, Ireland. https://doi.org/10.1121/2.0000277.

Sellheim K, Stachowicz JJ, Coates RC. 2010. Effects of a nonnative habitat-forming species on mobile and sessile epifaunal communities. Marine Ecology Progress Series. 398: 69-80.

[SMAST] University of Massachusetts Dartmouth, School of Marine Science and Technology . 2016. Average (2003-2012) Presence/Abundance from SMAST Survey Northeast United States [dataset]. North Dartmouth (MA): University of Massachusetts Dartmouth, SMAST; [published 2016 April; accessed 11 January 2021]. https://www.northeastoceandata.org/data-explorer/?habitat|biological.

Steimle FW, Zetlin C. 2000. Reef Habitats in the Middle Atlantic Bight: Abundance, Distribution, Associated Biological Communities, and Fishery Resource Use. Highlands, New Jersey. Marine Fisheries Review 62(2).

Stevenson D, Chiarella L, Stephan D, Reid R, Wilhelm K, McCarthy J, Pentony M. 2004. Characterization of the Fishing Practices and Marine Benthic Ecosystems of the Northeast U.S. Shelf, and an Evaluation of the Potential Effects of Fishing on Essential Fish Habitat. NOAA Technical Memorandum NMFS-NE-181.

Topham E, McMillan D. 2017. Sustainable decommissioning of an offshore wind farm. Renewable Energy. 102:470-480.

Tougaard J, Madsen PT, Wahlberg M. 2008. Underwater noise from construction and operation of offshore wind farms. Bioacoustics. 17(1-3):143-146.

Tougaard J, Carstensen J, Teilmann J. 2009a. Pile driving zone of responsiveness extends beyond 20 km for harbour porpoises (Phocoena phocoena). Journal of the Acoustical Society of America. 126(1):11-14.

Tougaard J, Carstensen J, Teilmann J, Skov H, Rasmussen P. 2009b. Pile driving zone of responsiveness extends beyond 20 km for harbor porpoises (Phocoena phocoena (L.)) (L). Journal of the Acoustical Society of America. 126(1):11-14.

Toupoint, N., L. Gilmore-Solomon, F. Bourque, B. Myrand, F. Pernet, F. Olivier, and R. Tremblay, 2012: Match/mismatch between the Mytilus edulis larval supply and seston quality: effect on recruitment. Ecology, 93, 1922-1934.

[URI] University of Rhode Island. 2020. Habitat Restoration-Species Gallery. Kingston (RI): University of Rhode Island; [accessed 1 December 2020]. https://www.edc.uri.edu/restoration/html/gallery/seagrass.htm.

[USDA] United States Department of Agriculture. 2021. National Invasive Species Information Center- Aquatic Invertebrates. [accessed 22 January 2021]. https://www.invasivespeciesinfo.gov/aquatic/invertebrates.

[USGS] United States Geological Survey. 2021. NAS-Nonindigenous Aquatic Species. [updated and accessed 22 January 2021]. https://nas.er.usgs.gov/viewer/omap.aspx?SpeciesID=183.

Voynova, Y. G., M. J. Oliver, and J. H. Sharp. 2013: Wind to zooplankton: Ecosystem-wide influence of seasonal wind-driven upwelling in and around the Delaware Bay. J. Geophys. Res. Oceans, 118, 6437-6450. doi:10.1002/2013JC008793.

Wahlberg M, Westerberg H. 2005. Hearing in fish and their reactions to sounds from offshore wind farms. Mar Ecol Prog Ser. 288:295-309.

West Point Partners, LLC. 2013. Application to the United States Army Corps of Engineers (New York District) for a Department of the Army Individual Permit. Volume 1 of 2. Fairfield (CT): West Point Partners, LLC.
http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7BC191AEEA-9CFF-4D39-9654-E21B59A3629A%7D.

Wilber, DH and Clarke, DG. 2001. Biological Effects of Suspended Sediments: A Review of Suspended Sediment Impacts on Fish and Shellfish with Relation to Dredging Activities in Estuaries. North American Journal of Fisheries Management, 21: 4, 855-875.

Wilhelmsson D, Malm T, Öhman MC. 2006. The influence of offshore windpower on demersal fish. ICES Journal of Marine Science, 63: 775-784.

Woodruff DL, Schultz IR, Marshall KE, Ward JA, Cullinan VI. 2012. Effects of Electromagnetic Fields on Fish and Invertebrates, Task 2.1.3: Effects on Aquatic Organisms Fiscal Year 2011 Progress Report. Prepared for U.S. Department of Energy. Richland, Washington: Pacific Northwest National Laboratory.

Woodruff DL, Schultz IR, Marshall KE, Ward JA, Cullinan VI. 2013. Effects of Electromagnetic Fields on Fish and Invertebrates, Task 2.1.3: Effects on Aquatic Organisms, Fiscal Year 2012 Progress Report. PNNL-22154. Prepared for U.S. Department of Energy. Richland, Washington: Pacific Northwest National Laboratory.

Zykov MM, Bailey L, Deveau TJ, Racca RG. 2013. South Stream Pipeline – Russian Sector – Underwater Sound Analysis. Technical report by JASCO Applied Sciences for South Stream Transport B.V.

4.6 Finfish, Invertebrates, and Essential Fish Habitat

Adams PB. 1980. Life history patterns in marine fishes and their consequences for management. NOAA – Fisheries Bulletin. 78(1).

Afsharian, S., Taylor, P.A. 2019: On the potential impact of Lake Erie wind farms on water temperatures and mixed-layer depths: Some preliminary 1-D modeling using COHERENS. J. of Geophy. Res.: Oceans, 124, 1736–1749.

Andersson MH. 2011. Offshore wind farms – ecological effects of noise and habitat alteration on fish. Stockholm University, Department of Zoology. ISBN 978-91-7447-172-4.

Andersson MH, Dock-Åkerman E, Ubral-Hedenberg R, Öhman MC, Sigray P. 2007. Swimming behavior of roach (Rutilus rutilus) and three-spined stickleback (Gasterosteus aculeatus) in response to wind power noise and single-tone frequencies. Ambio. 36(8):636-638.

[ASA] Applied Science Associates, Inc. 2008. Results from Modeling of Sediment Dispersion during Installation of the Proposed Bayonne Energy Center Submarine Cable. Narragansett (RI): ASA Project 2007-025. http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterSeq=28172.

[ASMFC] Atlantic States Marine Fisheries Commission. Fisheries Management. 2020. Arlington (VA): ASMFC; [accessed 2020 November 13]. http://www.asmfc.org/fisheries-management/program-overview.

Auld AH, Schubel JR. 1978. Effects of suspended sediment on fish eggs and larvae: a laboratory assessment. Estuarine and Coastal Marine Science 6:153–164.

Balazik M, Barber M, Altman S, Reine K, Katzenmeyer A, Bunch A, Garman G. 2020. Dredging activity and associated sound have negligible effects on adult Atlantic sturgeon migration to spawning habitat in a large coastal river. PLoS ONE 15(3): e0230029. https://doi.org/10.1371/journal.pone.0230029.

Berry WJ, Rubinstein NI, Hinchey EK, Klein-MacPhee G, Clarke DG (2011). Assessment of Dredging-Induced Sedimentation Effects on Winter Flounder (Pseudopleuronectes americanus) Hatching Success: Results of Laboratory Investigations, Proceedings of the Western Dredging Association Technical Conference and Texas A&M Dredging Seminar, Nashville, Tennessee, June 5-8, 2011.

Bureau of Ocean Energy Management (BOEM). 2012. Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New Jersey, Delaware, Maryland, and Virginia- Final Environmental Assessment. OCS EIS/EA BOEM 2012-003.

Bureau of Ocean Energy Management (BOEM). 2020. Vineyard Wind 1 Offshore Wind Energy Project Supplement to the Draft Environmental Impact Statement. OCS EIS/EA BOEM 2020-025.

Bureau of Ocean Energy Management (BOEM). 2021. South Fork Wind Farm and South Fork Export Cable Project Draft Environmental Impact Statement. Sterling (VA): BOEM; OCS EIS/EA BOEM 2020-057.

Bolle LJ, de Jong CAF, Bierman SM, van Beek PJ, van Keeken OA, Wessels PW, van Damme CJ, Winter HV, de Haan D, Dekeling RPA. 2012. Common sole larvae survive high levels of pile-driving sound in controlled exposure experiments. PLoS ONE. 7:e33052.

Braun CB, Grande T. 2008. Evolution of Peripheral Mechanisms for the Enhancement of Sound Reception. In: Webb JF, Fay RR, Popper AN, editors. Fish Bioacoustics. NY, USA: Springer. p. 99-144.

Brooks RA, Bell SS, Purdy CN, Sulak KJ. 2004. The benthic community of offshore sand banks: a literature synopsis of the benthic fauna resources in potential MMS OCS sand mining areas. Gainesville (FL): USGS Florida Integrated Science Center, Center for Aquatic Resource Studies. USGS Scientific Investigation Report No. 2004-5198.

Brooks RA, Purdy CN, Bell SS, Sulak KJ. 2006. The benthic community of the eastern U.S. continental shelf: A literature synopsis of benthic faunal resources. Continental Shelf Research 26:804-818.

Buerkle U. 1973. Gill-net catches of cod (Gadus morhua L.) in relation to trawling noise. Marine Behaviour and Physiology. 2:277-281.

Carpenter, J. R., L. Merckelbach, U. Callies, S. Clark, L. Gaslikova, and B. Baschek. 2016: Potential impacts of offshore wind farms on North Sea stratification. PLoS One, 11. e0160830.

Cargnelli LM, Griesbach SJ, McBride C, Zetlin CA, Morse WW. 1999. Essential Fish Habitat Source Document: Longfin Inshore Squid, *Loligo pealeii*, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-146.

Casper BM, Popper AN, Matthews F, Carlson TJ, Halvorsen MB. 2012. Recovery of barotrauma injuries in Chinook salmon, Oncorhynchus tshawytscha from exposure to pile driving sound. PLoS ONE. 7(6):e39593.

Castelao, R., S. Glenn, and O. Schofield. 2010: Temperature, salinity, and density variability in the central Middle Atlantic Bight. Journal of Geophysical Research: Oceans, 115. C10005.

Causon PD, Gill AB. 2018. Linking Ecosystem Services with Epibenthic Biodiversity Change Following Installation of Offshore Wind Farms. Environmental Science and Policy. 89: 340-347.

Chen Z. 2018. Dynamics and Spatio-Temporal Variability of the Mid-Atlantic Bight Cold Pool [doctoral dissertation]. New Brunswick (NJ). Rutgers University.

Chen, Z., and E. N. Curchitser. 2020: Interannual Variability of the Mid-Atlantic Bight Cold Pool. J. Geophys. Res. Oceans, 125. https://doi.org/10.1029/2020JC016445.

Chesapeake Bay Program. 2020. Field Guide. Annapolis (MD): Chesapeake Bay Program; [accessed 2020 December 4]. https://www.chesapeakebay.net/who/contact.

[CRRC] Coastal Response Research Center. 2010. Ocean Thermal Energy Conversion: Assessing Potential Physical, Chemical and Biological Impacts and Risk. Durham (NH): University of New Hampshire; [accessed 2021 October 1]. https://tethys.pnnl.gov/sites/default/files/publications/otecjun10wkshp.pdf.

CSA Ocean Sciences Inc. and Exponent. 2019. Evaluation of Potential EMF Effects on Fish Species of Commercial or Recreational Fishing Importance in Southern New England. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Headquarters, Sterling, VA. OCS Study BOEM 2019-049. 59 pp.

Dunton KJ, Jordaan A, McKown KA, Conover DO, Frisk MG. 2010. Abundance and distribution of Atlantic sturgeon (Acipenser oxyrinchus) within the Northwest Atlantic Ocean, determined from five fishery-independent surveys. Stony Brook (NY): Stony Brook University. Fisheries Bulletin 108: 450–465.

Elliott J, Smith K, Gallien DR, and Khan A. 2017. Observing Cable Laying and Particle Settlement During the Construction of the Block Island Wind Farm. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2017-027. 225 pp.

English PA et al. 2017. Improving Efficiencies of National Environmental Policy Act Documentation for Offshore Wind Facilities Case Studies Report. Norfolk (VA): Fugro Marine GeoServices Inc. and Fugro GB Marine Ltd. OCS Study, BOEM 20147-026.

Federal Register. 2018. Endangered and Threatened Wildlife and Plants; Final Rule to List the Giant Manta Ray as Threatened under the Endangered Species Act. A Rule by NOAA on January 22, 2018. [accessed January 29, 2021]. https://www.federalregister.gov/documents/2018/01/22/2018-01031/endangered-and-threatened-wildlife-and-plants-final-rule-to-list-the-giant-manta-ray-as-threatened.

Federal Register 2012. Endangered and Threatened Wildlife and Plants; Threatened and Endangered Status for Distinct Populations Segments of Atlantic Sturgeon in the Northeast Region. A Rule by NOAA on February 6, 2012. [accessed January 29, 2021]. https://www.federalregister.gov/documents/2012/02/06/2012-1946/endangered-and-threatened-wildlife-and-plants-threatened-and-endangered-status-for-distinct.

Fewtrell JL, McCauley RD. 2012. Impact of air gun noise on the behaviour of marine fish and squid. Marine Pollution Bulletin. 64(5):984-993.

Fisheries Hydroacoustic Working Group (FHWG). 2008. Agreement in Principle for Interim Criteria for Injury to Fish from Pile Driving Activities. 12 Jun 2008 ed.

Ganim J. Cold Pool. 2019. MARACOOS. Newark (DE): Mid-Atlantic Regional Association Coastal Ocean Observing System; [published 2019 April 23; accessed 2020 November 30].

https://www.integratedecosystemassessment.noaa.gov/regions/northeast/components/cold-pool/.

[GARFO] Greater Atlantic Regional Fisheries Office. 2020. GARFO Acoustics Tool: Analyzing the effects of pile driving on ESA-listed species in the Greater Atlantic Region. https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-consultation-technical-guidance-greater-atlantic.

Gedamke J, Harrison J, Hatch LT, Angliss RP, Barlow JP, Berchok CL, Caldow C, Castellote M, Cholewiak DM, DeAngelis ML et al. 2016. Ocean noise strategy roadmap. Washington, DC: National Oceanic and Atmospheric Administration.

Geo-Marine Inc. 2010. NJDEP Ocean/Wind Power Ecological Baseline Studies Final Report - Volume IV: Fish and Fisheries Studies. Plano (TX). https://www.nj.gov/dep/dsr/ocean-wind/.

Gilbert C. 1989. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic Bight)- Atlantic and Shortnose Sturgeon. Biological Report 82(11.122).

Guida, V., A. Drohan, H. Welch, J. McHenry, D. Johnson, V. Kentner, J. Brink, D. Timmons, E. Estela-Gomez. 2017. Habitat Mapping and Assessment of Northeast Wind Energy Areas. Sterling, VA: US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2017-088. 312 p.

Guarinello M, Carey D, Read LB. 2017. Year 1 Report for 2016 Summer Post-Construction Surveys to Characterize Potential Impacts and Response of Hard Bottom Habitats to Anchor Placement at the Block Island Wind Farm (BIWF). INSPIRE Environmental prepared for Deepwater Wind Block Island LLC. May.

Halvorsen MB, Casper BM, Woodley CM, Carlson TJ, Popper AN. 2011. Predicting and mitigating hydroacoustic impacts on fish from pile installations. Project 25–28. National Cooperative Highway Research Program Research Results Digest. 363:2011.

Halvorsen MB, Heaney KD. 2018. Propagation characteristics of high-resolution geophysical surveys: open water testing. Prepared by CSA Ocean Sciences Inc. for U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2018-052.

Hart Crowser IPE, Illingworth and Rodkin, Inc. 2009. Acoustic Monitoring and In-site Exposures of Juvenile Coho Salmon to Pile Driving Noise at the Port of Anchorage Marine Terminal Redevelopment Project, Knik Arm, Anchorage, Alaska. Report by Hart Crowser, Inc./Pentec Environmental and Illingworth and Rodkin, Inc. for URS Corporation for US Department of Transportation, Maritime Administration; Port of Anchorage; and Integrated Concepts and Research Corporation.

Haugen JB, Papastamatiou Y. 2019. Observation of a porbeagle shark Lamna nasus aggregation at a North Sea oil platform. Journal of Fish Biology. DOI: 10.1111/jfb.14149.

HDR. 2019a. Benthic Monitoring during Wind Turbine Installation and Operation at the Block Island Wind Farm, Rhode Island – Year 2. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2019-019.

HDR. 2019b. Field Observations during Wind Turbine Operations at the Block Island Wind Farm, Rhode Island. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2019-028. 281pp.

HDR. 2020. Seafloor Disturbance and Recovery Monitoring at the Block Island Wind Farm, Rhode Island – Summary Report. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2020-019.

Hendrickson LC, Homes EM. 2004. Essential Fish Habitat Source Document: Northerm Shortfin Squic, *Illex illecebrosus*, Life History and Habitat Characteristics, Second Edition. NOAA Technical Memorandum NMFS-NE-191.

Houghton J, Starkes J, Stutes J, Havey M, Reyff JA, Erikson D. 2010. Acoustic monitoring of in situ exposures of juvenile coho salmon to pile driving noise at the port of Anchorage Marine Terminal redevelopment project, Knik Arm, Alaska. Paper presented at: Alaska Marine Sciences Symposium, Anchorage.

Hutchison ZL, Sigray P, He H, Gill AB, King J, and Gibson C. 2018. Electromagnetic Field (EMF) Impacts on Elasmobranch (shark, rays, and skates) and American Lobster Movement and Migration from Direct Current Cables. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2018-003.

ICF. 2020. Comparison of Environmental Effects from Different Offshore Wind Turbine Foundations. Prepared for: U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Sterling (VA). OCS Study BOEM 2020-041.

JASCO Research Ltd. 2006. Vancouver Island Transmission Reinforcement Project: Atmospheric and Underwater Acoustics Assessment Report. Prepared for British Columbia Transmission Corporation 49 pp.

Johnson JH, Dropkin DS, Warkentine BE, Rachlin JW, Andrews WD. 1997. Food Habits of Atlantic Sturgeon off the Central New Jersey Coast. Transactions of the American Fisheries Society. 126 (1): 166-170.

Kane J. 2005. The demography of Calanus finmarchicus (Copepoda: Calanoida) in the Middle Atlatnic Bight, USA, 1977 – 2001. Narragansett (RI): NOAA – NMFS.

Kirkpatrick, AJ, Benjamin S, DePiper GS, Murphy T, Steinback S, and Demarest C. 2017. SocioEconomic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the U.S. Atlantic. Volume II—Appendices. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region, Washington, D.C. OCS Study BOEM 2017-012.

Kohut J, Brodie J. 2019. White Paper-Partners in Science Workshop: Offshore Wind and the Mid-Atlantic Cold Pool. New Brunswick (NJ): Rutgers, The State University of New Jersey; [hosted 2019 July 17; accessed 2020 December 16]. https://rucool.marine.rutgers.edu/wp-content/uploads/2020/10/PartnersWorkshop_WhitePaper_Final.pdf.

Ladich F, Popper AN. 2004. Parallel evolution in fish hearing organs. In: Manley GA, Popper AN, Fay RR, editors. Evolution of the Vertebrate Auditory System NY, USA: Springer-Verlag. p. 98-127.

Lentz SJ. 2017. Seasonal warming of the Middle Atlantic Bight Cold Pool. Journal of Geophysical Research: Oceans, 122: 941-954.

Leonhard SB, Stenberg C, StØttrup J. 2011. Effect of the Horns Rev 1 Offshore Wind Farm on Fish Communities Follow-up Seven Years after Construction. DTU Aqua Report No 246-2011.

[MARACOOS] Mid-Atlantic Regional Association Coastal Ocean Observing System. 2019. The Mid-Atlantic Bight Cold Pool. Newark (DE): MARACOOS; [accessed 2020 December 7]. https://maracoos.org/mid-atlantic-bight-cold-pool.shtml.

Madsen PT, Wahlberg M, Tougaard J, Lucke K, Tyack PL. 2006. Wind turbine underwater noise and marine mammals: Implications of current knowledge and data needs. Mar Ecol Prog Ser. 309:279-295.

McPherson CR, Quijano JE, Weirathmueller MJ, Hiltz KR, Lucke K. 2019. Browse to North-West-Shelf Noise Modelling Study: Assessing Marine Fauna Sound Exposures. Technical report by JASCO Applied Sciences for Jacobs.

Meißner K, Schabelon H, Bellebaum J, Sordyl H. 2006. Impacts of submarine cables on the marine environment: A literature review. Report by the Institute of Applied Ecology Ltd for the Federal Agency of Nature Conservation, Germany.

Merson, R.R., and H.L. Pratt Jr. 2007. Sandbar shark nurseries in New Jersey and New York: Evidence of northern pupping grounds along the United States east coast. In C.T. McCandless, N.E. Kohler, and H.L. Pratt, Jr. editors. Shark nursery grounds of Gulf of Mexico and the east coast waters of the United States. American Fisheries Society Symposium, 50, pgs 35-43, Bethesda, Maryland.

Miles, T., Murphy, S., Kohut, J., Borsetti, S., and Munroe, D., 2020. Could federal wind farms influence continental shelf oceanography and alter associated ecological processes? A literature review. Science Center for Marine Fisheries, Rutgers University. [accessed 2021 February]. https://scemfis.org/wp-content/uploads/2021/01/ColdPoolReview.pdf.

Miller TJ, Hare JA, Alade LA. 2016. A state-space approach to incorporating environmental effects on recruitment in an age-structured assessment model with an application to southern New England yellowtail flounder. Canadian Journal of Fisheries and Aquatic Sciences, 76(9): 1528-1540.

Mitson RB, Knudsen HP. 2003. Causes and effects of underwater noise on fish abundance estimation. Aquat Living Resour. 16(3):255-263.

Morley EL, Jones G, Radford AN. 2014. The importance of invertebrates when considering the impacts of anthropogenic noise. Proceedings of the Royal Society of London Series B. 281(1776).

Moum JN, Smoyth WD. 2019. Upper Ocean Mixing. Encyclopedia of Ocean Sciences (3rd Edition). 1: 71-79.

Mueller-Blenkle C, McGregor PK, Gill AB, Andersson MH, Metcalfe J, Bendall V, Sigray P, Wood DT, Thomsen F. 2010. Effects of Pile-driving Noise on the Behaviour of Marine Fish. COWRIE Ref: Fish 06-08; Cefas Ref: C3371.

[NCDEQ] North Carolina Department of Environmental Quality. 2021. About our Reefs. Raleigh (NC): Division of Marine Fisheries; [accessed 2021 February 1]. http://portal.ncdenr.org/web/mf/about-nc-reefs.

[NMFS] National Marine Fisheries Service. 1998. Recovery Plan for the Shortnose Sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 104 pages. https://repository.library.noaa.gov/view/noaa/15971.

NMFS. 2021. Ecology of the Northeast US Continental Shelf. Woods Hole (MA): National Marine Fisheries Service, Northeast Fisheries Science Center; [accessed 2021 October 28]. https://apps-nefsc.fisheries.noaa.gov/nefsc/ecosystem-ecology/zooplankton.html.

NOAA. 2005. Notice of Public Scoping and Intent to Prepare an Environmental Impact Statement. Federal Register. 70(7):1871-1875.

NOAA. 2016. Endangered Species Act Status Review Report: Giant Manta Ray (*Manta birostris*) and Reef Manta Ray (*Manta alfredi*). Silver Springs (MD): National Marine Fisheries Service. https://www.cio.noaa.gov/services_programs/prplans/pdfs/ID353_FinalWorkProduct_MantaRay.pdf.

NOAA. 2017. Final Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan: Essential Fish Habitat and Environmental Assessment. Office of Sustainable Fisheries Atlantic Highly Migratory Species Management Division.

NOAA. 2020a. Current Conditions of the Northeast Shelf Ecosystem: Spring 2020 Update. Silver Springs (MD): NOAA National Ocean Service; [updated 2020 May 1; accessed 2021 March 16]. https://www.fisheries.noaa.gov/new-england-mid-atlantic/ecosystems/current-conditions-northeast-shelf-ecosystem-spring-2020-update.

NOAA. 2020b. The Greater Atlantic Region ESA Section 7 Mapper. Gloucester (MA) :Greater Atlantic Regional Fisheries Office; [updated 2019 November; accessed 2021 February 3]. https://www.fisheries.noaa.gov/resource/map/greater-atlantic-region-esa-section-7-mapper.

NOAA. 2020c. Species Directory. Silver Springs (MD): NOAA; [accessed 2020 November 13]. https://www.fisheries.noaa.gov/species-directory.

NOAA. 2020d. What is a benthic habitat map? Silver Springs (MD): NOAA National Ocean Service; [updated 2020 April 7; accessed 2021 February 1]. https://oceanservice.noaa.gov/facts/benthic.html.

NOAA. 2020e. What are Pelagic Fish? Silver Springs (MD): NOAA National Ocean Service; [updated 2020 May 1; accessed 2021 February 1]. https://oceanservice.noaa.gov/facts/pelagic.html.

NOAA. 2020f. Landings. Silver Springs (MD): NOAA Fisheries; [accessed 2020 November 16]. https://foss.nmfs.noaa.gov/apexfoss/f?p=215:200.

NOAA. 2021a. Species Directory – ESA Threatened and Endangered. Silver Springs (MD): NOAA Fisheries; [accessed 2021 January 26]. https://www.fisheries.noaa.gov/species-directory/threatened-endangered.

NOAA. 2021b. Fisheries Glossary-Voices of the Bay. Silver Springs (MD): National Marine Sanctuaries; (accessed 2021 February 1). https://sanctuaries.noaa.gov/education/voicesofthebay/glossary.html.

NOAA. 2021c. Essential Fish (EFH) Habitat Mapper. accessed September 24, 2018. https://www.habitat.noaa.gov/protection/efh/efhmapper/.[NROC] Northeast Regional Ocean Council. 2009. Northeast Ocean Data Portal. [accessed 2020 December 17]. www.northeastoceandata.org.

Normandeau, Exponent, T. Tricas, and A. Gill. 2011. Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, CA. OCS Study BOEMRE 2011-09.

Olsen K, Agnell J, Pettersen F, Løvik A. 1983. Observed fish reactions to a surveying vessel with special reference to herring, cod, capelin and polar cod. FAO Fisheries Reports. 300:131-138.

Ona E, Godø OR, Handegard NO, Hjellvik V, Patel R, Pedersen G. 2007. Silent research vessels are not quiet. J Acoust Soc Am. 121(4):EL145-EL150.

Orr TL, Herz SM, Oakley DL. 2013. Evaluation of Lighting Schemes for Offshore Wind Facilities and Impacts to Local Environments. OCS Study. BOEM 2013-0116.

Pangerc T, Theobald PD, Wang LS, Robinson SP, Lepper PA. 2016. Measurement and characterisation of radiated underwater sound from a 3.6 MW monopile wind turbine. J Acoust Soc Am. 140(4):2913-2922.

Paskyabi, M. B., 2015: Offshore Wind Farm Wake Effect on Stratification and Coastal Upwelling. Energy Procedia, 80, 131-140.

Paxton AB, Newton EA, Adler AM, Van Hoeck RV, Iversen ES, Taylor J, Peterson CH, Silliman BR. 2020. Artificial habitats host elevated densities of large reef-associated predators. PLoS ONE 15(9). https://doi.org/10.1371/journal.

Popper AN, Fay RR. 2011. Rethinking sound detection by fishes. Hear Res. 273(1):25-36.

Popper AN, Hastings MC. 2009. The effects of human-generated sound on fish. Integr Zool. 4(1):43-52.

Popper AN, Hawkins AD, Fay RR, Mann DA, Bartol S, Carlson TJ, Coombs S, Ellison WT, Gentry RL, Halvorsen MB et al. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. ASA Press and Springer.

Purser J, Radford AN. 2011. Acoustic noise induces attention shifts and reduces foraging performance in three-spined sticklebacks (Gasterosteus aculeatus). PLoS ONE. 6(2):e17478.

Rausche F, Beim J. 2012. Analyzing and Interpreting Dynamic Measurements Taken During Vibratory Pile Driving. Paper presented at: International Conference on Testing and Design Methods for Deep Foundations. Kanazawa, Japan.

Rechisky, E., Wetherbee, B. 2003. Short-term Movements of Juvenile and Neonate Sandbar Sharks, Carcharhinus plumbeus, on their Nursery Grounds in the Delaware Bay. Environmental Biology of Fishes, 68, 113-128. https://doi.org/10.1023/B:EBFI.0000003820.62411.cb.

Riefolo L, Lanfredi C, Azzellino A, Tomasicchio GR, Felice DA, Penchev V, Vicinanza D. 2016. Offshore wind turbines: an overview of the effects on the marine environment. Paper presented at: 26th International Ocean and Polar Engineering Conference. International Society of Offshore and Polar Engineers; Rhodes, Greece.

[SAFMC] South Atlantic Fishery Management Council. 2021. Artificial Reef Habitats. North Charleston (SC): SAFMC; [accessed 2021 February 1]. https://safmc.net/uncategorized/artificial-reef-habitats/.

Sarà G, Dean JM, D'Amato D, Buscaino G, Oliveri A, Genovese S, Ferro S, Buffa G, Lo Martire M, Mazzola S. 2007. Effect of boat noise on the behaviour of bluefin tuna Thunnus thynnus in the Mediterranean Sea. Mar Ecol Prog Ser. 331:243-253.

Schwarz AL, Greer GL. 1984. Responses of Pacific Herring, Clupea harengus pallasi, to Some Underwater Sounds. Can J Fish Aquat Sci. 41(8):1183-1192.

Sherk JA, O'Connor JM, Neumann DA, Prince RD, Wood KV. 1974. Effects of suspended and deposited sediments on estuarine organisms. Phase II. University of Maryland Natural Resources Institute, Reference 74-20.

Sherman K, Lasker R, Richards W, Kendall A. 1983. Ichthyoplankton and Fish Recruitment Studies in Large Marine Ecosystems. Marine Fisheries Review 45 (10-12).

Shortnose Sturgeon Status Review Team. 2010. Biological Assessment of Shortnose Sturgeon, *Acipenser brevirostrum*. Gloucester (MA): National Marine Fisheries Service, National Oceanic and Atmospheric Administration; Northeast Regional Office. p. 417.

Slacum HW, Burton WH, Methratta ET, Weber, ED, Llansó RJ, Dew-Baxter J. 2010. Assemblage Structure in Shoal and Flat- Bottom Habitats on the Inner Continental Shelf of the Middle Atlantic Bight, USA. Marine and Coastal Fisheries, 2(1): 277-298.

Soria, M, Fréon P, Gerlotto F. 1996. Analysis of vessel influence on spatial behaviour of fish schools using a multi-beam sonar and consequences for biomass estimates by echo-sounder. ICES Journal of Marine Science 53(2): 453-458. https://doi.org/10.1006/jmsc.1996.0064.

Springer, S. 1960. Natural history of the sandbar shark, Eulamia milberti. Fish. Bull. 61: 1–38.

Sullivan MC, Cowen RK, Steves BP. 2005. Evidence for atmosphere-ocean forcing of yellowtail flounder (*Limanda ferruginea*) recruitment in the Middle Atlantic Bight. Fisheries Oceanography, 14(5):386-399.

Sogard SM, Able KW, Fahay MP. 1992. Early life history of the tautog, *Tautog onitis*, in the Mid-Atlantic Bight. NOAA Fishery Bulletin, U.S., 90: 529-539.

Stadler JH, Woodbury DP. 2009. Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria. Paper presented at: Inter-Noise 2009: Innovations in Practical Noise Control. Ottawa, Canada.

Steimle FW, Figley W. 1996. The Importance of Artificial Reef Epifauna to Black Sea Bass Diets in the Middle Atlantic Bight. North American Journal of Fisheries Management. 16: 433-439.

Steimle FW, Zetlin C. 2000. Reef Habitats in the Middle Atlantic Bight: Abundance, Distribution, Associated Biological Communities, and Fishery Resource Use. Marine Fisheries Review. 62(2).

Stein AB, Friedland FD, Sutherland M. 2004a. Atlantic Sturgeon Marine Distribution and Habitat Use along the Northeastern Coast of the United States. Transactions of the American Fisheries Society. 133: 527–537.

Stein AB, Friedland FD, Sutherland M. 2004b. Atlantic Sturgeon Marine Bycatch and Mortality on the Continental Shelf of the Northeast United States. North American Journal of Fisheries Management. 24:171–183.

Stenberg C, Støttrup JG, van Deurs M, Berg CW, Dinesen GE, Mosegaard H, Grome TM, Leonhard SB. 2015. Long-term effects of an offshore wind farm in the North Sea on fish communities. Mar Ecol Prog Ser. 528:257-265.

Steves BP, Cowen RK, Malchoff MH. 1999. Settlement and Nursery Habitats for Demersal Fishes on the Continental Shelf of the New York Bight. Fish. Bull. 98:167–188.

The Nature Conservancy. 2015. Northwest Atlantic Marine Ecosystem Assessment- Soft Sediments (Chapter 3) [dataset]. Arlington (VA): Conservation Gateway; [accessed 2020 December 16]. http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/marine/data/Pages/default.aspx.

Thomsen F, Lüdemann K, Kafemann R, Piper W. 2006. Effects of offshore wind farm noise on marine mammals and fish. Hamburg, Germany: Report by Biola for COWRIE Ltd.

Topham E, McMillan D. 2017. Sustainable decommissioning of an offshore wind farm. Renewable Energy. 102:470-480.

Tougaard J, Madsen PT, Wahlberg M. 2008. Underwater noise from construction and operation of offshore wind farms. Bioacoustics. 17(1-3):143-146.

[USDOE] US Department of Energy, Minerals Management Service. (2009). Final Environmental Impact Statement for the Proposed Cape Wind Energy Project, Nantucket Sound, Massachusetts (Adopted), DOE/EIS-0470. Retrieved from https://www.boem.gov/Cape-Wind-FEIS/.

Vabø R, Olsen K, Huse I. 2002. The effect of vessel avoidance of wintering Norwegian spring spawning herring. Fish Res. 58(1):59-77.

Vanhellemont Q, Ruddick K. 2014. Turbid wakes associated with offshore wind turbines observed with Landsat 8. Remote Sensing of Environment, 145: 105-115.

Voynova, Y. G., M. J. Oliver, and J. H. Sharp. 2013: Wind to zooplankton: Ecosystem-wide influence of seasonal wind-driven upwelling in and around the Delaware Bay. J. Geophys. Res. Oceans, 118, 6437-6450. doi:10.1002/2013JC008793.

Wahlberg M, Westerberg H. 2005. Hearing in fish and their reactions to sounds from offshore wind farms. Mar Ecol Prog Ser. 288:295-309.

West Point Partners, LLC. 2013. Application to the United States Army Corps of Engineers (New York District) for a Department of the Army Individual Permit. Volume 1 of 2. Fairfield (CT): West Point Partners, LLC. http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7BC191AEEA-9CFF-4D39-9654-E21B59A3629A%7D.

Wilber, DH and Clarke, DG. 2001. Biological Effects of Suspended Sediments: A Review of Suspended Sediment Impacts on Fish and Shellfish with Relation to Dredging Activities in Estuaries. North American Journal of Fisheries Management, 21: 4, 855-875,

Wilhelmsson D, Malm T, Öhman MC. 2006. The influence of offshore windpower on demersal fish. ICES Journal of Marine Science, 63: 775-784.

Woodruff DL, Schultz IR, Marshall KE, Ward JA, Cullinan VI. 2013. Effects of Electromagnetic Fields on Fish and Invertebrates, Task 2.1.3: Effects on Aquatic Organisms, Fiscal Year 2012 Progress Report. PNNL-22154. Prepared for U.S. Department of Energy. Richland, Washington: Pacific Northwest National Laboratory.

Wysocki LE, Amoser S, Ladich F. 2007. Diversity in ambient noise in European freshwater habitats: Noise levels, spectral profiles, and impact on fishes. J Acoust Soc Am. 121(5):2559-2566.

Zykov MM, Bailey L, Deveau TJ, Racca RG. 2013. South Stream Pipeline – Russian Sector – Underwater Sound Analysis. Technical report by JASCO Applied Sciences for South Stream Transport B.V.

4.7 Marine Mammals

[BOEM] Bureau of Ocean Energy Management. 2012. Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017. Final Programmatic Environmental Impact Statement. US Department of the Interior. BOEM 2012-030. https://www.boem.gov/uploadedFiles/BOEM/Oil_and_Gas_Energy_Program/Leasing/Five_Year_Program/2012-2017_Five_Year_Program/2012-2017_Final_PEIS.pdf.

[BOEM] Bureau of Ocean Energy Management. 2014. Atlantic OCS Proposed Geological and Geophysical Activities Mid-Atlantic and South Atlantic Planning Area Final Programmatic Environmental Impact Statement http://www.boem.gov/BOEM-2014-001-v1/.

[CeTAP] Cetacean and Turtle Assessment Program, University of Rhode Island. 1982. A Characterization of marine mammals and turtles in the mid- and North Atlantic aeas of the US Outer Continental Shelf, final report. Contract AA551-CT8-48. Bureau of Land Management, Washington, DC.

[CWFNJ] Conserve Wildlife Foundation of New Jersey. 2015. Harbor Seals in New Jersey https://www.arcgis.com/apps/MapJournal/index.html?appid=d2266f32c36449e0b9630453e56c3888&webmap=564588c5cff04fa990aab644400475f9. (accessed 27 Oct 2020).

[DoN] Department of the Navy (US). 2005. Marine resources assessment for the Northeast operating areas: Atlantic City, Narragansett Bay, and Boston--Report PDF. Department of the Navy, US Fleet Forces Command, Norfolk, VA, USA.

[DoN] Department of the Navy (US). 2008. Request for Regulations and Letters of Authorization for the Incidental Harassment of Marine Mammals Resulting from Navy Training Activities Conducted within the Northwest Training Range Complex. 323 p.

[GARFO] Greater Atlantic Regional Fisheries Office. 2021. Whale Watching and Wildlife Viewing in New England and the Mid-Atlantic (Marine Life Viewing Guidelines). Available online at https://www.fisheries.noaa.gov/new-england-mid-atlantic/marine-life-viewing-guidelines/whale-watching-and-wildlife-viewing-new.

[HESS] High Energy Seismic Survey. 1999. High Energy Seismic Survey Review Process and Interim Operational Guidelines for Marine Surveys Offshore Southern California. Prepared for the California State Lands Commission and the United States Minerals Management Service Pacific Outer Continental Shelf Region by the High Energy Seismic Survey Team, Camarillo, CA, USA. 98 p. https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/PB2001100103.xhtml.

[NEFSC] Northeast Fisheries Science Center and [SEFSC] Southeast Fisheries Science Center. 2011a. 2010 Annual Report to the Inter-Agency Agreement M10PG00075/0001: A Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the western North Atlantic Ocean. https://nefsc.noaa.gov/psb/AMAPPS/docs/Final_2010AnnualReportAMAPPS_19Apr2011.pdf.

[NEFSC] Northeast Fisheries Science Center and [SEFSC] Southeast Fisheries Science Center. 2011b. 2011 Annual Report to the Inter-Agency Agreement M10PG00075/0001: A Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the western North Atlantic Ocean. https://nefsc.noaa.gov/psb/AMAPPS/docs/NMFS_AMAPPS_2011_annual_report_final_BOEM.pdf.

[NEFSC] Northeast Fisheries Science Center and [SEFSC] Southeast Fisheries Science Center. 2012. 2012 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic

Ocean.
https://nefsc.noaa.gov/psb/AMAPPS/docs/NMFS_AMAPPS_2012_annual_report_FINAL.pdf.

[NEFSC] Northeast Fisheries Science Center and [SEFSC] Southeast Fisheries Science Center. 2014a. 2013 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic Ocean.
https://nefsc.noaa.gov/psb/AMAPPS/docs/NMFS_AMAPPS_2013_annual_report_FINAL3.pdf.

[NEFSC] Northeast Fisheries Science Center and [SEFSC] Southeast Fisheries Science Center. 2014b. 2014 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic Ocean.
https://nefsc.noaa.gov/psb/AMAPPS/docs/NMFS_AMAPPS_2014_annual_report_Final.pdf.

[NEFSC] Northeast Fisheries Science Center and [SEFSC] Southeast Fisheries Science Center. 2015. 2015 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic Ocean – AMAPPS II. https://doi.org/10.25923/kxrc-g028.

[NEFSC] Northeast Fisheries Science Center and [SEFSC] Southeast Fisheries Science Center. 2016. 2016 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic Ocean – AMAPPS II. https://doi.org/10.25923/gbap-g480.

[NEFSC] Northeast Fisheries Science Center and [SEFSC] Southeast Fisheries Science Center. 2018. 2017 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic Ocean – AMAPPS II. https://doi.org/10.25923/q4ae-aa65.

[NEFSC] Northeast Fisheries Science Center and [SEFSC] Southeast Fisheries Science Center. 2019. 2018 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic Ocean – AMAPPS II. https://repository.library.noaa.gov/view/noaa/22040.

[NMFS] National Marine Fisheries Service (US). 1991. Final Recovery Plan for the Humpback Whale (Megaptera novaeangliae). Report by the Humpback Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, MD, USA. 105 p.
https://repository.library.noaa.gov/view/noaa/15993.

[NMFS] National Marine Fisheries Service (US). 2018. 2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. US Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 p. https://www.fisheries.noaa.gov/webdam/download/75962998.

[NOAA] National Oceanic and Atmospheric Administration (US). 2005. Notice of Public Scoping and Intent to Prepare an Environmental Impact Statement. Federal Register 70(7): 1871-1875. https://www.govinfo.gov/content/pkg/FR-2005-01-11/pdf/05-525.pdf.

[USFWS] US Fish and Wildlife Service. 2019. West Indian manatee Trichechus manatus. [accessed 17 Oct 2019]. https://www.fws.gov/southeast/wildlife/mammals/manatee.

Abend, A.G. and T.D. Smith. 1999. Review of the distribution of the long-finned pilot whale (Globicephala melas) in the North Atlantic and Mediterranean. In: US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, and Northeast Fisheries Science Center. Volume 117. NOAA Technical Memorandum NMFS-NE-117. 1-22 p. http://www.nefsc.noaa.gov/nefsc/publications/tm/tm117/tm117.pdf.

American Cetacean Society. 2018. Pilot Whale © Copyright 2018 by the American Cetacean Society. https://www.acsonline.org/index.php?option=com_content&view=article&id=65:pilot-whale&catid=20:site-content.

Baird, R.W. and P.J. Stacey. 1991. Status of Risso's dolphin, Grampus griseus, in Canada. Canadian Field-Naturalist 105(2): 233-242.

Barco, S., W. McLellan, J. Allen, R. Asmutis-Silvia, R. Mallon-Day, E. Fougeres, D. Pabst, J. Robbins, R. Seton, et al. 2002. Population identity of humpback whales. Journal of Cetacean Research and Management 4: 135-141.

Barlas, M.E. 1999. The distribution and abundance of harbor seals (Phoca vitulina concolor) and gray seals (Halichoerus grypus) in southern New England, winter 1998-summer 1999. PhD Thesis. Boston University.

Barlow, J.P. 1988. Harbor porpoise, Phocoena phocoena, abundance estimation for California, Oregon, and Washington. I: Ship surveys. Fishery Bulletin 86(3): 417-432. https://www.st.nmfs.noaa.gov/spo/FishBull/863/barlow.pdf.

Barlow, J.P. and P.J. Clapham. 1997. A new birth-interval approach to estimating demographic parameters of humpback whales. Ecology 78(2): 535-546. https://doi.org/10.1890/0012-9658(1997)078[0535:ANBIAT]2.0.CO;2.

Baumgartner, M.F., S.M. Van Parijs, F.W. Wenzel, C.J. Tremblay, H.C. Esch, and A.M. Warde. 2008. Low frequency vocalizations attributed to sei whales (Balaenoptera borealis). Journal of the Acoustical Society of America 124(2): 1339-1349. https://doi.org/10.1121/1.2945155.

Bel'kovich, V.M. 1960. Some biological observations on the white whale from the aircraft. Zoologicheskii Zhurnal 39(9): 1414-1422.

Bellmann, M.A., A. May, T. Wendt, S. Gerlach, P. Remmers, and J. Brinkmann. 2020. Unterwasserschall während des Impulsrammverfahrens: Einflussfaktoren auf Rammschall und technische Möglichkeiten zur Einhaltung von Lärmschutzwerten. Report by ITAP GmbH, Oldenburg, Germany. https://www.itap.de/media/erfahrungsbericht_rammschall_era-bericht_.pdf

Bergström, L., F. Sundqvist, and U. Bergström. 2013. Effects of an offshore wind farm on temporal and spatial patterns in the demersal fish community. Marine Ecology Progress Series 485: 199-210. https://doi.org/10.3354/meps10344.

Biedron, I., N. Mihnovets, A. Warde, J. Michalec, C.W. Clark, C. Diamond, B. Estabrook, B. Howard, C. McCarthy, et al. 2009. Determining the seasonal distribution of cetaceans in New York coastal waters using passive acoustic monitoring. Abstracts, Eighteenth Biennial Conference on the Biology of Marine Mammals. 12-16 Oct 2009, Quebec City, Canada. p. 34.

Bonner, W.N. 1971. Grey seal Halichoerus grypus fabricus. In Ridgway, S.H. and H.J. Harrison (eds.). Handbook of Marine Mammals. Academic Press, London.

Bowers-Altman, J. and NJ Division of Fish and Wildlife. 2009. Species Status Review of Marine Mammals: Final Report. Report by the NJ Division of Fish and Wildlife, Endangered and Nongame Species Program. https://www.state.nj.us/dep/fgw/ensp/pdf/marine_mammal_status_rprt.pdf.

British Columbia Ministry of Transportation and Infrastructure (BC MTI). 2016. George Massey Tunnel Replacement Project – Part B Underwater Noise Assessment. Available: https://projects.eao.gov.bc.ca/api/document/589b9bd5343013001d41579d/fetch.

Brown, D.M., J. Robbins, P.L. Sieswerda, R. Schoelkopf, and E.C.M. Parsons. 2017. Humpback whale (Megaptera novaeangliae) sightings in the New York-New Jersey harbor estuary. Marine Mammal Science 34(1): 250-257. https://doi.org/10.1111/mms.12450.

Brown, M.W., D. Fenton, K. Smedbol, C. Merriman, K. Robichaud-Leblanc, and J.D. Conway. 2009. Recovery Strategy for the North Atlantic Right Whale (Eubalaena glacialis) in Atlantic Canadian Waters [Final]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada. 66 p.

Charif, R.A., D.K. Mellinger, K.J. Dunsmore, K.M. Fristrup, and C.W. Clark. 2002. Estimated source levels on fin whale (Balaenoptera physalus) vocalizations: Adjustment for surface interference. Marine Mammal Science 18(1): 81-98. https://doi.org/10.1111/j.1748-7692.2002.tb01020.x.

Clark, C.W. and G.C. Gagnon. 2002. Low-frequency vocal behaviors of baleen whales in the North Atlantic: Insights from IUSS detections, locations and tracking from 1992 to 1996. U.S. Navy Journal of Underwater Acoustics 52(3): 609-640.

Clark, C.W. and P.J. Clapham. 2004. Acoustic monitoring on a humpback whale (Megaptera novaeangliae) feeding ground shows continual singing into late spring. The Royal Society of

London. Volume 271(1543). pp. 1051-1058. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1691688/pdf/15293859.pdf.

Clark, C.W. and W.T. Ellison. 2004. Potential use of low-frequency sounds by baleen whales for probing the environment: Evidence from models and empirical measurements. In Thomas, J.A., C. Moss, and M. Vater (eds.). Echolocation in Bats and Dolphins. The University of Chicago Press, Chicago. pp. 564-582.

Cole, T., A. Glass, P.K. Hamilton, P. Duley, M. Niemeyer, C. Christman, R.M. Pace, III, and T. Frasier. 2009. Potential mating ground for North Atlantic right whales off the northeast USA. 18th Biennial Conference on the Biology of Marine Mammals, 12-16 Oct 2009, Quebec, Canada.

Copping, A., N. Sather, L. Hanna, J. Whiting, G. Zydlewski, G. Staines, A.B. Gill, I. Hutchison, A. O'Hagan, et al. 2016. Annex IV 2016 state of the science report: Environmental effects of marine renewable energy development around the world. Report by Pacific Northwest National Laboratory for US Department of Energy (the Annex IV Operating Agent) and other partnering nations under the International Energy Agency (IEA) Ocean Energy Systems Initiative (OES). 224 p. https://tethys.pnnl.gov/sites/default/files/publications/Annex-IV-2016-State-of-the-Science-Report_LR_0.pdf.

Curtice, C., J. Cleary, E. Shumchenia, and P.N. Halpin. 2019. Marine-life Data and Analysis Team (MDAT) Technical Report on the Methods and Development of Marine-life Data to Support Regional Ocean planning and Management. Report for the Marine-life Data and Analysis Team (MDAT). http://seamap.env.duke.edu/models/MDAT/MDAT-Technical-Report.pdf.

Davies, J.L. 1957. The Geography of the Gray Seal. Journal of Mammalogy 38(3): 297-310. https://doi.org/10.2307/1376229.

Davis, G.E., M.F. Baumgartner, P.J. Corkeron, J. Bell, C. Berchok, J.M. Bonnell, J.B. Thornton, S. Brault, G.A. Buchanan, D.M. Cholewiak, C.W. Clark, J. Delarue, L.T. Hatch, H.Klinck, S.D. Kraus, B. Martin, D.K. Mellinger, H. Moors-Murphy, S. Nieukirk, D.P. Nowacek, S.E. Parks, D. Parry, N. Pegg, A.J. Read, A.N. Rice, D. Risch, A. Scott, M.S. Soldevilla, K.M. Stafford, J.E. Stanistreet, E. Summers, S. Todd, and S.M. Van Parijs. 2020. Exploring movement patterns and changing distributions of baleen whales in the western North Atlantic using a decade of passive acoustic data. Glob Change Biol. 00:1-29. https://doi.org/10.1111/gcb.15191.

Davis, G.E., M.F. Baumgartner, J.M. Bonnell, J. Bell, C. Berchok, J. Bort Thornton, S. Brault, G. Buchanan, R.A. Charif, et al. 2017. Long-term passive acoustic recordings track the changing distribution of North Atlantic right whales (Eubalaena glacialis) from 2004 to 2014. Scientific Reports 7(1): 1-12. https://doi.org/10.1038/s41598-017-13359-3.

deHart, P.A.P. 2002. The distribution and abundance of harbor seals (Phoca vitulina concolor) in the Woods Hole region. M.A. Thesis. Boston University. 88 p.

Dickerson, C., K. J. Reine, and D. G. Clarke. 2001. Characterization of Underwater Sounds Produced by Bucket Dredging Operations. DOER Technical Notes Collection (ERDC TN-DOER-E14), U.S. Army Engineer Research and Development Center, Vicksburg, MS. 17 pp.

DiGiovanni, R., K. Durham, J. Wocial, R.D.V.M. Pisciotta, R.D.V.M. Hanush, A. Chaillet, A. Sabrosky, and R. Scott. 2005a. Post Release Monitoring of a male Risso's dolphin (Grampus griseus) rehabilitated and released in New York waters. Abstract from the 16th Biennial Conference on the Biology of Marine Mammals, San Diego, CA .

DiGiovanni, R.A., Jr., K.F. Durham, J.N. Wocial, R.D. Pisciotta, R. Hanush, A.M. Chaillet, A.D. Hallett, A.M. Sabrosky, and R.A. Scott. 2005b. Rehabilitation and Post Release Monitoring of a Male Risso's Dolphin (Grampus griseus) Released in New York Waters [abstract]. Abstract from the 16th Biennial Conference on the Biology of Marine Mammals. 12-16 Dec 2005, San Diego, CA, USA.

Doksæter, L., E. Olsen, L. Nøttestad, and A. Fernö. 2008. Distribution and feeding ecology of dolphins along the Mid-Atlantic Ridge between Iceland and the Azores. Deep Sea Research Part II 55(1): 243-253. https://doi.org/10.1016/j.dsr2.2007.09.009.

Donovan, G.P. 1991. A review of IWC stock boundaries. Reports of the International Whaling Commission 13(Special Issue): 39-68.

Dow Piniak, W.E., S.A. Eckert, C.A. Harms, and E.M. Stringer. 2012. Underwater hearing sensitivity of the leatherback sea turtle (Dermochelys coriacea): Assessing the potential effect of anthropogenic noise. US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2012-00156. 35 p.

Dunlop, R.A., M.J. Noad, R.D. McCauley, L. Scott-Hayward, E. Kniest, R. Slade, D. Paton, and D.H. Cato. 2017. Determining the behavioural dose–response relationship of marine mammals to air gun noise and source proximity. Journal of Experimental Biology 220(16): 2878-2886. https://jeb.biologists.org/content/220/16/2878.

Ellison, W.T., B.L. Southall, C.W. Clark, and A.S. Frankel. 2012. A New Context-Based Approach to Assess Marine Mammal Behavioral Responses to Anthropogenic Sounds. Conservation Biology 26(1): 21-28. https://doi.org/10.1111/j.1523-1739.2011.01803.x.

Ellison, W.T., C.W. Clark, D.A. Mann, B.L. Southall, and D.J. Tollit. 2016a. A risk assessment framework to assess the biological significance of noise exposure on marine mammals. Poster presented at the 21st Conference on the Biology of Marine Mammals, San Francisco. http://sea-inc.net/wp-content/uploads/2016/01/EWG-Framework_SMM-poster.jpg.

Ellison, W.T., R.G. Racca, C.W. Clark, B. Streever, A.S. Frankel, E. Fleishman, R.P. Angliss, J. Berger, D.R. Ketten, et al. 2016b. Modeling the aggregated exposure and responses of bowhead whales Balaena mysticetus to multiple sources of anthropogenic underwater sound. Endangered Species Research 30: 95-108. https://doi.org/10.3354/esr00727.

Ellison, W.T., B.L. Southall, A.S. Frankel, K. Vigness-Raposa, and C.W. Clark. 2018. An Acoustic Scene Perspective on Spatial, Temporal, and Spectral [short note]. Aquatic Mammals 44(3): 239-243. https://doi.org/10.1578/AM.44.3.2018.239.

Garrison, L.P., A.A. Hohn, and Hansen L.J. 2017b. Seasonal movements of Atlantic common bottlenose dolphin stocks based on tag telemetry data. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division 75 Virginia Beach Dr., Miami, FL 33140: PRBD Contribution # PRBD-2017-02, XX pp.

Gedamke, J. 2004. Minke whale song, spacing, and acoustic communication on the Great Barrier Reef, Australia. PhD thesis, University of California, Santa Cruz.

Geo-Marine. 2009a. Marine mammal monitoring during geophysical surveys in support of the construction of a meteorological data collection facility for the Bluewater Delaware Offshore Wind Park (MMS Lease Block 6325): October 2009. Final summary report by Geo-Marine for Bluewater Wind, LLC.

Geo-Marine. 2009b. Marine mammal monitoring during geophysical surveys in support of the construction of a meteorological data collection facility for the Bluewater Delaware Offshore Wind Park (MMS Lease Block 6936): August 2009. Final summary report by Geo-Marine for Bluewater Wind, LLC.

Geo-Marine. 2010. Ocean/Wind Power Ecological Baseline Studies: January 2008 – December 2009. Final Report. Volume III: Marine Mammal and Sea Turtle Studies. Report by Geo-Marine, Inc. for the New Jersey Department of Environmental Protection, Office of Science. https://tethys.pnnl.gov/sites/default/files/publications/Ocean-Wind-Power-Baseline-Volume3.pdf.

Gilbert, J.R., G.T. Waring, K.M. Wynne, and N. Guldager. 2005. Changes in abundance of harbor seals in Maine, 1981–2001. Marine Mammal Science 21(3): 519-535. https://doi.org/10.1111/j.1748-7692.2005.tb01246.x.

Gill, A.B., I. Gloyne-Philips, J. Kimber, and P. Sigray. 2014. Marine renewable energy, electromagnetic (EM) fields and EM-sensitive animals. In Shields, M. and A. Payne (eds.). Humanity and the Sea: Marine Renewable Energy Technology and Environmental Interactions. Springer. pp. 61-79.

Gowans, S. and H. Whitehead. 1995. Distribution and habitat partitioning by small odontocetes in the Gully, a submarine canyon on the Scotian Shelf. Canadian Journal of Zoology 73(9): 1599-1608. https://doi.org/10.1139/z95-190.

Hain, J.H.W., M.J. Ratnaswamy, R.D. Kenney, and H.E. Winn. 1992. The fin whale, Balaenoptera physalus, in waters of the northeastern United States continental shelf. Reports of the International Whaling Commission 42: 653-669.

Hamazaki, T. 2002. Spatiotemporal prediction models of cetacean habitats in the mid-western North Atlantic Ocean (from Cape Hatteras, North Carolina, USA to Nova Scotia, Canada). Marine Mammal Science 18(4): 920-939. https://doi.org/10.1111/j.1748-7692.2002.tb01082.x.

Hart Crowser, I.P.E. and Illingworth and Rodkin, Inc. 2009. Acoustic Monitoring and In-site Exposures of Juvenile Coho Salmon to Pile-driving Noise at the Port of Anchorage Marine Terminal Redevelopment Project, Knik Arm, Anchorage, Alaska. Report by Hart Crowser, Inc./Pentec Environmental and Illingworth and Rodkin, Inc. for URS Corporation for US Department of Transportation, Maritime Administration; Port of Anchorage; and Integrated Concepts and Research Corporation. https://www.fisheries.noaa.gov/resource/document/acoustic-monitoring-and-situ-exposures-juvenile-coho-salmon-pile-driving-noise.

Hatch, J.M. and C.D. Orphanides. 2017. Estimates of cetacean and pinniped bycatch in the 2015 New England sink and mid-Atlantic Gillnet fisheries. Northeast Fish Sci Cent Ref Doc 17-18: 21.

Hatch, L.T., C.W. Clark, S.M. Van Parijs, A.S. Frankel, and D.W. Ponirakis. 2012. Quantifying loss of acoustic communication space for right whales in and around a U.S. National Marine Sanctuary. Conservation Biology 26(6): 983-994. https://doi.org/10.1111/j.1523-1739.2012.01908.x.

Haug, T., M. Hammill, and D. Olafsdóttir. 2013. Introduction. In Grey seals in the North Atlantic and the Baltic. Volume 6. NAMMCO Scientific Publications. pp. 7-12. https://doi.org/10.7557/3.2717.

Hayes, S.A., E. Josephson, K. Maze-Foley, and P.E. Rosel. 2017. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2016 (second edition). NOAA Technical Memorandum NMFS-NE-241, Woods Hole, MA, USA. 274 p.

Hayes, S.A., E. Josephson, K. Maze-Foley, and P.E. Rosel. 2018a. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2017 (first edition). NOAA Technical Memorandum NMFS-NE-245, Woods Hole, MA, USA. 371 p.

Hayes, S.A., E. Josephson, K. Maze-Foley, and P.E. Rosel. 2018b. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2017 (second edition). NOAA Technical Memorandum NMFS-NE-245, Woods Hole, MA, USA. 371 p. https://www.nefsc.noaa.gov/publications/tm/tm245/.

Hayes, S.A., E. Josephson, K. Maze-Foley, and P.E. Rosel. 2019. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2018. NOAA Technical Memorandum NMFS-NE-258, Woods Hole, MA, USA. 298 p. https://doi.org/10.25923/9rrd-tx13.

Hayes, S.A., E. Josephson, K. Maze-Foley, P.E. Rosel, and J. Turek. 2021. Draft U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2021. NOAA Technical Memorandum, Woods Hole, MA, USA.

HDR. 2019. Field Observations during Wind Turbine Operations at the Block Island Wind Farm, Rhode Island. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2019-028. 281 p. https://espis.boem.gov/final%20reports/BOEM_2019-028.pdf.

Hoover, K., S. Sadove, and P. Forestell. 1999. Trends of harbor seal, Phoca vitulina, abundance from aerial surveys in New York waters: 1985-1999 [abstract]. Proceedings of the 13th Biennial Conference on the Biology of Marine. 28 Nov to 3 Dec 1999, Wailea, HI.

Horwood, J.W. 1989. Biology and exploitation of the minke whale. CRC press.

Hotchkin, C.F. and S.E. Parks. 2013. The Lombard effect and other noise-induced vocal modifications: Insight from mammalian communication systems. Biological Reviews 88(4): 809-824. https://doi.org/10.1111/brv.12026.

Houghton, J., J. Starkes, J. Stutes, M. Havey, J.A. Reyff, and D. Erikson. 2010. Acoustic monitoring of in situ exposures of juvenile coho salmon to pile-driving noise at the port of Anchorage Marine Terminal redevelopment project, Knik Arm, Alaska. Alaska Marine Sciences Symposium, Anchorage.

Jacobs, S.R. and J.M. Terhune. 2000. Harbor seal (Phoca vitulina) numbers along the New Brunswick coast of the Bay of Fundy in the fall in relation to aquaculture. Northeastern Naturalist 7(3): 289-296. https://doi.org/10.1656/1092-6194(2000)007[0289:HSPVNA]2.0.CO;2.

Jefferson, T.A., M.A. Webber, and R.L. Pitman. 2008. Marine Mammals of the World, A Comprehensive Guide to their Identification. Elsevier, Amsterdam.

Jefferson, T.A., C.R. Weir, R.C. Anderson, L.T. Ballance, R.D. Kenney, and J.J. Kiszka. 2014. Global distribution of Risso's dolphin Grampus griseus: A review and critical evaluation. Mammal Review 44(1): 56-68. https://doi.org/10.1111/mam.12008.

Kastelein, R.A., P.J. Wensveen, L. Hoek, W.C. Verboom, and J.M. Terhune. 2009. Underwater detection of tonal signals between 0.125 and 100 kHz by harbor seals (Phoca vitulina). Journal of the Acoustical Society of America 125(2): 1222-1229. https://doi.org/10.1121/1.3050283.

Katona, S.K. and J.A. Beard. 1990. Population size, migrations and feeding aggregations of the humpback whale (Megaptera novaeangliae) in the western North Atlantic Ocean. Report of the International Whaling Commission 12(Special Issue): 295-306.

Katona, S.K., V. Rough, and D.T. Richardson. 1993. A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland. Smithsonian Institution Press, Washington, DC. 316 p.

Kenney, M.K. 1994. Harbor seal population trends and habitat use in Maine. M.Sc. Thesis. University of Maine, Orono, ME. 55 p.

Kenney, R.D., M.A.M. Hyman, and H.E. Winn. 1985. Calculation of standing stocks and energetic requirements of the cetaceans of the northeast United States Outer Continental Shelf. NOAA technical memorandum NMFS-F/NEC-41. https://repository.library.noaa.gov/view/noaa/5641.

Kenney, R.D. 1990. Bottlenose dolphins off the north-eastern United States. In Leatherwood, S. and R.R. Reeves (eds.). The Bottlenose Dolphin. Academic Press, San Diego, CA, USA.

Kenney, R.D., G.P. Scott, T.J. Thompson, and H.E. Winn. 1997. Estimates of prey consumption and trophic impacts of cetaceans in the USA northeast continental shelf ecosystem. Journal of Northwest Atlantic Fishery Science 22: 155-171.

Kenney, R.D. and K.J. Vigness-Raposa. 2010. Marine mammals and sea turtles of Narragansett Bay, Block Island Sound, Rhode Island Sound, and nearby waters: An analysis of existing data for the Rhode Island Ocean Special Area Management Plan. (Chapter 10) In RICRMC (Rhode Island Coastal Resources Management Council) Ocean Special Area Management Plan (SAMP). Appendix A: Technical Reports for the Rhode Island Ocean Special Area Management Plan. Volume 2. pp. 705-1042.
http://seagrant.gso.uri.edu/oceansamp/pdf/appendix/full_volume2_osamp_4.26.13.pdf.

Kleĭnenberg, S.E.e., A.V. Yablokov, B.M. Bel'kovich, and M.N. Tarasevich. 1964. Beluga (Delphinapterus leucas): Investigation of the species [Belukha; opyt monograficheskogo issledovaniya vida)]. Israel Program for Scientific Translation (1st translated edition 1 Jan 1969), Jerusalem. 376 p. http://hdl.handle.net/2027/uc1.31822014463194.

Knowlton, A.R. and S.D. Kraus. 2001. Mortality and serious injury of northern right whales (Eubalaena glacialis) in the western North Atlantic Ocean. Journal of Cetacean Research and Management 2(Special Issue): 193-208.

Knowlton, A.R., J. Beaudin Ring, B. Russell, and New England Aquarium. 2002. Right whale sightings and survey effort in the Mid Atlantic Region: Migratory corridor, time frame, and proximity to port entrances. Report for the NMFS Ship Strike Working Group. 25 p.

Kraus, S.D., M.W. Brown, H. Caswell, C.W. Clark, M. Fujiwara, P.K. Hamilton, R.D. Kenney, A.R. Knowlton, S. Landry, et al. 2005. North Atlantic Right Whales in Crisis. Science 309(5734): 561-562. https://science.sciencemag.org/content/309/5734/561.

Kraus, S.D., S. Leiter, K. Stone, B. Wikgren, C.A. Mayo, P. Hughes, R.D. Kenney, C.W. Clark, A.N. Rice, et al. 2016. Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles. US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2016-054, Sterling, Virginia. 117 + appendices p. https://www.boem.gov/RI-MA-Whales-Turtles.

LaBrecque, E., C. Curtice, J. Harrison, S.M. Van Parijs, and P.N. Halpin. 2015. 2. Biologically Important Areas for cetaceans within U.S. waters - East Coast region. Aquatic Mammals 41(1): 17-29. http://dx.doi.org/10.1578/AM.41.1.2015.1.

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet, and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal Science 17(1): 35-75. https://doi.org/10.1111/j.1748-7692.2001.tb00980.x.

Lavigueur, L. and M.O. Hammill. 1993. Distribution and seasonal movements of grey seals, Halichoerus grypus, born in the Gulf of St. Lawrence and eastern Nova Scotia shore. Canadian Field-Naturalist 107(3): 329-340.

Lawson, J.W. and J.-F. Gosselin. 2018. Estimates of cetacean abundance from the 2016 NAISS aerial surveys of eastern Canadian waters, with a comparison to estimates from the 2007 TNASS. Document Number NAMMCO SC/25/AE/09. Report for the NAMMCO Secretariat. 40 p.

Leatherwood, S., D.K. Caldwell, and H.E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. NOAA Technical Report NMFS Circ. 396.

Lesage, V. and M.O. Hammill. 2001. The status of the grey seal, Halichoerus grypus, in the Northwest Atlantic. Canadian Field-Naturalist 115(4): 653-662.

Lesage, V. and M.O. Hammill. 2003. Proceedings of the workshop on the development of research priorities forthe Northwest Atlantic blue whale population, 20−21 November 2002. DFO Can. Sci. Advis. Sec. Proceed. Ser.Longhurst, A.R. 1998. Ecological geography of the sea. 2nd edition. Elsevier Academic Press.

Luksenburg, J. and E.C.M. Parsons. 2009. The effects of aircraft on cetaceans: implications for aerial whalewatching. 61st Meeting of the International Whaling Commission. 8 Jun to 6 Jul 2012, Panama City.

Malme, C.I., P.R. Miles, C.W. Clark, P.L. Tyack, and J.E. Bird. 1983. Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior. Final Report for the Period of 7 June 1982 - 31 July 1983. Report Number 5366. Report by Bolt Beranek and Newman Inc. for US Department of the Interior, Minerals Management Service, Alaska OCS Office, Cambridge, MA, USA. https://www.boem.gov/sites/default/files/boemnewsroom/Library/Publications/1983/rpt5366.pdf.

Malme, C.I., P.R. Miles, C.W. Clark, P.L. Tyack, and J.E. Bird. 1984. Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior. Phase II: January 1984 Migration. Report Number 5586. Report by Bolt Beranek and Newman Inc. for the US Department of the Interior, Minerals Management Service, Cambridge, MA, USA. https://www.boem.gov/sites/default/files/boemnewsroom/Library/Publications/1983/rpt5586.pdf.

Mansfield, A.W. 1966. The grey seal in eastern Canadian waters. Canadian Audubon Magazine 28: 161-166.

Marine Mammal Stranding Center. 2020. 2019 Stranding Totals https://mmsc.org/strandings/stranding-stats.

Matthews, L.P., J.A. McCordic, and S.E. Parks. 2014. Remote acoustic monitoring of North Atlantic right whales (Eubalaena glacialis) reveals seasonal and diel variations in acoustic behavior. PLOS ONE 9(3). https://doi.org/10.1371/journal.pone.0091367.

Mayo, C.A., L. Ganley, C.A. Hudak, S. Brault, M.K. Marx, E. Burke, and M.W. Brown. 2018. Distribution, demography, and behavior of North Atlantic right whales (Eubalaena glacialis) in Cape Cod Bay, Massachusetts, 1998–2013. Marine Mammal Science 34(4): 979-996. https://doi.org/10.1111/mms.12511.

McDonald, M.A., J.A. Hildebrand, S.M. Wiggins, D. Thiele, D. Glasgow, and S.E. Moore. 2005. Sei whale sounds recorded in the Antarctic. Journal of the Acoustical Society of America 118(6): 3941-3945. https://doi.org/10.1121/1.2130944.

McQueen, A. D., B. C. Suedel, and Justin L. Wilkens. 2019. Review of the Adverse Biological Effects of Dredging-induced Underwater Sounds. WEDA Journal of Dredging 17:1–22.

Mead, J.G. 1975. Preliminary report on the former net fisheries for Tursiops truncatus in the western North Atlantic. Journal of the Fisheries Board of Canada 32(7): 1155-1162.

Mead, J.G. and C.W. Potter. 1995. Recognizing two populations of the bottlenose dolphin (Tursiops truncatus) of the Atlantic coast of North America-morphologic and ecologic considerations. International Biological Research Institute Reports 5: 31-43.

Meißner, K., H. Schabelon, J. Bellebaum, and H. Sordyl. 2006. Impacts of submarine cables on the marine environment: A literature review. Report by the Institute of Applied Ecology Ltd for the Federal Agency of Nature Conservation, Germany. 88 p.

Moore, M.J., A. Bogomolni, R.S. Bowman, C.T. Harry, A.R. Knowlton, S. Landry, D.S. Rotstein, and K. Touhey. 2006. Fatally entangled right whales can die extremely slowly. OCEANS 2006. 18-21 Sep 2006. IEEE, oston, MA, USA. pp. 1-3. https://doi.org/10.1109/OCEANS.2006.306792.

Morano, J.L., D.P. Salisbury, A.N. Rice, K.L. Conklin, K.L. Falk, and C.W. Clark. 2012. Seasonal changes in fin whale song in the western north Atlantic Ocean. Journal of the Acoustical Society of America 132(2): 1207-1212. https://doi.org/10.1121/1.4730890.

National Marine Fisheries Service (NMFS). 2018. *US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2017*. NOAA Tech. Memo. NMFS-NE-245.

National Marine Fisheries Service (NMFS). 2016a. Biological Opinion. Continued Prosecution of Fisheries and Ecosystem Research Conducted and Funded by the Northeast Fisheries Science Center and the Issuance of a Letter of Authorization under the Marine Mammal Protection Act for the Incidental Take of Marine Mammals Pursuant to those Research Activities. NER-2015-12532.

National Marine Fisheries Service (NMFS). 2021a. *Biological Opinion. Construction, Operation, Maintenance, and Decommissioning of the South Fork Offshore Energy Project (Lease OCS-A 0517)*. GARFO-2021-00353.

Nedwell, J.R. and A.W. Turnpenny. 1998. The use of a generic frequency weighting scale in estimating environmental effect. Workshop on Seismics and Marine Mammals. 23–25 Jun 1998, London, UK.

Nedwell, J.R., A.W. Turnpenny, J. Lovell, S.J. Parvin, R. Workman, J.A.L. Spinks, and D. Howell. 2007. A validation of the dBht as a measure of the behavioural and auditory effects of underwater noise. Document Number 534R1231 Report prepared by Subacoustech Ltd. for Chevron Ltd, TotalFinaElf Exploration UK PLC, Department of Business, Enterprise and Regulatory Reform, Shell UK Exploration and Production Ltd, The Industry Technology Facilitator, Joint Nature Conservation Committee, and The UK Ministry of Defence. 74 p. https://tethys.pnnl.gov/sites/default/files/publications/Nedwell-et-al-2007.pdf.

Newhall, A.E., Y.T. Lin, J.F. Lynch, and M.F. Baumgartner. 2009. Sei whale localization and vocalization frequency sweep rate estimation during the New Jersey Shallow Water 2006 experiment. Journal of the Acoustical Society of America 125(4): 2738-2738. https://doi.org/10.1121/1.4784544.

NOAA Fisheries. 2010. Final recovery plan for the sperm whale (Physeter macrocephalus). National Marine Fisheries Service, Silver Spring, MD, USA.

NOAA Fisheries. 2018a. Common bottlenose dolphin (Tursiops truncatus) overview. [accessed 20 August 2020]. https://www.fisheries.noaa.gov/species/common-bottlenose-dolphin.

NOAA Fisheries. 2018b. Fin whale (Balaenoptera physalus) overview (accessed 20 August 2020). https://www.fisheries.noaa.gov/species/fin-whale.

NOAA Fisheries. 2018c. Harbor porpoise (Phocoena phocoena) overview [accessed 20 August 2020]. https://www.fisheries.noaa.gov/species/harbor-porpoise.

NOAA Fisheries. 2018d. Humpback whale (Megaptera novaeangliae) overview [accessed 20 August 2020]. https://www.fisheries.noaa.gov/species/humpback-whale.

NOAA Fisheries. 2018e. Long-finned pilot whale (Globicephala melas) overview [accessed 20 August 2020]. https://www.fisheries.noaa.gov/species/long-finned-pilot-whale.

NOAA Fisheries. 2018f. Sei Whale (Balaenoptera borealis) overview [accessed 20 August 2020] https://www.fisheries.noaa.gov/species/sei-whale.

NOAA Fisheries. 2018g. 2016-2018 Humpback Whale Unusual Mortality Event along the Atlantic Coast, [accessed 20 August 2020]. https://www.fisheries.noaa.gov/national/marine-life-distress/2016-2018-humpback-whale-unusual-mortality-event-along-atlantic-coast.

NOAA Fisheries. 2018h. Short-beaked common dolphin (Delphinus delphis) overview [accessed 20 August 2020] https://www.fisheries.noaa.gov/species/short-beaked-common-dolphin.

NOAA Fisheries. 2018j. Minke whale (Balaenoptera acutorostrata) overview [accessed 20 August 2020]. https://www.fisheries.noaa.gov/species/minke-whale.

NOAA Fisheries. 2018k. Risso's dolphin (Grampus griseus) overview [accessed 20 August 2020]. https://www.fisheries.noaa.gov/species/rissos-dolphin.

NOAA Fisheries. 2018l. Gray seal (Halichoerus grypus atlantica) overview [accessed 20 August 2020]. https://www.fisheries.noaa.gov/species/gray-seal.

NOAA Fisheries. 2018m. North Atlantic right whale (Eubalaena glacialis) overview [accessed 20 August 2020]. https://www.fisheries.noaa.gov/species/north-atlantic-right-whale.

NOAA Fisheries. 2020a. Short-beaked Common Dolphin (Delphinus delphis) [accessed 27 October 2020]. https://www.fisheries.noaa.gov/species/short-beaked-common-dolphin.

NOAA Fisheries. 2020b. North Atlantic Right Whale (Eubalaena glacialis) [accessed 27 October 2020]. https://www.fisheries.noaa.gov/species/north-atlantic-right-whale.

NOAA Fisheries. 2020c. Common Bottlenose Dolphin (Tursiops truncatus) [accessed 27 October 2020]. https://www.fisheries.noaa.gov/species/common-bottlenose-dolphin.

NOAA Fisheries. 2020e. 2017–2020 North Atlantic Right Whale Unusual Mortality Event Office of Protected Resources [accessed 20 August 2020]. https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2020-north-atlantic-right-whale-unusual-mortality-event.

Noren, D.P., A.H. Johnson, D. Rehder, and A. Larson. 2009. Close approaches by vessels elicit surface active behaviors by southern resident killer whales. Endangered Species Research 8(3): 179-192.

Normandeau Associates, Inc., T.C. Tricas, and A.B. Gill. 2011. Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species. Final Report to US Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region. OCS Study BOEMRE 2011-09, Camarillo, CA. https://espis.boem.gov/final%20reports/5115.pdf.

Northridge, S.P., M.L. Tasker, A. Webb, K. Camphuysen, and M. Leopold. 1997. White-beaked Lagenorhynchus albirostris and Atlantic white-sided dolphin L. acutus distributions in northwest

European and US North Atlantic waters. Report of the International Whaling Commission 47: 797-805. https://archive.iwc.int/?r=52&k=4bf9610eaa

Nowacek, D.P., L.H. Thorne, D.W. Johnston, and P.L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. Mammal Review 37(2): 81-115. https://doi.org/10.1111/j.1365-2907.2007.00104.x.

Orphanides, C.D. 2019. Estimates of cetacean and pinniped bycatch in the 2016 New England sink and mid-Atlantic Gillnet fisheries. Northeast Fish Sci Cent Ref Doc. 19-04: 12.

Pace III RM, Corkeron PJ, Kraus SD. State–space mark–recapture estimates reveal a recent decline in abundance of North Atlantic right whales. Ecol Evol. 2017;7:8730–8741. https://doi.org/10.1002/ece3.3406

Pace, R. M., R. Williams, S. D. Kraus, A. R. Knowlton, and H. M. Pettis. 2021. Cryptic Mortality of North Atlantic Right Whales. Conservation Science and Practice 2021:e346.

Palka, D.L. 2012. Cetacean abundance estimates in U.S. northwestern Atlantic Ocean waters from summer 2011 line transect survey. In: US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center (ed.). US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center. https://www.nefsc.noaa.gov/publications/crd/crd1229/crd1229.pdf

Palka, D.L., S. Chavez-Rosales, E. Josephson, D.M. Cholewiak, H.L. Haas, L.P. Garrison, M. Jones, D. Sigourney, G.T. Waring, et al. 2017. Atlantic Marine Assessment Program for Protected Species: 2010-2014. US Department of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region. OCS Study BOEM 2017-071, Washington, DC. 211 p. https://espis.boem.gov/final%20reports/5638.pdf.

Palsbøll, P.J., J. Allen, M. Bérube´, P.J. Clapham, T.P. Feddersen, P.S. Hammond, R.R. Hudson, H. Jørgensen, S. Katona, et al. 1997. Genetic tagging of humpback whales. Nature 388(6644): 767-769. https://doi.org/10.1038/42005.

Parks, S.E., P.K. Hamilton, S.D. Kraus, and P.L. Tyack. 2005. The gunshot sound produced by male North Atlantic right whales (Eubalaena glacialis) and its potential function in reproductive advertisement. Marine Mammal Science 21(3): 458-475. https://doi.org/10.1111/j.1748-7692.2005.tb01244.x.

Parks, S.E. and P.L. Tyack. 2005. Sound production by North Atlantic right whales (Eubalaena glacialis) in surface active groups. Journal of the Acoustical Society of America 117(5): 3297-3306. https://doi.org/10.1121/1.1882946.

Parks, S.E., M. Johnson, D.P. Nowacek, and P.L. Tyack. 2011. Individual right whales call louder in increased environmental noise. Biology Letters 7: 33-35. https://doi.org/10.1098/rsbl.2010.0451.

Patenaude, N.J., W.J. Richardson, M.A. Smultea, W.R. Koski, G.W. Miller, B. Würsig, and C.R. Greene, Jr. 2002. Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the alaskan Beaufort sea. Marine Mammal Science 18(2): 309-335. https://doi.org/10.1111/j.1748-7692.2002.tb01040.x.

Payne, P.M., L.A. Selzer, and A.R. Knowlton. 1984. Distribution and density of cetaceans, marine turtles, and seabirds in the shelf waters of the northeastern United States, June 1980-December 1983, based on shipboard observations. Report to National Marine Fisheries Service, Woods Hole, MA.

Payne, P.M. and L.A. Selzer. 1989. The distribution, abundance, and selected prey of the harbor seal, Phoca vitulina concolor, in southern New England. Marine Mammal Science 5(2): 173-192. https://doi.org/10.1111/j.1748-7692.1989.tb00331.x.

Payne, P.M. and D.W. Heinemann. 1990. A distributional assessment of cetaceans in the shelf and shelf edge waters of the northeastern United States based on aerial and shipboard surveys, 1978-1988. Report to National Marine Fisheries Science Center, Woods Hole, MA. 108 p.

Payne, P.M. and D.W. Heinemann. 1993. The distribution of pilot whales (Globicephala spp.) in shelf/shelf edge and slope waters of the north-eastern United States, 1978-1988. Report of the International Whaling Commission 14(Special Issue): 51-68.

Pendleton, D.E., A.J. Pershing, M.W. Brown, C.A. Mayo, R.D. Kenney, N.R. Record, and T.V.N. Cole. 2009. Regional-scale mean copepod concentration indicates relative abundance of North Atlantic right whales. Marine Ecology Progress Series 378: 211-225. https://doi.org/10.3354/meps07832.

Pershing, A.J., L.B. Christensen, N.R. Record, G.D. Sherwood, and P.B. Stetson. 2010. The Impact of Whaling on the Ocean Carbon Cycle: Why Bigger Was Better. PLOS ONE 5(8): e12444. https://doi.org/10.1371/journal.pone.0012444.

Pettis, H.M., R.M. Pace, III, R.S. Schick, and P.K. Hamilton. 2017. North Atlantic Right Whale Consortium 2017 Annual Report Card. Report to the North Atlantic Right Whale Consortium. https://www.narwc.org/uploads/1/1/6/6/116623219/2017_report_cardfinal.pdf.

Pettis, H.M., Pace, R.M. III, Hamilton, P.K. 2022. North Atlantic Right Whale Consortium 2021 Annual Report Card. Report to the North Atlantic Right Whale Consortium.

Popper, A.N. 1980. Sound emission and detection by delphinids. Cetacean Behavior, (ed. L.M. Herman), pp. 1–52, John Wiley & Sons, New York.

Potter, C.W. 1979. The marine fauna. Symposium on Endangered and Threatened Plants and Animals of Virginia. 19-20 May 1978, Blacksburg, VA, USA. pp. 595-602.

Potter, C.W. 1984. Marine mammals of Maryland. In Norden, A.W., D.C. Forester, and G.H. Fenwick (eds.). Threatened and endangered plants and animals of Maryland. Maryland Natural Heritage Program Publication 84-1, Annapolis, MA, USA. pp. 442-453.

Rankin, S. and J.P. Barlow. 2005. Source of the North Pacific "boing" sound attributed to minke whales. Journal of the Acoustical Society of America 118(5): 3346-3351. https://doi.org/10.1121/1.2046747.

Rankin, S. and J.P. Barlow. 2007. Vocalizations of the sei whale Balaenoptera borealis off the Hawaiian Islands. Bioacoustics 16(2): 137-145. https://doi.org/10.1080/09524622.2007.9753572.

Reeves, R.R. 1992. The Sierra Club handbook of seals and sirenians. Sierra Club Books, San Francisco, CA.

Reeves, R.R. and A.J. Read. 2003. Bottlenose dolphin, harbor porpoise, sperm whale and other toothed cetaceans. In Feldhamer, G.A., B.C. Thomspon, and J.A. Chapman (eds.). Wild Mammals of North America: Biology, Management and Conservation. 2nd edition. John Hopkins University Press, Baltimore, MD. pp. 397-424.

Richardson, D.T. 1976. Assessment of harbor and gray seal populations in Maine 1974-1975. Final report for Marine Mammal Commission, Washington, DC.

Richardson, D.T. and V. Rough. 1993. A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland. Smithsonian Institution Press, Washington.

Richardson, W.J., M.A. Fraker, B. Würsig, and R.S. Wells. 1985a. Behaviour of Bowhead Whales Balaena mysticetus summering in the Beaufort Sea: Reactions to industrial activities. Biological Conservation 32(3): 195-230. https://doi.org/10.1016/0006-3207(85)90111-9.

Richardson, W.J., R.S. Wells, and B. Würsig. 1985b. Disturbance responses of bowheads, 1980-84. In Richardson, W.J. (ed.). Behavior, disturbance responses and distribution of bowhead whales Balaena mysticetus in the eastern Beaufort Sea, 1980-84. Report by LGL Ecological Research Associates, Inc. and US Minerals Managment Service. OCS Study MMS 85-0034. pp. 89-196.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine Mammals and Noise. Academic Press, San Diego, CA, USA. 576 p. https://doi.org/10.1016/C2009-0-02253-3.

Richardson, W.J. and B. Würsig. 1997. Influences of man-made noise and other human actions on cetacean behaviour. Marine and Freshwater Behaviour and Physiology 29(1-4): 183-209. https://doi.org/10.1080/10236249709379006.

Risch, D., C.W. Clark, P.J. Dugan, M. Popescu, U. Siebert, and S.M. Van Parijs. 2013. Minke whale acoustic behavior and multi-year seasonal and diel vocalization patterns in Massachusetts Bay, USA. Marine Ecology Progress Series 489: 279-295. https://doi.org/10.3354/meps10426.

Risch, D., M. Castellote, C.W. Clark, G.E. Davis, P.J. Dugan, L.E.W. Hodge, A. Kumar, K. Lucke, D.K. Mellinger, et al. 2014. Seasonal migrations of North Atlantic minke whales: Novel insights from large-scale passive acoustic monitoring networks. Movement Ecology 2(24). https://doi.org/10.1186/s40462-014-0024-3.

Roberts, J.J., B.D. Best, L. Mannocci, P.N. Halpin, D.L. Palka, L.P. Garrison, K.D. Mullin, T.V.N. Cole, and W.M. McLellan. 2015. Density Model for Seals (Phocidae) Along the U.S. East Coast, Preliminary Results. Version 3.2. Marine Geospatial Ecology Lab, Duke University, Durham, NC.

Roberts, J.J., B.D. Best, L. Mannocci, E. Fujioka, P.N. Halpin, D.L. Palka, L.P. Garrison, K.D. Mullin, T.V.N. Cole, et al. 2016a. Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. Scientific Reports 6. https://doi.org/10.1038/srep22615.

Roberts, J.J., L. Mannocci, and P.N. Halpin. 2016b. Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2015-2016 (Base Year). Version 1.0. Report by the Duke University Marine Geospatial Ecology Lab for Naval Facilities Engineering Command, Atlantic Durham, NC, USA.

Roberts, J.J., L. Mannocci, and P.N. Halpin. 2017. Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2016-2017 (Opt. Year 1). Version 1.4. Report by Duke University Marine Geospatial Ecology Lab for Naval Facilities Engineering Command, Atlantic, Durham, NC, USA.

Roberts, J.J., L. Mannocci, R.S. Schick, and P.N. Halpin. 2018. Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2017-2018 (Opt. Year 2). Version 1.2. Report by the Duke University Marine Geospatial Ecology Lab for Naval Facilities Engineering Command, Atlantic Durham, NC, USA.

Roberts, J.J., R.S. Schick, and P.N. Halpin. 2020. Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2018-2020 (Opt. Year 3). Version 1.4. Report by the Duke University Marine Geospatial Ecology Lab for Naval Facilities Engineering Command, Atlantic Durham, NC, USA.

Robinson, S. P., P. D. Theobald, G. Hayman, L.-S. Wang, P. A. Lepper, V. F. Humphrey, and S. Mumford. 2011. Measurement of Underwater Noise Arising from Marine Aggregate Dredging Operations: Final Report. Document Number 09/P108. Marine Environment Protection Fund (MEPF). Available: https://webarchive.nationalarchives.gov.uk/20140305134555/http://cefas.defra.gov.uk/alsf/projects/directand-indirect-effects/09p108.aspx.

Roman, J. and J.J. McCarthy. 2010. The whale pump: Marine mammals enhance primary productivity in a coastal basin. PLOS ONE 5(10): e13255. https://doi.org/10.1371/journal.pone.0013255.

Roman, J., J.A. Estes, L. Morissette, C. Smith, D.P. Costa, J. McCarthy, J.B. Nation, S. Nicol, A. Pershing, et al. 2014. Whales as marine ecosystem engineers. Frontiers in Ecology and the Environment 12(7): 377-385. https://doi.org/10.1890/130220.

Rone, B.K. and R.M. Pace, III. 2012. A simple photograph-based approach for discriminating between free-ranging long-finned (Globicephala melas) and short-finned (G. macrorhynchus) pilot whales off the east coast of the United States. Marine Mammal Science 28(2): 254-275. https://doi.org/10.1111/j.1748-7692.2011.00488.x.

Rosenfeld, M., M. George, and J.M. Terhune. 1988. Evidence of autumnal harbour seal, Phoca vitulina, movement from Canada to the United States. Canadian Field-Naturalist 102(3): 527-529.

Rough, V. 1995. Gray seals in Nantucket Sound, Massachusetts, winter and spring, 1994. Final report to the Marine Mammal Commission. 28 p. https://www.nefsc.noaa.gov/psb/docs/Rough - 1995 - Seals in Nantucket Sound, Massachusetts, winter an.pdf.

Rowlett, R.A. 1980. Observations of marine birds and mammals in the northern Chesapeake Bight. Document Number FWS/OBS-80/04. Report by US Fish and Wildlife Service, Washington, DC, USA.

Russell, D.J.F., G.D. Hastie, D. Thompson, V.M. Janik, P.S. Hammond, L.A.S. Scott-Hayward, J. Matthiopoulos, E.L. Jones, and B.J. McConnell. 2016. Avoidance of wind farms by harbour seals is limited to pile-driving activities. Journal of Applied Ecology 53(6): 1642-1652. https://doi.org/10.1111/1365-2664.12678.

Sabinsky, P.F., O.N. Larsen, M. Wahlberg, and J. Tougaard. 2017. Temporal and spatial variation in harbor seal (Phoca vitulina L.) roar calls from southern Scandinavia. Journal of the Acoustical Society of America 141(3): 1824–1834. https://doi.org/10.1121/1.4977999.

Schilling, M.R., I. Seipt, M.T. Weinrich, S.E. Frohock, A.E. Kuhlberg, and P.J. Clapham. 1992. Behavior of individually-identified sei whales Balaenoptera borealis during an episodic influx into the southern Gulf of Maine in 1986. Fisheries Bulletin 90(4): 749-755. https://spo.nmfs.noaa.gov/content/behavior-individually-identified-sei-whales-balaenoptera-borealis-during-episodic-influx

Schneider, D.C. and P.M. Payne. 1983. Factors affecting haul-out of harbor seals at a site in southeastern Massachusetts. Journal of Mammalogy 64(3): 518-520. https://doi.org/10.2307/1380370.

Schroeder, C.L. 2000. Population status and distribution of the harbor seal in Rhode Island waters. M.S. Thesis. University of Rhode Island, Narragansett, RI. 197 p.

Schwartz, F.J. 1962. Summer occurrence of an immature little piked whale,Balaenoptera acutorostrata, in Chesapeake Bay, Maryland. Chesapeake Science 3(3): 206-209. https://doi.org/10.2307/1350996.

Scott, M.D., R.S. Wells, and A.B. Irvine. 1990. A long-term study of bottlenose dolphins on the west coast of Florida. (Chapter 11) In Leatherwood, S. and R.R. Reeves (eds.). The Bottlenose Dolphin. Volume 235. Academic Press, San Diego, CA, USA. pp. 235-244.

Scott, T.M. and S.S. Sadove. 1997. Sperm whale, Physeter macrocephalus, sightings in the shallow shelf waters off Long Island, New York. Marine Mammal Science 13(2): 317-321. https://doi.org/10.1111/j.1748-7692.1997.tb00636.x.

Selzer, L.A. and P.M. Payne. 1988. The distribution of white-sided (Lagenorhynchus acutus) and common dolphins (Delphinus delphis) vs. environmental features of the continental shelf of the northeastern United States. Marine Mammal Science 4(2): 141-153. https://doi.org/10.1111/j.1748-7692.1988.tb00194.x.

Sergeant, D.E., A.W. Mansfield, and B. Beck. 1970. Inshore Records of Cetacea for Eastern Canada, 1949–68. Journal of the Fisheries Research Board of Canada 27(11): 1903-1915. https://doi.org/10.1139/f70-216.

Sergeant, D.E. 1977. Stocks of fin whales (Balaenoptera physalus L.) in the North Atlantic Ocean. Reports of the International Whaling Commission 27: 460-473.

Sieswerda, P.L., C.A. Spagnoli, and D.S. Rosenthal. 2015. Notes on a new feeding ground for humpback whales in the Western New York Bight. Southeast and Mid-Atlantic Marine Mammal Symposium. 27-29 Mar 2015, Virginia Beach, VI.

Slocum, C.J., R. Schoelkopf, S. Tulevech, M. Stevens, S. Evert, and M. Moyer. 1999. Seal populations wintering in New Jersey (USA) have increased in abundance and diversity [abstract]. Proceedings of the 13th Biennial Conference on the Biology of Marine. 28 Nov to 3 Dec 1999, Wailea, HI.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, et al. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals 33(4): 411-521.

Southall, B.L., D.P. Nowaceck, P.J.O. Miller, and P.L. Tyack. 2016. Experimental field studies to measure behavioral responses of cetaceans to sonar. Endangered Species Research 31: 293-315. https://doi.org/10.3354/esr00764.

Southall, B.L., J.J. Finneran, C.J. Reichmuth, P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek, and P.L. Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 45(2): 125-232. https://doi.org/10.1578/AM.45.2.2019.125.

Spalding, M.D., H.E. Fox, G.R. Allen, N. Davidson, Z.A. Ferdaña, M. Finlayson, B.S. Halpern, M.A. Jorge, A. Lombana, et al. 2007. Marine Ecoregions of the World: A Bioregionalization of Coastal and Shelf Areas. BioScience 57(7): 573-583. https://doi.org/10.1641/B570707.

Stenberg, C., J.G. Støttrup, M. van Deurs, C.W. Berg, G.E. Dinesen, H. Mosegaard, T.M. Grome, and S.B. Leonhard. 2015. Long-term effects of an offshore wind farm in the North Sea on fish communities. Marine Ecology Progress Series 528: 257-265. https://doi.org/10.3354/meps11261.

Sutcliffe, M.H. and P.F. Brodie. 1977. Whale distributions in Nova Scotia waters. Fisheries and Marine Service Technical Report No. 722. Vi, 83 p. http://www.dfompo.gc.ca/Library/18300.pdf.

Swingle, M., S. Barco, T. Pitchford, W. McLellan, and D. Pabst. 2006. Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia. Marine Mammal Science 9: 309-315.

Swingle, W.M., S.G. Barco, T.D. Pitchford, W.A. Mclellan, and D.A. Pabst. 1993. Appearance of juvenile humpback whales feeding in nearshore waters of Virginia. Marine Mammal Science 9(3): 309-315. https://doi.org/10.1111/j.1748-7692.1993.tb00458.x.

Todd, Victoria L. G., Ian B. Todd, Jane C. Gardiner, Erica C. N. Morrin, Nicola A. MacPherson, Nancy A. DiMarzio, Frank Thomsen. 2015. A review of impacts of marine dredging activities on marine mammals. ICES Journal of Marine Science, Volume 72, Issue 2, January/February 2015, Pages 328–340, https://doi.org/10.1093/icesjms/fsu187.

Tollit, D.J., P.M. Thompson, and S.P.R. Greenstreet. 1997. Prey selection by harbour seals, Phoca vitulina, in relation to variations in prey abundance. Canadian Journal of Zoology 75(9): 1508-1518. https://doi.org/10.1139/z97-774.

Tyler, D.E. 2008. Robust Statistics: Theory and Methods. Journal of the American Statistical Association 103(482): 888-889. https://doi.org/10.1198/jasa.2008.s239.

Ulmer, F.A.J. 1981. New Jersey's dolphins and porpoises. New Jersey Audubon Society Occasional Paper 137.

Vester, H., K. Hammerschmidt, M. Timme, and S. Hallerberg. 2014. Bag-of-calls analysis reveals group-specific vocal repertoire in long-finned pilot whales. Quantitative Methods.

Villadsgaard, A., M. Wahlberg, and J. Tougaard. 2007. Echolocation signals of wild harbour porpoises, Phocoena phocoena. Journal of Experimental Biology 210: 56-64. http://jeb.biologists.org/content/jexbio/210/1/56.full.pdf.

Vu, E.T., D. Risch, C.W. Clark, S. Gaylord, L.T. Hatch, M.A. Thompson, D.N. Wiley, and S.M. Van Parijs. 2012. Humpback whale (Megaptera novaeangliae) song occurs extensively on feeding grounds in the Northwest Atlantic Ocean. Aquatic Biology 14(2): 175-183. https://doi.org/10.3354/ab00390.

Wahlberg, M. 2002. The acoustic behaviour of diving sperm whales observed with a hydrophone array. Journal of Experimental Marine Biology and Ecology, 281(1–2), 53–62. https://doi.org/10.1016/S0022-0981(02)00411-2.

Wahlberg, M. and H. Westerberg. 2005. Hearing in fish and their reactions to sounds from offshore wind farms. Marine Ecology Progress Series 288: 295-309. https://www.int-res.com/abstracts/meps/v288/p295-309/.

Waring, G.T., E. Josephson, C.P. Fairfield, and K. Maze-Foley. 2007. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2007. NOAA Technical Memorandum NMFS-NE-205, Woods Hole, MA, USA. 415 p. https://repository.library.noaa.gov/view/noaa/3567.

Waring, G.T., D.L. Palka, and P.G.H. Evans. 2009. North Atlantic Marine Mammals. In Perrin, W.F., B. Würsig, and J.G.M. Thewissen (eds.). Encyclopedia of Marine Mammals. 2nd edition. Academic Press, London. pp. 773-781. https://doi.org/10.1016/B978-0-12-373553-9.00181-4

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel. 2015. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2014. NOAA Technical Memorandum NMFS-NE-232, Woods Hole, MA, USA. 361 p. https://repository.library.noaa.gov/view/noaa/5043.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel. 2016. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2015. NOAA Technical Memorandum NMFS-NE-238, Woods Hole, MA, USA. 501 p. https://repository.library.noaa.gov/view/noaa/11985.

Watkins, W.A., P.L. Tyack, K.E. Moore, and J.E. Bird. 1987. The 20-Hz signals of finback whales (Balaenoptera physalus). Journal of the Acoustical Society of America 82(6): 1901–1912. https://doi.org/10.1121/1.395685.

Whitman, A.A. and P.M. Payne. 1990. Age of harbour seals, Phoca vitulina concolor, wintering in southern New England. Canadian Field-Naturalist 104(4): 579-582.

Whitt, A.D., K. Dudzinski, and J.R. Laliberté. 2013. North Atlantic right whale distribution and seasonal occurrence in nearshore waters off New Jersey, USA, and implications for management. Endangered Species Research 20(1): 59-69. https://doi.org/10.3354/esr00486.

Wilson, S.C. 1978. Social Organization and Behavior of Harbor Seals, Phoca Vitulina Concolor', in Maine. Final Report to US Marine Mammal Commission in Fulfillment of Contract MM6AC013. 103 p.

Winn, H.E., E.A. Scott, and R.D. Kenney. 1985. Aerial surveys for right whales in the Great South Channel, Spring 1984. Report by Graduate School of Oceanography, University of Rhode Island for the US Marine Mammal Commission.

Winn, H.E., C.A. Price, and P.W. Sorensen. 1986. The distributional ecology of the right whale Eubalaena glacialis in the western North Atlantic. Report to the International Whaling Commission 10(Special Issue): 129-138.

Wood, J.D., B.L. Southall, and D.J. Tollit. 2012. PG&E offshore 3-D Seismic Survey Project Environmental Impact Report–Marine Mammal Technical Draft Report. Report by SMRU Ltd. 121 p. https://www.coastal.ca.gov/energy/seismic/mm-technical-report-EIR.pdf.

Würsig, B., S.K. Lynn, T.A. Jefferson, and K.D. Mullin. 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. Aquatic Mammals 24(1): 41-50. http://www.aquaticmammalsjournal.org/share/AquaticMammalsIssueArchives/1998/AquaticMammals_24-01/24-01_Wursig.pdf.

4.8 Sea Turtles

[BOEM] Bureau of Ocean Energy Management. 2012a. Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New Jersey, Delaware, Maryland, and Virginia.

[BOEM] Bureau of Ocean Energy Management. 2012b. Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017. Final Programmatic Environmental Impact Statement. US Department of the Interior. BOEM 2012-030. https://www.boem.gov/uploadedFiles/BOEM/Oil_and_Gas_Energy_Program/Leasing/Five_Year_Program/2012-2017_Five_Year_Program/2012-2017_Final_PEIS.pdf.

[BOEM] Bureau of Ocean Energy Management. 2014. Atlantic OCS Proposed Geological and Geophysical Activities Mid-Atlantic and South Atlantic Planning Area Final Programmatic Environmental Impact Statement. http://www.boem.gov/BOEM-2014-001-v1/.

BOEM. Bureau of Ocean Energy Management. 2014. Appendix I: Sea Turtle Hearing and Sensitivity to Acoustic Impacts in Atlantic G&G Programmatic EIS. BOEM 2014-001.

[NMFS] National Marine Fisheries Service (US) and [USFWS] US Fish and Wildlife Service. 2013. Hawksbill Sea Turtle (Eretmochelys Imbricata) 5-Year Review: Summary and Evaluation. Report for US Department of Commerce, US Department of the Interior, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, and US Fish and Wildlife Service, Silver Spring, MD. https://repository.library.noaa.gov/view/noaa/17041.

[NMFS] National Marine Fisheries Service (US) and [USFWS] US Fish and Wildlife Service. 2015. Status Review of the Green Turtle (Chelonia mydas) under the Endangered Species Act. https://www.fisheries.noaa.gov/resource/document/status-review-green-turtle-chelonia-mydas-under-endangered-species-act.

[NMFS] National Marine Fisheries Service (US) and [USFWS] US Fish and Wildlife Service. 2014. Olive Ridley Sea Turtle (Lepidochelys Olivacea) 5-Year Review: Summary and Evaluation. https://repository.library.noaa.gov/view/noaa/17036.

[NMFS] National Marine Fisheries Service (US) and [USFWS] US Fish and Wildlife Service. 2015. Kemp's Ridley Sea Turtle (Lepidochelys Kempii) 5-Year Review: Summary and Evaluation. https://repository.library.noaa.gov/view/noaa/17048.

[NMFS] National Marine Fisheries Service (US). 2016. Endangered Species Act Section 7 Consultation on the Continued Prosecution of the Fisheries and Ecosystem Research Conducted and Funded by the Northeast Fisheries Science Center and the Issuance of a Letter of Authorization under the Marine Mammal Protection Act for the Incidental Take of Marine Mammals Pursuant to Those Research Activities. NER-2015-12532.

[NOAA] National Oceanic and Atmospheric Administration. 2018. Marine Life Viewing Guidelines. https://www.fisheries.noaa.gov/topic/marine-life-viewing-guidelines.

[TEWG] Turtle Expert Working Group. 2007. An assessment of the leatherback turtle population in the Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-555. 116 p. https://repository.library.noaa.gov/view/noaa/8608.

[USCG] US Coast Guard. 2006. Final Environmental Impact Statement for the Compass Port LLC Deepwater Port License Application. Volume 1 of 2. Document Number USCG 2004-17659.

[USFWS] US Fish and Wildlife Service. 2018. Leatherback Sea Turtle (Dermochelys coriacea) [accessed 7 Feb 2021]. https://www.fws.gov/northflorida/SeaTurtles/Turtle Factsheets/leatherback-sea-turtle.htm.

Ambrose, R.F. and T.W. Anderson. 1990. Influence of an artificial reef on the surrounding infaunal community. Marine Biology 107: 41-52. https://doi.org/10.1007/BF01313240.

Arena, P.T., L.K.B. Jordan, and R.E. Spieler. 2007. Fish assemblages on sunken vessels and natural reefs in southeast Florida, USA. In Relini, G. and J. Ryland (eds.). Biodiversity in Enclosed Seas and Artificial Marine Habitats. Volume 193. Springer Netherlands, Dordrecht. pp. 157-171. https://doi.org/10.1007/978-1-4020-6156-1_14.

Bell, C.D.L., J. Parsons, T.J. Austin, A.C. Broderick, G. Ebanks-Petrie, and B.J. Godley. 2005. Some of them came home: The Cayman Turtle Farm headstarting project for the green turtle Chelonia mydas. Oryx 39(2): 137-148. https://doi.org/10.1017/S0030605305000372.

Bellman, M.A., A. May, T. Wendt, S. Gerlach, P. Remmers, and J. Brinkmann. 2020. Underwater noise during percussive pile driving: Influencing factors on pile-driving noise and technical possibilities to comply with noise mitigation values. Report edited by the itap GmbH for the Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie) and supported by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit).

Bellmann, M.A. 2014. Overview of existing noise mitigation systems for reducing pile-driving noise. Inter-noise2014. Melbourne, Australia. https://www.acoustics.asn.au/conference_proceedings/INTERNOISE2014/papers/p358.pdf.

Bjorndal, K.A. 1997. Foraging ecology and nutrition of sea turtles. (Chapter 8) In Lutz, P.L. and J.A. Musick (eds.). The Biology of Sea Turtles. Volume 1. CRC press, Boca Raton, FL. pp. 199-231.

Bohnsack, J.A. 1989. Are high densities of fishes at artificial reefs the result of habitat limitation or behavioral preference? Bulletin of Marine Science 44(2): 631-645.

Bohnsack, J.A., D.E. Harper, D.B. McClellan, and M. Hulsbeck. 1994. Effects of reef size on colonization and assemblage structure of fishes at artificial reefs off southeastern Florida, USA. Bulletin of Marine Science 55(2-3): 796-823.

Bouchard, S.S. and K.A. Bjorndal. 2000. Sea turtles as biological transporters of nutrients and energy from marine to terrestrial ecosystems. Ecology 81(8): 2305-2313.

Bräutigam, A. and K.L. Eckert. 2006. Turning the tide: Exploitation, trade and management of marine turtles in the Lesser Antilles, Central America, Colombia and Venezuela. A Traffic Report Commissioned by the Cites Secretariat. https://www.traffic.org/site/assets/files/5086/traffic_species_reptiles10.pdf.

Burke, V.J., E.A. Standora, and S.J. Morreale. 1993. Diet of Juvenile Kemp's Ridley and Loggerhead Sea Turtles from Long Island, New York. Copeia 1993(4): 1176-1180. https://www.jstor.org/stable/144710.

Carballo, J.L., C. Olabarria, and T.G. Osuna. 2002. Analysis of Four Macroalgal Assemblages along the Pacific Mexican Coast during and after the 1997–98 El Niño. Ecosystems 5(8): 0749-0760. https://doi.org/10.1007/s10021-002-0144-2.

Casale, P., M. Affronte, G. Insacco, D. Freggi, C. Vallini, P. Pino d'Astore, R. Basso, G. Paolillo, G. Abbate, et al. 2010. Sea turtle strandings reveal high anthropogenic mortality in Italian waters. Aquatic Conserv: Mar Freshw Ecosyst 20(6): 611-620. https://doi.org/10.1002/aqc.1133.

Conant, R. 1975. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. The Peterson Field Guide Series. Houghton Mifflin Harcourt.

Conant, T.A., P.H. Dutton, T. Eguchi, S.P. Epperly, C.C. Fahy, M.H. Godfrey, S.L. MacPherson, E.E. Possardt, B.A. Schroeder, et al. 2009. Loggerhead sea turtle (Caretta caretta) 2009 status review under the U.S. Endangered Species Act. Report by the Loggerhead Biological Review Team for NMFS. 222 p. ftp://ftp.library.noaa.gov/noaa_documents.lib/NMFS/OfcProtectedResources/Status_Review/SR_loggerheadturtle_2009-ACCESSIBLE.pdf.

da Silva ACCD da, Castilhos JC de, Lopez GG, Barata PCR. 2007. Nesting biology and conservation of the olive ridley sea turtle (Lepidochelys olivacea) in Brazil, 1991/1992 to 2002/2003. Journal of the Marine Biological Association of the United Kingdom. 87(4):1047–1056. doi:10.1017/S0025315407056378.

Dodd, C.K., Jr. 1988. Synopsis of the biological data on the loggerhead sea turtle Caretta caretta (Linnaeus 1758). US Fish and Wildlife Services. Biological Report 88 (44). 110 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/a322813.pdf.

Eckert, K.L., B.P. Wallace, J.G. Frazier, and S.A. Eckert. 2012. Synopsis of the Biological Data on the Leatherback Sea Turtle (Dermochelys Coriacea). Biological Technical Publication. Createspace Independent Pub.

Eckert, S.A. 2002. Swim speed and movement patterns of gravid leatherback sea turtles (Dermochelys coriacea) at St. Croix, US Virgin Islands. Journal of Experimental Biology 205: 3689-3697. https://jeb.biologists.org/content/205/23/3689.

Epperly, S.P., S.S. Heppell, R.M. Richards, M.A. Castro Martínez, A.L. Sarti Martínez, L.J. Peña, and D.J. Shaver. 2013. Mortality rates of Kemp's ridley sea turtles in the neritic waters of the United States. 33rd Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Symposium. 8 Feb 2013. NOAA Technical Memorandum NMFS-SEFSC-645, Baltimore, MD, USA. https://repository.library.noaa.gov/view/noaa/4403.

Finneran, J.J., E.E. Henderson, D.S. Houser, K. Jenkins, S. Kotecki, and J. Mulsow. 2017. Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III). Technical report by Space and Naval Warfare Systems Center Pacific (SSC Pacific). 183 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/a561707.pdf.

Friedlander, A.M., E. Ballesteros, M. Fay, and E. Sala. 2014. Marine Communities on Oil Platforms in Gabon, West Africa: High Biodiversity Oases in a Low Biodiversity Environment. PLOS ONE 9(8). https://doi.org/10.1371/journal.pone.0103709.

Gallaway, B.J., S.T. Szedlmayer, and W.J. Gazey. 2009. A life history review for red snapper in the Gulf of Mexico with an evaluation of the importance of offshore petroleum platforms and other artificial reefs. Reviews in Fisheries Science 17(1): 48-67.

Gallaway, B.J., C.W. Caillouet, Jr., P.T. Plotkin, W.J. Gazey, J.G. Cole, and S.W. Raborn. 2013. Kemp's Ridley Stock Assessment Project. Report by LGL Ecological Research Associates, Inc., Marine Fisheries Scientist Conservation Volunteer, Texas Sea Grant, and W.J. Gazey Research for the Gulf States Marine Fisheries Commission. https://www.gsmfc.org/publications/Miscellaneous/Kemp Ridley Stock Assessment Report Final June 27 2013.pdf.

Geo-Marine. 2010. Ocean/Wind Power Ecological Baseline Studies: January 2008 – December 2009. Final Report. Volume III: Marine Mammal and Sea Turtle Studies. Report by Geo-Marine, Inc. for the New Jersey Department of Environmental Protection, Office of Science. https://tethys.pnnl.gov/sites/default/files/publications/Ocean-Wind-Power-Baseline-Volume3.pdf

Gitschlag, G.R., B.A. Herczeg, and T.R. Barcak. 1997. Observations of sea turtles and other marine life at the explosive removal of offshore oil and gas structures in the Gulf of Mexico. Gulf and Caribbean Research 9(4): 247-262.

Greene, J.K., M.G. Anderson, J. Odell, and N. Steinberg. 2010. The Northwest Atlantic Marine Ecoregional Assessment: Species, habitats and ecosystems. Phase One. Report by the Nature Conservancy, Eastern US Division, Boston, MA.

Groombridge, B. and R.A. Luxmoore. 1989. The green turtle and hawksbill (Reptilia: Cheloniidae): World status, exploitation and trade. Secretariat of the Convention on International Trade in Engangererd Species of Wild Fauna and Flora. http://archive.org/details/greenturtlehawks89groo.

Hannan, L.B., J.D. Roth, L.M. Ehrhart, and J.F. Weishampel. 2007. Dune vegetation fertilization by nesting sea turtles. Ecology 88: 1053-1058.

Hawkes, L.A., A.C. Broderick, M.S. Coyne, M.H. Godfrey, and B.J. Godley. 2007. Only some like it hot—quantifying the environmental niche of the loggerhead sea turtle. Diversity and Distributions 13(4): 447-457. https://doi.org/10.1111/j.1472-4642.2007.00354.x.

Insacco, G. and F. Spadola. 2010. First record of Kemp's ridley sea turtle, Lepidochelys kempii (Garman, 1880) (Cheloniidae), from the Italian waters (Mediterranean Sea). Acta Herpetologica 5(1). https://doi.org/10.13128/Acta_Herpetol-8540.

Johnson, A. 2018. The Effects of Increased Turbidity and Suspended Sediment on ESA-Listed Species from Projects Occurring in the Greater Atlantic Region. Greater AtlanticRegion Policy Series. Document Number 18-02. Report by NOAA Fisheries, Greater Atlantic Regional FisheriesOffice, Gloucester, MA, USA. 106 p. https://www.greateratlantic.fisheries.noaa.gov/policyseries/index.php/GARPS/article/view/8/8.

Kraus, S.D., S. Leiter, K. Stone, B. Wikgren, C.A. Mayo, P. Hughes, R.D. Kenney, C.W. Clark, A.N. Rice, et al. 2016. Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles. US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2016-054, Sterling, Virginia. 117 + appendices p. https://www.boem.gov/RI-MA-Whales-Turtles/.

Lowe, C.G., K.M. Anthony, E.T. Jarvis, L.F. Bellquist, and M.S. Love. 2009. Site fidelity and movement patterns of groundfish associated with offshore petroleum platforms in the Santa Barbara Channel. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 1(1): 71-89.

Lyn, H., A. Coleman, M. Broadway, J. Klaus, S. Finerty, D. Shannon, and M. Solangi. 2012. Displacement and Site Fidelity of Rehabilitated Immature Kemp's Ridley Sea Turtles (Lepidochelys kempii). Marine Turtle Newsletter 135: 10-13. http://www.seaturtle.org/mtn/archives/mtn135/mtn135p10.shtml.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, et al. 2000a. Marine seismic surveys: A study of environmental implications. Australian Petroleum Production Exploration Association (APPEA) Journal 40(1): 692-708. https://doi.org/10.1071/AJ99048.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, et al. 2000b. Marine seismic surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid. Report Number R99-15. Prepared for Australian Petroleum Production Exploration Association by Centre for Maine Science and Technology, Western Australia. 198 p. https://cmst.curtin.edu.au/wp-content/uploads/sites/4/2016/05/McCauley-et-al-Seismic-effects-2000.pdf.

McMichael, E., A. Norem, R.R. Carthy, and T. Summers. 2006. Summary of 2003 cold stun turtles in St Joseph Bay, Florida. 23rd Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-536. 17-21 Mar 2003, Kuala Lumpur, Malaysia. pp. 184-186. https://repository.library.noaa.gov/view/noaa/4418.

Meißner, K., H. Schabelon, J. Bellebaum, and H. Sordyl. 2006. Impacts of submarine cables on the marine environment: A literature review. Report by the Institute of Applied Ecology Ltd for the Federal Agency of Nature Conservation, Germany. 88 p.

Nedwell, J.R., J. Langworthy, and D. Howell. 2003. Assessment of Sub-Sea Acoustic Noise and Vibration from Offshore Wind Turbines and Its Impact on Marine Wildlife; Initial Measurements of Underwater Noise during Construction of Offshore Windfarms, And Comparison with Background Noise. Document Number 544 R 0424 Report Number 544 R 0424. Report by Subacoustech Ltd. for the Crown Estates Office. 68 p. http://www.subacoustech.com/wp-content/uploads/544R0424.pdf.

NOAA Fisheries. 2020. Loggerhead Turtle [accessed 27 Oct 2020]. https://www.fisheries.noaa.gov/species/loggerhead-turtle.

Normandeau Associates Inc. and APEM Inc. 2018. Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy: Summer 2018 Taxonomic Analysis Summary Report. Report by Normandeau Associates Inc. and APEM Inc. for New York State Energy Research and Development Authority. https://remote.normandeau.com/docs/NYSERDA_Summer_2018_Taxonomic_Analysis_Summary_Report.pdf.

Normandeau Associates Inc. and APEM Inc. 2019a. Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy: Spring 2019 Taxonomic Analysis Summary Report. Report by Normandeau Associates Inc. and APEM Inc. for New York State Energy Research and Development Authority. https://remote.normandeau.com/docs/NYSERDA_Spring_2019_Taxonomic_Analysis_Summary_Report.pdf.

Normandeau Associates Inc. and APEM Inc. 2019b. Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy: Summer 2016–Spring 2018 Fourth Interim Report. Second annual report by Normandeau Associates Inc. and APEM Ltd. for New York State Energy Research. 149 p. https://remote.normandeau.com/docs/NYSERDA_2016-2018_4th_Semi-Annual_report.pdf.

Normandeau Associates Inc. and APEM Inc. 2019c. Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy: Fall 2018 Taxonomic Analysis Summary Report. Report by Normandeau Associates Inc. and APEM Inc. for New York State Energy Research and Development Authority. https://remote.normandeau.com/docs/NYSERDA_Fall_2018_Taxonomic_Analysis_Summary_Report.pdf.

Normandeau Associates Inc. and APEM Inc. 2020. Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy: Winter 2018-2019 Taxonomic Analysis Summary Report. Report by Normandeau Associates Inc. and APEM Inc. for New York State Energy Research and Development Authority. https://remote.normandeau.com/docs/NYSERDA_Winter_2018_19_Taxonomic_Analysis_Summary_Report.pdf

Nuttall, S.M., and L.D. Wood. 2012. A comparison of hawksbill sea turtle site occupancy between natural and artificial reefs in Palm Beach County, FL, USA. In Jones, T.T., and B.P. Wallace, compilers, Proceedings of the thirty-first annual symposium on sea turtle biology and conservation, NOAA Technical Memorandum NMFS-SEFSC-631, pp. 152-153.

Patterson, W. 2010. The effect of unpublished artificial reefs deployed on the Northwest Florida Shelf. Final Report. Florida Fish and Wildlife Conservation Commission Grant Number FWC08267. 38 pp.

Petersen, J.K. and T. Malm. 2006. Offshore Windmill Farms: Threats to or Possibilities for the Marine Environment. Volume 35. Document Number 2 Report Number 0044-7447. Ambio Special Report. Royal Swedish Academy of Sciences. 75-80 p. https://doi.org/10.1579/0044-7447(2006)35[75:OWFTTO]2.0.CO;2

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, et al. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. ASA

S3/SC1.4 TR-2014. SpringerBriefs in Oceanography. ASA Press and Springer. https://doi.org/10.1007/978-3-319-06659-2.

Rostal, D.C. 2007. Reproductive physiology of the ridley sea turtle. (Chapter 7) In Plotkin, P.T. (ed.). Biology and conservation of ridley sea turtles. Johns Hopkins University Press. pp. 151–165.

Sammarco, P.W., A. Lirette, Y. Tung, G. Boland, M. Genazzio, and J. Sinclair. 2014. Coral communities on artificial reefs in the Gulf of Mexico: standing vs. toppled oil platforms. ICES Journal of Marine Science 71(2): 417-426.

Shaver, D.J., B.A. Schroeder, R.A. Byles, P.M. Burchfield, J. Peña, R. Márquez, and H.J. Martinez. 2005. Movements and Home Ranges of Adult Male Kemp's Ridley Sea Turtles (Lepidochelys kempii) in the Gulf of Mexico Investigated by Satellite Telemetry. Chelonian Conservation and Biology 4(4): 817-827.

Shaver, D.J. and T. Wibbels. 2007. Head-starting the Kemp’s ridley sea turtle. (Chapter 14) In Plotkin, P.T. (ed.). Biology and conservation of ridley sea turtles. Johns Hopkins University Press. pp. 297-323.

Shoop, C.R. and R.D. Kenney. 1992. Seasonal Distributions and Abundances of Loggerhead and Leatherback Sea Turtles in Waters of the Northeastern United States. Herpetological Monographs 6: 43-67. http://www.jstor.org/stable/1466961.

Smolowitz, R.J., S.H. Patel, H.L. Haas, and S.A. Miller. 2015. Using a remotely operated vehicle (ROV) to observe loggerhead sea turtle (Caretta caretta) behavior on foraging grounds off the mid-Atlantic United States. Journal of Experimental Marine Biology and Ecology 471: 84-91. https://doi.org/10.1016/j.jembe.2015.05.016.

Stoneburner, D.L. 1982. Satellite telemetry of loggerhead sea turtle movement in the Georgia bight. Copeia 1982(2): 400-408.

Thomson JA, Cooper AB, Burkholder DA, Heithaus MR, Dill LM. 2013. Correcting for heterogeneous availability bias in surveys of long-diving marine turtles. Biological conservation. 165: 154-161.

Wilson, E.G., K.L. Miller, D. Allison, and M. Magliocca. 2010. Why Healthy Oceans Need Sea Turtles: The Importance of Sea Turtles to Marine Ecosystems. Report by Oceana. 17 p. https://oceana.org/reports/why-healthy-oceans-need-sea-turtles-importance-sea-turtles-marine-ecosystems.

Winton, M.V., G. Fay, H.L. Haas, M.D. Arendt, S.G. Barco, M.C. James, C. Sasso, and R.J. Smolowitz. 2018. Estimating the distribution and relative density of satellite-tagged loggerhead sea turtles using geostatistical mixed effects models. Marine Ecology Progress Series 586: 217-232. https://doi.org/10.3354/meps12396.

Witherington, B.E. 1997. The problem of photopollution for sea turtles and other nocturnal animals. Behavioral approaches to conservation in the wild: 303-328.

Witt, M.J., R. Penrose, and B.J. Godley. 2007. Spatio-temporal patterns of juvenile marine turtle occurrence in waters of the European continental shelf. Marine Biology 151(3): 873-885. https://doi.org/10.1007/s00227-006-0532-9.

Witzell WN, Schmid JR. 2004. Immature sea turtles in Gullivan Bay, Ten Thousand Islands, southwest Florida. Gulf of Mexico Science. 22(1): 5.

4.9 Summary of Protected Species

Conserve Wildlife Foundation of New Jersey. 2021. Species Field Guide Search Results. [accessed 25 March 2021]. http://www.conservewildlifenj.org/species/fieldguide/search/all/.

NJDEP. 2020. Wildlife Species of Special Concern in New Jersey. [accessed 25 March 2021]. https://www.nj.gov/dep/fgw/spclspp.htm#:~:text=The%20term%20%22Species%20of%20Special,their%20becoming%20a%20Threatened%20species.

USFWS. 2020. Species Status Codes. [accessed 25 March 2021]. https://www.fws.gov/endangered/about/listing-status-codes.html#:~:text=Under%20Review%20(UR)%20%2D%20Species,published%20in%20the%20Federal%20Register.

USFWS. 2021. Endangered Species. [accessed 25 March 2021]. https://www.fws.gov/endangered/about/listing-status-codes.html.

5.0 Visual Resources

Brodie, Joseph F. and B. Frei. 2020. Initial Visibility Modeling Study for Offshore Wind for New Jersey's Atlantic Shores Offshore Wind Project. Center for Ocean Observing Leadership School of Environmental and Biological Sciences Rutgers. New Brunswick, New Jersey.

Capitol Airspace Group, 2021. *Atlantic Shores Offshore Wind Project Aircraft Detection Lighting System (ADLS) Efficacy Analysis.* Alexandria, VA.

Federal Aviation Administration (FAA). 2020. Obstruction Marking and Lighting. Advisory Circular AC 70/7460-1M. DOT/FAA/AR-TN 05/50. U.S. Department of Transportation, Washington, D.C.

Robert G. Sullivan, Leslie B. Kirchler, Jackson Cothren & Snow L. Winters (2013) Research Articles: Offshore Wind Turbine Visibility and Visual Impact Threshold Distances, Environmental Practice, 15:1, 33-49. [accessed 11 January 2021]. https://www.tandfonline.com/doi/abs/10.1017/S1466046612000464.

Sullivan RG. 2021. Methodology for Assessment of Seascape, Landscape, and Visual Impacts of Offshore Wind Energy Developments on the Outer Continental Shelf of the United States. Washington (DC): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-032.78 p.

Smardon, R.C., J.F. Palmer, A. Knopf, K. Grinde, J.E. Henderson and L.D. Peyman-Dove. 1988. *Visual Resources Assessment Procedure for U.S. Army Corps of Engineers*. Instruction Report EL-88-1. Department of the Army, U.S. Army Corps of Engineers. Washington, D.C.

6.1 Aboveground Historic Properties

Advisory Council on Historic Preservation (ACHP). 2004. 36 CFR 800 – Protection of Historic Properties - Special Requirements for Protecting National Historic Landmarks (36 CFR 800.10). [accessed 11 January 2021]. https://www.achp.gov/sites/default/files/regulations/2017-02/regs-rev04.pdf.

Bureau of Ocean Energy Management (BOEM). 2020a. Guidelines for Information Requirements for a Renewable Energy Construction and Operations Plan (COP). May 2020. United States Department of the Interior. Washington, D.C. [accessed 11 January 2021]. https://www.boem.gov/sites/default/files/documents/about-boem/Archaeology%20and%20Historic%20Property%20Guidelines.pdf.

BOEM. 2020b. OCS EIS/EA, BOEM 2020-025, Vineyard Wind 1 Offshore Wind Energy Project, Supplement to the Draft Environmental Impact Statement, June 2020. United States Department of the Interior, Washington, D.C. [accessed 11 January 2021]. https://www.boem.gov/sites/default/files/documents/renewable-energy/Vineyard-Wind-1-Supplement-to-EIS.pdf.

Code of Federal Regulations (CFR). 2019. 36 CFR 800 – Protection of Historic Properties [incorporating amendments effective August 5, 2004. https://www.govinfo.gov/content/pkg/CFR-2019-title36-vol1/pdf/CFR-2019-title36-vol1-part60.pdf.

Environmental Design & Research, Landscape Architecture, Engineering & Environmental Services, D.P.C. (EDR). 2021. Visual Impact Assessment, Atlantic Shores Offshore Wind, LLC, New Jersey, US. March 2021.

New Jersey State Historic Preservation Office (NJHPO). 2008. *Standards for Architectural Survey Reports.* New Jersey Administrative Code. New Jersey Department of Environmental Protection. Trenton, NJ. Effective February 2, 2008. [accessed 25 September 2020]. https://www.nj.gov/dep/hpo/2protection/register_historic_places09_29_08.pdf.

6.2 Terrestrial Archaeological Resources

Atlantic County Department of Regional Planning and Economic Development (Atlantic County Planning). 2000. *Atlantic County Master Plan*. Atlantic County Department of Regional Planning and Economic Development. Northfield, NJ.

Bache, A.D. 1864. *Absecom Inlet New Jersey; From a Trigonometrical Survey, under the direction of A.D. Bach, Superintendent of the SURVEY OF THE COAST OF THE UNITED STATES*. 1:20,000 scale. Accessed 9 November 2021. Available at http://mapmaker.rutgers.edu/.

Beers FW. 1872. Topographical map of Atlantic County, New Jersey: from recent and actual surveys. In state atlas of New Jersey: based on state geological surveys and from additional surveys. New York, NY: Beers, Comstock, and Cline. Library of Congress, Geography and Map Division; [accessed 16 October 2020]. https://lccn.loc.gov/2012586901.

Beers F.W. 1873. Atlas of Monmouth Co. New Jersey From Recent and Actual Surveys and Records. Beers, Comstock & Cline. New York, New York.

Bureau of Ocean Energy Management (BOEM). 2020. Guidelines for Providing Archaeological and Historical Property Information Pursuant to 30 CFR Part 585. United States Department of the Interior. Washington, D.C. Available at https://www.boem.gov/sites/default/files/documents/about-boem/Archaeology%20and%20Historic%20Property%20Guidelines.pdf.

Boyer, C.S. 1931. Early Forges & Furnaces in New Jersey. University of Pennsylvania Press.

Braun D.P. 1974. Explanatory models for the evolution of coastal adaptation in prehistoric eastern New England. Am. Antiq. 39(4):582-596.

Bureau of Ocean Energy Management (BOEM). 2020. *Guidelines for Providing Archaeological and Historical Property Information Pursuant to 30 CFR Part 585*. United States Department of the Interior. Washington, D.C.

Chelser O, editor. 1982. New Jersey's archaeological resources: A review of research problems and survey priorities the Paleo-Indian period to the present. Trenton, NJ: Office of New Jersey Heritage, Department of Environmental Protection.

Chelser O, editor. 1984. Historic preservation planning in New Jersey: selected papers on the identification, evaluation, and protection of cultural resources. Trenton, NJ: Office of New Jersey Heritage, Department of Environmental Protection.

Chesler O, Richardson D. 1980. Annotated bibliography of cultural resource reports submitted to the New Jersey State historic preservation officer through December 31, 1979. Trenton, NJ: Office of New Jersey Heritage, Department of Environmental Protection.

Cook GH, Smock JC, and Vermeule CC. 1888. A topographical map of Egg Harbor and vicinity including the Atlantic shore from Barnegat to Great Egg Harbor. New York, NY: Julius Bien. David Rumsey Historical Map Collection; [accessed 16 October 2020].

Cunningham, J.T. 1997. Railroad in New Jersey. Afton Publishing Co., Inc. Andover, New Jersey.

Custer, J. F. 2001. *Classification Guide for Arrowheads and Spearpoints of Eastern Pennsylvania and the Central Middle Atlantic*. Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

Ellis, F. 1885. History of Monmouth County, New Jersey. R.T. Peck & Co. Philadelphia, Pennsylvania.

Environmental Design and Research (EDR). 2021. Phase IA Terrestrial Archaeological Resources Assessment, Atlantic Shores Offshore Wind Project - Operations and Maintenance Facility, Atlantic City, Atlantic County, New Jersey. Report prepared by EDR for Atlantic Shores Offshore Wind. Syracuse, NY.

EDR. 2022. Terrestrial Archaeological Resources Assessment, Atlantic Shores Offshore Wind Project - Onshore Interconnection Facilities, Monmouth and Atlantic County, New Jersey. Report prepared by EDR for Atlantic Shores Offshore Wind. Syracuse, NY.

Gordon T. 1828. A map of the state of New Jersey: with part of the adjoining states. Trenton, NJ: T. Gordon. MIT Libraries, MIT GeoWeb; [accessed 22 October 2020]. https://geodata.mit.edu/catalog/princeton-9k41zg570.

Greater Egg Harbor Township Historical Society. 2020. Website. [accessed 22 October 2020]. https://www.gehthsmuseum.org/.

Grossman-Bailey, I. 2001. *"The People Who Lived By The Ocean": Native American Resource Use and Settlement In The Outer Coastal Plain of New Jersey*. Doctoral Thesis, Temple University.

Hall, John. F. 1900. History of Atlantic City and County, New Jersey. Daily Union Printing Company. Atlantic City, NJ.

Historic Aerials. 2020. Historic Aerials Viewer. Nationwide Environmental Title Research, LLC. [accessed 11 January 2021]. https://www.historicaerials.com/viewer.

Hopkins, G.M. 1860. Topographical Map of the State of New Jersey: Together with the Vicinities of New York and Philadelphia, and with Most of the State of Delaware: From the State Geological Survey and U.S. Coast Survey, and from Surveys. H.G. Bond.

Howell, G.W. 1878. The State of New Jersey 1877. From U.S. Coast Survey Records, N.J. Geological and Topographical Surveys and Various Local Surveys to Date. Woolman & Rose, Philadelphia, Pennsylvania.

Howell Heritage and Historical Society. 2020. [accessed 11 January 2021]. https://howellheritagehistoricalsociety.org/.

Meredith AB, Hood VP. 1921. Geography and history of New Jersey. Boston, MA: Ginn and Company.

Morrison RH. 1950. Outline history of New Jersey. New Brunswick, NJ: Rutgers University Press.

Mounier RA, Cresson J, Martin JW. 1993. New evidence of Paleoindian biface fluting from the outer coastal plain of New Jersey at 28-OC-100. Archaeol. East. N. Am. 21(Fall 1993):1-23.

National Park Service. 2018. Geology of the Atlantic coastal plain. Washington, D.C.: National Park Service; [accessed 22 October 2020]. https://www.nps.gov/articles/coastalplain.htm.

New Jersey Department of Environmental Protection (NJDEP). 2021. 1930s Aerial Photography of New Jersey. [accessed 2021 Sept 28]. https://img.nj.gov/imagerywms/BlackWhite1930.

New Jersey Historic Preservation Office (NJHPO). 2000. Guidelines for Preparing Cultural Resources Management Archaeological Reports Submitted to the Historic Preservation Office.

NJHPO. 2008. Guidelines for Phase I Archaeological Investigations: Identification of Archaeological Resources.

NJHPO. 2020. New Jersey and National Registers of Historic Places: Atlantic County. New Jersey Historic Preservation Office; [Updated June 25, 2020].

Pagoulatos P. 2003. Early Archaic settlement patterns of New Jersey. Archaeol. East. N. Am. 31(2003):15-43.

Pagoulatos P. 2004. Paleoindian site location in New Jersey. Archaeol. East. N. Am. 32(2004):123-149.

Parsons, F.W., ed. 1928. New Jersey Life, Industries and Resources of a Great State. New Jersey State Chamber of Commerce. Newark, New Jersey.

Polistina, V. 2002. *Egg Harbor Township Master Plan*. Prepared by Mott, Polistina & Associates, LLC. Egg Harbor Township, NJ.

Salter, E. 1890. History of Monmouth and Ocean Counties. E. Gardner & Son, Bayonne, New Jersey.

Sanborn Fire Insurance Map. 1886/1891/1903 editions. Egg Harbor City, NJ. Sanborn Fire Insurance Map Company, New York, NY. [accessed 22 October 2020]. https://www.loc.gov/collections/sanborn-maps/?fa=location:new+jersey%7Clocation:atlantic+county.

Sanborn Fire Insurance Map. 1889/1890/1905/1921 editions. Manasquan, NJ. Sanborn Fire Insurance Map Company, New York, NY. [accessed 11 January 2021]. https://www.loc.gov/collections/sanborn-maps/?q=Manasquan,+NJ.+Sanborn+Fire+Insurance+Map.

Sanborn Fire Insurance Map. 1890/1905 editions. Sea Girt, NJ. Sanborn Fire Insurance Map Company, New York, NY. [accessed 11 January 2021]. https://www.loc.gov/collections/sanborn-maps/?q=Sea+Girt,+NJ.+Sanborn+Fire+Insurance+Map.

Sanborn Fire Insurance Map. 1906/1921/1943 editions. Atlantic City, NJ. Sanborn Fire Insurance Map Company, New York, NY. [accessed 22 October 2020]. https://www.loc.gov/collections/sanborn-maps/?fa=location:new+jersey%7Clocation:atlantic+county.

Sanborn Fire Insurance Map. 1906/1911/1924 editions. Pleasantville, NJ. Sanborn Fire Insurance Map Company, New York, NY. [accessed 22 October 2020]. https://www.loc.gov/collections/sanborn-maps/?fa=location:new+jersey%7Clocation:atlantic+county.

Sanborn Fire Insurance Map. 1930 edition. Wall Township, NJ. Sanborn Fire Insurance Map Company, New York, NY. [accessed 11 January 2021]. https://www.loc.gov/collections/sanborn-maps/?q=Wall+Township,+NJ.+Sanborn+Fire+Insurance+Map.

Schrabisch M. 1915. Indian habitations in Sussex County in New Jersey. Union Hill, NJ: Dispatch Printing Company. Geological Survey of New Jersey. Bulletin 13.

Schrabisch M. 1917. Archaeology of Warren and Hunterdon Counties. Trenton, NJ: MacCrellish & Quigley Co. Department of Conservation and Development. Bulletin 18.

Spier L. 1915. Indian remains near Plainfield, Union Co., and along the Lower Delaware Valley. Union Hill, NJ: Dispatch Printing Company. Geological Survey of New Jersey. Bulletin 13.

Stanford, D.J., and B.A. Bradley. 2012. Across Atlantic ice: the origin of America's Clovis culture. Berkeley, CA: University of California Press.

Stanzeski AJ. 1996. Agate Basin and Dalton in a new home: 28 BU 214 in New Jersey. Archaeol East N. Am. 24(1996):59-79.

Stanzeski A. 1998. Four Paleoindian and early Archaic sites in southern New Jersey. Archaeol. East. N. Am. 26(1998):41-53.

Stanzeski AJ. 2005. Atlantic City site 28AT105: a Paleoindian site on the present day coast of New Jersey. Archaeol. East. N. Am. 33(2005):57-77.

Stewart, R. M., K. W. Carr, and P. A. Raber. 2015. *The Nature and Pace of Change in American Indian Cultures, Pennsylvania, 4000 to 3000 B.P.* Pennsylvania State University Press, State College.

Tuck JA. 1978. Regional cultural development 3000 to 300 B.C. In: Smithsonian Handbook of North American Indians. Washington, D.C.: Smithsonian Institution Press. Vol 15 Northeast, p. 28-43.

United States Geological Survey (USGS). 1890. Great Egg Harbor, NJ. Topographic Quadrangle Map. 1:62,500-scale. Washington, D.C.: USGS; [accessed 22 October, 2020]. https://ngmdb.usgs.gov/topoview/

USGS. 1893. Great Egg Harbor, NJ. Topographic Quadrangle Map. 1:62,500-scale. Washington, D.C.: USGS; [accessed 22 October 2020]. https://ngmdb.usgs.gov/topoview/.

USGS. 1894. Atlantic City, NJ. Topographic Quadrangle Map. 1:62,500-scale. Washington, D.C.: USGS; [accessed 22 October 2020]. https://ngmdb.usgs.gov/topoview/.

USGS. 1901. Asbury Park, NJ. Topographic Quadrangle Map. 1:62,500-scale. Washington, D.C.: USGS; [accessed 11 January 2021]. https://ngmdb.usgs.gov/topoview/.

USGS. 1918. Great Egg Harbor, NJ. Topographic Quadrangle Map. 1:62,500-scale. Washington, D.C.: USGS; [accessed 22 October 2020]. https://ngmdb.usgs.gov/topoview/ .

USGS. 1941. Atlantic City, NJ. Topographic Quadrangle Map. 1:62,500-scale. Washington, D.C.: USGS; [accessed 22 October 2020]. https://ngmdb.usgs.gov/topoview/ .

USGS. 1943. Pleasantville, NJ. Topographic Quadrangle Map. 1:62,500-scale. Washington, D.C.: USGS; [accessed 22 October 2020]. https://ngmdb.usgs.gov/topoview/ .

USGS. 1953. Point Pleasant, NJ. Topographic Quadrangle Map. 1:24,000-scale. Washington, D.C.: USGS; [accessed 11 January 2021]. https://ngmdb.usgs.gov/topoview/ .

USGS. 1954. Asbury Park, NJ. Topographic Quadrangle Map. 1:24,000-scale. Washington, D.C.: USGS; [accessed 11 January 2021]. https://ngmdb.usgs.gov/topoview/ .

USGS. 1954. Lakewood, NJ. Topographic Quadrangle Map. 1:24,000-scale. Washington, D.C.: USGS; [accessed 11 January 2021]. https://ngmdb.usgs.gov/topoview/ .

USGS. 1954. Farmingdale, NJ. Topographic Quadrangle Map. 1:24,000-scale. Washington, D.C.: USGS; [accessed 11 January 2021]. https://ngmdb.usgs.gov/topoview/ .

Veit R, Lattanzi GD, Bello CA. 2004. More precious than gold: a preliminary study of the varieties and distribution of pre-contact copper artifacts in New Jersey. Archaeol. East. N. Am. 32(2004):73-88.

Willis LLT, editor. 1915. Early history of Atlantic County New Jersey: record of the first year's work of Atlantic County's historical society. Kutztown, PA: Kutztown Publishing Company.

Wilson, C.W., Jr. 1974. Allaire Village. National Register of Historic Places Registration Form. National Park Service, U.S. Department of the Interior, Washington, D.C.

Wiser, S. and E. Walberg. 2008. *Comprehensive Master Plan Update, City of Pleasantville, Atlantic County, N.J.* Remington, Vernick & Walberg Engineers, Pleasantville, NJ.

Wolverton, C. 1889. Atlas of Monmouth County, "Howell Township." Chester Wolverton, New York, New York.

6.3 Marine Archaeological Resources

Atlantic Shores Offshore Wind, LLC (ASOW). 2020. Marine High-Resolution Geophysical Survey Plan. Submitted to Bureau of Ocean Energy Management, January 8, 2020; revised version submitted February 24, 2020.

Buchholz MT. 2004. New Jersey Shipwrecks: 350 Years in the Graveyard of the Atlantic. Down the Shore Publishing, Harvey Cedars, New Jersey.

Bureau of Ocean Energy Management (BOEM). 2013. 2013 Shipwreck Database. Atlantic Ocean, Outer Continental Shelf Region.

Cathie. 2020. Atlantic Shore Offshore Wind Farm Geotechnical Interpretive Report, Doc. No.C1193-R07.

Duncan, C. S., J. A. Goff, J. A. Austin, C. S. Fulthorpe, 2000. Tracking the last sea-level cycle: seafloor morphology and shallow stratigraphy of the latest Quaternary New Jersey middle continental shelf. Marine Geology, Volume 170, Issues 3–4, Pages 395-421, ISSN 0025-3227. [accessed 18 January, 2021]. https://doi.org/10.1016/S0025-3227(00)00082-7. http://www.sciencedirect.com/science/article/pii/S0025322700000827.

Emery K and Edwards RL. 1966. Archaeological Potential of the Atlantic Continental Shelf. American Antiquity 31:733-737.

R.C. Goodwin & Associates, Inc. (RCG&A). 2021a. Atlantic Shores Offshore Wind Project (Project Area) – Geoarchaeological Analyses. Technical Memorandum prepared for EDR, Inc.

RCG&A. 2021b. Marine Archaeological Resource Sensitivity Assessment - Geological and Cultural Contexts. Technical Memorandum prepared for EDR, Inc.

Marshall SB. 1982. Aboriginal Settlement in New Jersey During the Paleo-Indian Period, ca. 10,000 B.C. to 6,000 B. C. Electronic document. [accessed 18 May 2020]. https://www.nj.gov/dep/hpo/1identify/pg_10_AborigianalSettleNJMarshall.pdf#:~:text=ABORIGINAL%20SETTLEMENT%20IN%20NEW%20JERSEY%20DURING%20THE%20PALEO-INDIAN,and%20discuss%20Paleo-Indian%20site%20distribution,%20preservation,%20and%20protection.

National Oceanographic and Atmospheric Administration (NOAA/NOS). 1985. Bathymetric Chart of the Northeastern United States (Chart #BR1PT1). Electronic image. [accessed 14 July 2020]. https://historicalcharts.noaa.gov/historicals/search.

2000. Approaches to New York (Nautical Chart #12300). National Ocean Survey. Electronic image. [accessed 13 July 2020]. https://historicalcharts.noaa.gov/historicals/search.

2018. Automated Shipwreck and Obstruction Information System (AWOIS): Section 5. Office of Coast Survey. [accessed 18 January 2021]. https://www.nauticalcharts.noaa.gov/index.html.

2020. Little Egg Inlet to Hereford Inlet (Chart #12318). NOAA Office of Coast Survey. Electronic Image. [accessed 18 January 2021]. https://charts.noaa.gov/OnLineViewer/12318.shtml.

(n.d.). Historical Map and Chart Collection. Office of Coast Survey. [accessed 18 January 2021]. https://historicalcharts.noaa.gov/historicals/search.

Pearson, C.E, S.R. James, Jr, M.C. Krivor, S.D. El Darragi, and L. Cunningham. 2003. Refining and Revising the Gulf of Mexico Outer Continental Shelf Region High-Probability Model for Historic Shipwrecks: Final report. Volume I: Executive Summary. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2003-060, 13 pp, 3 volumes.

Smith PC. 1996. Nearshore Ridges and Underlying Upper Pleistocene Sediments of the Inner Continental Shelf of New Jersey. Unpublished Master's thesis, Department of Geological Sciences, Rutgers University, New Brunswick, New Jersey.

TerraSond. 2020. TerraSond, Geophysical and Geohazard Survey, Atlantic Shores Wind, LLC. Project no. 2019-054.

TeraSond. 2020. TerraSond, Archaeological Assessment, Atlantic Shores Wind, LLC. Project No. 2019-054.

Tiemann, Frank J. n.d. A History of South Atlantic City and the Early Days of Margate. The Margate Historical Society and Museum. Margate Public Library

TRC Environment Corporation (TRC). 2012. *Inventory and Analysis of Archaeological Site Occurrence on the Atlantic Outer Continental Shelf*. OCS Study, BOEM 2012-008 [accessed 18 January 2021].https://espis.boem.gov/final%20reports/5196.pdf.

Uchupi, E., N. Driscoll, R.D. Ballard, and S.T. Bolmer. 2001 Drainage of late Wisconsin glacial lakes and the morphology and late quaternary stratigraphy of the New Jersey – southern New England continental shelf and slope. In Marine Geology 172, pp. 117-145.

7.1 Demographics, Employment, and Economics

NOAA Office For Coastal Management. 2020. *Economics: National Ocean Watch*. [accessed 14 October 2020]. https://coast.noaa.gov/digitalcoast/data/enow.html.

U.S. Bureau of Economic Analysis. 2017-2018. Regional Data, GDP & Personal Income, Tables CAGDP1 and SQGDP9. [accessed 14 October 2020]. https://apps.bea.gov/iTable/index_regional.cfm.

U.S. Census Bureau. 2000 & 2010. Decennial Census. Total Population, Table P001. [accessed 14 October 2020]. https://data.census.gov/cedsci/.

U.S. Census Bureau. 2010. U.S. Census Bureau QuickFacts. Population Density and Land Area (Sq. Mi.). [accessed 14 October 2020]. https://data.census.gov/cedsci/.

U.S. Census Bureau. 2017. American Community Survey Supplemental Estimates. Industry for the Civilian Employed Population 16 Years and Over, Table K202403. [accessed 14 October 2020]. https://data.census.gov/cedsci/.

U.S. Census Bureau. 2017-2018. American Community Survey 5-year Estimates. Per Capita Income, Table DP03. [accessed 14 October 2020]. https://data.census.gov/cedsci/.

U.S. Census Bureau. 2018. American Community Survey 5-year Estimates. Population, Age and Sex, Table S0101. [accessed 14 October 2020]. https://data.census.gov/cedsci/.

U.S. Census Bureau. 2018. American Community Survey 5-year Estimates. Labor Force and Employment, Table S2301. [accessed 14 October 2020]. https://data.census.gov/cedsci/.

U.S. Census Bureau. 2018. American Community Survey 5-year Estimates. Selected Housing Characteristics, Table DP03. [accessed 14 October 2020]. https://data.census.gov/cedsci/.

U.S. Census Bureau. 2018. American Community Survey 5-year Estimates. Vacant Status, Table B25004. [accessed October 2020]. https://data.census.gov/cedsci/.

U.S. Census Bureau. 2018. American Community Survey 5-year Estimates. Owner-Occupied Housing Units Value, Table B25075. [accessed 14 October 2020]. https://data.census.gov/cedsci/.

7.2 Environmental Justice

Council on Environmental Quality, 1997. Environmental Justice Guidance Under the National Environmental Policy Act. [accessed 14 October 2020]. https://ceq.doe.gov/docs/ceq-regulations-and-guidance/regs/ej/justice.pdf.

Environmental Protection Agency, 2015. Guidance on Considering Environmental Justice During the Development Of Regulatory Actions. [accessed 14 October 2020]. https://www.epa.gov/sites/production/files/2015-06/documents/considering-ej-in-rulemaking-guide-final.pdf.

New York City Council. Local Law 2017/060: Identifying and addressing environmental justice issues. (2017). [accessed 2 November 2020]. https://legistar.council.nyc.gov/LegislationDetail.aspx?ID=1805815&GUID=8901A89B-078E-4D47-88D8-EA3E48E715A1&Options=ID|Text|&Search=.

New York City Department of Health. 2020. Environment & Health Data Portal. [accessed 2 November 2020]. http://a816-dohbesp.nyc.gov/IndicatorPublic/publictracking.aspx.

New York State Department of Environmental Conservation. (2003). Commissioner Policy 29, Environmental Justice and Permitting. [accessed 2 November 2020]. https://www.dec.ny.gov/regulations/36951.html.

New York State Department of Environmental Conservation. 2020. Maps & Geospatial Information System (GIS) Tools for Environmental Justice. [accessed 2 November 2020]. https://www.dec.ny.gov/public/911.html.

State Of New Jersey 219th Legislature. New Jersey Senate, No. 232 (2020). [accessed 14 October 2020]. https://www.njleg.state.nj.us/bills/BillView.asp?BillNumber=S232.

United States Environmental Protection Agency. 2019. EJSCREEN: Environmental Justice Screening and Mapping Tool, EJSCREEN Data. [accessed 2 November 2020]. https://www.epa.gov/ejscreen/download-ejscreen-data.

7.3 Recreation and Tourism

Carr-Harris, Andrew and Corey Lang. 2019. Sustainability and tourism: the effect of the United States' first offshore wind farm on the vacation rental mark. Resource and Energy Economics, Volume 57, August 2019, Pages 51-67.

Global Insight. 2008. An Assessment of the Potential Coasts and Benefits of Offshore Wind Turbines, A Report for the State of New Jersey. Global Insight Travel & Tourism. September 2008. pp. 102.

ICF Incorporated, L.L.C. 2012. Atlantic Region Wind Energy Development: Recreation and Tourism Economic Baseline Development. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA. OCS Study BOEM 2012-085, 35 pp.

Lieberman Research Group. 2006. New Jersey Shore Opinions About Off-Shore Wind Turbines. Presentation to the New Jersey Commerce, Economic Growth & Tourism Commission and

Brushfire, Inc. [published September 14, 2006; accessed 3 February 2021]. http://www.njcleanenergy.com/files/file/document.pdf.

Marine Trades Association of New Jersey. 2008. Recreational Boating in New Jersey: An Economic Impact Analysis. Prepared by HDR for the MTA NJ. [published April 2008; accessed 3 February 2021]. https://www.mtanj.org/ecoimpact.html.

National Oceanic and Atmospheric Administration (NOAA). 2019. Fisheries Office of Science and Technology, Commercial Landings Query. [accessed 18 June 2020]. https://foss.nmfs.noaa.gov/apexfoss/f?p=215:200.

[NOAA MRIP] National Oceanic and Atmospheric Administration Marine Recreational Information Program. 2017. Recreational Fishing Data and Statistics Queries. [accessed November 2020]. https://www.st.nmfs.noaa.gov/recreational-fisheries/data-and-documentation/queries/index.

NJ Department of Environmental Protection (NJDEP). 2021. State, Local and Nonprofit Open Space of New Jersey (Land_owner_openspace). Edition 20200729. [published January 19, 2021, accessed 3 February 2021]. https://njogis-newjersey.opendata.arcgis.com/datasets/4a1f9d3075a04cd792a14f78b9697df3_65

New Jersey Board of Public Utilities (NJBPU) and the Interagency Taskforce on Offshore Wind, 2020. New Jersey Offshore Wind Strategic Plan (DRAFT July 2020). Prepared by Ramboll U.S. Corporation, Princeton, NJ.

Parsons, G. Firestone, J., 2018. Atlantic Offshore Wind Energy Development: Values and Implications for Recreation and Tourism. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2018-013. 52 p.

Parson, George, Jeremy Firestone, Lingxiao Yan, and Jenna Toussaint, 2020. The effect of offshore wind power projects on recreational beach use on the east coast of the United States: Evidence from contingent-behavior data. Published in Energy Policy, Volume 144, September 2020, 111659.

Tourism Economics. 2018. Economic Impact of Tourism in New Jersey, 2017. Prepared for the State of New Jersey. [published January 2018; accessed November 2020]. https://www.visitnj.org/sites/default/files/2017-nj-economic-impact.pdf.

7.4 Commercial Fisheries and For-Hire Recreational Fishing

Azavea. 2020. Fishing route analytics report. Report prepared for Last Tow, LLC. February 3, 2020.

Benjamin S, Lee MY, DePiper G. 2018. Visualizing Fishing Data as Rasters. Woods Hole (MA): Northeast Fisheries Sciences Center. Ref Doc 18-12. [published December 2018; accessed 15 October 2020]. https://repository.library.noaa.gov/view/noaa/23030.

[BOEM] Bureau of Ocean Energy Management. 2020. Vineyard Wind 1 Offshore Wind Energy Project Supplement to the Draft Environmental Impact Statement. OCS EIS/EA BOEM 2020-025. [published June 2020; accessed 22 October 2020]. https://www.boem.gov/sites/default/files/documents/renewable-energy/Vineyard-Wind-1-Supplement-to-EIS.pdf.

DePiper GS. 2014. Statistically assessing the precision of self-reported VTR fishing locations. Woods Hole (MA): Northeast Fisheries Sciences Center. NOAA Technical Memorandum NMFS-NE-229. [published June 2014; accessed 31 August 2020]. http://doi.org/10.7289/V53F4MJN

Fontenault J. 2018. Vessel Monitoring Systems (VMS) commercial fishing density Northeast and Mid-Atlantic Regions. [published April 2018; accessed 15 September 2020]. https://www.northeastoceandata.org/files/metadata/Themes/CommercialFishing/VMSCommercialFishingDensity.pdf

[GSSA] Garden State Seafood Association. Gillnet Fishing. Cape May (NJ): New Jersey Fishing Sponsored by the Garden State Seafood Association. [accessed 24 February 2021]. https://www.fishingnj.org/techgn.htm#:~:text=Species%20sought%20by%20gillnetters%20in,and%20chips%22)%20and%20shad.

Hutt CP, Silva G. 2015. The economics of Atlantic highly migratory species for-hire fishing trips, July-November 2013. National Oceanic and Atmospheric Administration Technical Memorandum. NMFS-OSF-4. [published November 2015; accessed 31 January 2021]. https://repository.library.noaa.gov/view/noaa/9064.

Hoffman EE, Powell EN, Klinck JN, Munrow DM, Mann R, Haidvogel DB, Narvael, DA, Zhang X, Kuykendall, KM. 2018. An Overview of factors affecting distribution of the Atlantic surfclam (*Spisula solidissima*), a continental shelf biomass dominant, During a Period of Climate Change. Journal of Shellfish Research, 37(4):821-831. [published October 2018; accessed February 2020]. http://www.bioone.org/doi/full/10.2983/035.037.0412.

Kirkpatrick AJ, Benjamin S, DePiper G, Murphy T, Steinbeck S, Demarest C. 2017. Socio-Economic impact of outer continental shelf wind energy development on fisheries in the U.S. Atlantic. OCS Study BOEM 2017-012. Prepared under BOEM Interagency Agreement No: M12PG00028 by National Oceanic and Atmospheric Administration National Marine Fisheries Service Northeast [published February 2017; accessed 15 September 2020]. https://espis.boem.gov/final%20reports/5580.pdf.

[MARCO] Mid-Atlantic Regional Council on the Ocean. 2016. Mid-Atlantic Ocean Data Portal. Williamsburg (VA). [accessed 1 December 2020]. https://portal.midatlanticocean.org/.

[NOAA] National Oceanic and Atmospheric Administration, Northeast Fisheries Science Center. 2014. Snapshots of human communities and fisheries in the Northeast. [accessed 2021 September 6]. https://apps-nefsc.fisheries.noaa.gov/read/socialsci/communitySnapshots.php.

New Jersey Department of Agriculture. New Jersey fishing and aquaculture: harvesting the Garden State's waters. [accessed 1 December 2020]. https://www.jerseyseafood.nj.gov/seafoodreport.pdf.

[NMFS] National Marine Fisheries Service. 2020. Atlantic Shores Wind Summary [dataset]. Report prepared for Atlantic Shores. 27 August 2020.

[NMFS] National Marine Fisheries Service. 2021a. Descriptions of Selected Fishery Landings and Estimates of Vessel Revenue from Areas: A Planning-level Assessment. [published March 10; accessed 14 March 2021]. https://www.greateratlantic.fisheries.noaa.gov/ro/fso/reports/WIND/WIND_AREA_REPORTS/Atlantic_Shores_Wind.html.

[NMFS] National Marine Fisheries Service. 2021b. Descriptions of Selected Fishery Landings and Estimates of Recreational Party and Charter Vessel Revenue from Areas: A Planning-level Assessment. [published July 6; accessed 1 September 2021]. https://www.greateratlantic.fisheries.noaa.gov/ro/fso/reports/WIND/WIND_AREA_REPORTS/party_charter_reports/Atlantic_Shores_Wind_rec.html

[NOAA] National Oceanic and Atmospheric Administration. 2020. Annual commercial landings statistics [dataset]. [accessed 1 December 2020]. https://www.fisheries.noaa.gov/foss.

[NOAA MRIP] National Oceanic and Atmospheric Administration Marine Recreational Information Program. 2017. Recreational Fishing Data and Statistics Queries. [accessed 19 November 2020]. https://www.st.nmfs.noaa.gov/recreational-fisheries/data-and-documentation/queries/index.

Rutgers University. 2023. Surfclam Fishing and Windfarms in the Future Ocean. Clam Forecast Project Data Summary. [published February 2023]. SUBCOM. 2019. Coastal Consistency Review Application – HAVFRUE Cable System Project. [published June 2019; accessed 24 February 2021]. https://www.dos.ny.gov/opd/programs/pdfs/Consistency/F-2019-0606_ApplicationForPN.pdf.

[USCG] U. S. Coast Guard. 2020. The Areas Offshore of Massachusetts and Rhode Island Port Access Route Study. Final Report, 14 May 2020. USCG-2019-0131.

7.5 Land Use and Coastal Infrastructure

N/A.

7.6 Navigation and Vessel Traffic

[BWEA] British Wind Energy Association. (2007). Investigation of Technical and Operational Effects on Marine Radar Close to Kentish Flats Offshore Wind Farm.

Azavea. (2020). Fishing Route Analytics Report. Report prepared for Last Tow, LLC. February 3.

U.S. Coast Guard (2015). The Atlantic Coast Port Access Route Study. Final Report, 08 July 2015. USCG-2011-0351.

U.S. Coast Guard. (2020). The Areas Offshore of Massachusetts and Rhode Island Port Access Route Study. Final Report, 14 May 2020. USCG-2019-0131.

7.7 Other Marine Uses and Military Activities

[BOEM] Bureau of Ocean Energy Management. 2012. Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New Jersey, Delaware, Maryland, and Virginia- Final Environmental Assessment. OCS EIS/EA BOEM 2012-003.

BOEM. 2017. Munitions and Explosives of Concern Survey Methodology and In-field Testing for Wind Energy Areas on the Atlantic Outer Continental Shelf. U.S. Department of Interior, Bureau of Ocean Energy Management. Sterling, Virginia.

BOEM. 2020a. Atlantic Outer Continental Shelf Aliquots with Sand Resources [dataset]. Sterling, (VA): U.S. Department of Interior, Bureau of Ocean Energy Management, Marine Minerals Program; [published 2020 February 19; accessed 1 December 2020]. https://www.marinecadastre.gov/data/.

BOEM. 2020b. Federal Outer Continental Shelf (OCS) Sand and Gravel Borrow Areas (Lease Areas). [dataset]. Sterling, (VA): U.S. Department of Interior, Bureau of Ocean Energy Management, Marine Minerals Program; [published 2020 February 19; accessed 1 December 2020]. https://www.marinecadastre.gov/data/.

Celestino M, Pyle J, Barry L, Hinks G. 2014. NJ Fisheries Surveys: Signals from our Research. Trenton (NJ): New Jersey Fish and Wildlife; [accessed 2020 December 1]; https://www.njfishandwildlife.com/pdf/2014/digmar6-11.pdf.

Commander, Navy Installations Command Notification (CNICN) [date unknown]. Mission Statement. [accessed 1 December 2020]. https://www.cnic.navy.mil/regions/cnrma/installations/nws_earle/about/mission_and_vision.html.

Department of Homeland Security. 2017. Station Manasquan [Squan] Beach, New Jersey. [accessed 1 December 2020]. https://media.defense.gov/2017/Jul/04/2001772994/-1/-1/0/SQUANBEACH.PDF.

Environmental Protection Agency (EPA). 2020. Ocean Disposal Site Designation. Washington D.C.: EPA Ocean Dumping Management Program; [updated 2020 September 11; accessed 1 December 2020]. https://www.epa.gov/ocean-dumping/ocean-disposal-site-designation.

[GOANG] Go Air National Guard. 2020. Atlantic City Air National Guard Base. [accessed 1 December 2020] https://www.goang.com/locations/new-jersey/atlantic-city-air-national-guard-base.html.

Joint Base McGuire-Dix-Lakehurst [date unknown]. About Us. [accessed 1 December 2020]. https://www.jbmdl.jb.mil/About-Us/About-Us/.

Secretary of Defense. 2003. Report of the Defense Science Board Task Force on Unexploded Ordnance. Washington D.C: Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics; 20301-3140.

National Guard. 2020. Joint Operations Center coordinates NJ COVID-19 response. [published 27 April 2020; accessed 30 November 2020]. https://www.nationalguard.mil/News/Article/2165762/joint-operations-center-coordinates-nj-covid-19-response/.

[NAWCAD] Naval Air Warfare Center Air Division [date unknown]. NAWCAD Lakehurst. [accessed 1 December 2020]. https://www.navair.navy.mil/lakehurst/.

[NEFSC] Northeast Fisheries Science Center. 2020. 2019 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic Ocean - AMAPPS II. Woods Hole (MA): NEFSC.

New Jersey Department of Military and Veterans Affairs. 2020. National Guard Training Center. Trenton (NJ); [accessed 30 November 2020]. https://www.nj.gov/military/admin/departments/ngtc/.

[NOAA] National Oceanic and Atmospheric Administration. 2015. North American Submarine Cable Association Submarine Cables. [dataset]. Charleston (SC): NOAA Office of Coastal Management; [published 2015 August; accessed 1 December 2020]. https://www.marinecadastre.gov/data/.

NOAA. 2018a. Unexploded Ordinances. [dataset]. Charleston (SC): NOAA Office for Coastal Management; [published 2018 December 12; accessed 2020 December 1]. https://marinecadastre.gov/data/.

NOAA. 2018b. Ocean Disposal Sites. [dataset]. Charleston (SC): NOAA Office for Coastal Management; [published 2018 October 31; accessed 1 December 2020]. https://www.fisheries.noaa.gov/inport/item/54193.

NOAA. 2018c. NOAA Charted Submarine Cables. [dataset]. Charleston (SC): NOAA Office of Coastal Management; [published 2018 May 1; accessed 1 December 2020]. https://marinecadastre.gov/data/.

NOAA. 2019. Military Operating Area Boundary. [dataset]. Charleston (SC): NOAA Office of Coastal Management; [published 2019 February 2; accessed 1 December 2020]. https://www.marinecadastre.gov/data/.

NOAA. 2020. Beach Nourishment Projects. [dataset]. Charleston (SC): NOAA Office of Coastal Management; [published 2020 June 23; accessed 1 December 2020]. https://marinecadastre.gov/data/.

United States Army. 2019. About Picatinny. [updated 2020 March 19; accessed 1 December 2020]. https://www.pica.army.mil/Picatinny/about/default.aspx.

[USGS] Station Manasquan [Squan] Beach, New Jersey [date unknown (a)]. [1 December 2020]. https://media.defense.gov/2017/Jul/04/2001772994/-1/-1/0/SQUANBEACH.PDF.

[USCG] United States Coast Guard. Atlantic City, New Jersey [date unknown (b)]. [1 December 2020]. https://www.atlanticarea.uscg.mil/Our-Organization/District-5/District-Units/Air-Station-Atlantic-City/Missions/.

[USGS] United States Coast Guard: Mission [date unknown(c)]. [accessed 2020 December 1]. https://www.mycg.uscg.mil/Missions/#:~:text=The%20mission%20of%20the%20United,maritime%20safety%2C%20security%20and%20stewardship.

[USGS] Training Center Cape May [date unknown (d)]. [accessed 1 December 2020]. https://www.forcecom.uscg.mil/Our-Organization/FORCECOM-UNITS/TraCen-Cape-May/.

[USGS] Station Ocean City, Maryland [date unknown (e)]. [accessed 1 December 2020]. https://media.defense.gov/2017/Jul/04/2001772874/-1/-1/0/OCEANCITYMD.PDF.

[USGS] United States Geological Survey 2007. United States Coast Guard (USCG) Units. [dataset]. USGS Logistics Geospatial Integration Center; [published 10 January 2007; 1 December 2020]. https://www.sciencebase.gov/catalog/item/4f4e4783e4b07f02db483873.

United States Navy. Mission and Vision [date unknown]. [accessed 2020 November]. https://www.cnic.navy.mil/regions/cnrma/installations/nws_earle/about/mission_and_vision.html.

7.8 Aviation and Radar

Federal Aviation Administration (FAA). 2011. Aeronautical Information Manual, Section 5. Surveillance Systems. [accessed 23 March 2021]. https://tfmlearning.faa.gov/Publications/atpubs/AIM/Chap4/aim0405.html.

FAA. 2016. United States Standard for Performance Based Navigation (PBN) Instrument Procedure Design. AFS-400 8260.58A. [published March 2016; accessed 13 August 2020]. https://www.faa.gov/documentLibrary/media/Order/FAA_Order_8260.58A_Including_Change_1_and_2.pdf.

FAA. 2018a. Obstruction Evaluation/Airport Airspace Analysis Desk Reference Guide. IOE/AAA V_2018 2.0. [published 2020; accessed 23 March 2021].

https://oeaaa.faa.gov/oeaaa/downloads/external/content/deskReferenceGuides/Download%20Archives%20-%20Desk%20Reference%20Guide%20V_2018.2.0.pdf.

FAA. 2018b. United States Standard for Terminal Instrument Procedures (TERPS). AFS-400 8260.3DE. [published February 2018; accessed 2020 13 August 2020]. https://www.faa.gov/documentLibrary/media/Order/Order_8260.3D_vs3.pdf

FAA. 2019. Procedures for Handling Airspace Matters. AJV-O 7400.2M. [accessed 2021 23 March 2021]. https://www.faa.gov/air_traffic/publications/atpubs/pham_html/.

FAA. 2020. Advisory Circular: Obstruction Marking and Lighting. AJV-P13 AC 70/7460-1M. [published November 2020; accessed 23 March 2021]. https://www.faa.gov/documentLibrary/media/Advisory_Circular/Advisory_Circular_70_7460_1M.pdf

FAA. 2021a. Aeronautical Data. National Airspace System Resource (NASR). [accessed 23 March 2021]. https://www.faa.gov/air_traffic/flight_info/aeronav/Aero_Data/#:~:text=The%20Aeronautical%20Data%20Team%20is%20responsible%20for%20the,and%20status%20of%20all%20components%20of%20the%20NAS

FAA. 2021b. Airport Airspace Analysis. [accessed 23 March 2021]. https://www.faa.gov/airports/engineering/airspace_analysis/.

FAA. 2021c. U.S. Terminal Procedures Publication. [accessed 23 March 2021]. https://www.faa.gov/air_traffic/flight_info/aeronav/digital_products/dtpp/.

14 C.F.R. §77.9. 2010. Safe, Efficient Use, and Preservation of the Navigable Airspace. FR 35 (139), 42296-42308. [published July 2010; accessed 23 March 2021]. https://www.govinfo.gov/content/pkg/FR-2010-07-21/pdf/2010-17767.pdf.

7.9 Onshore Transportation and Traffic

N/A.

8.0 Onshore Transportation, Traffic, and Noise

[EPA] Environmental Protection Agency. 1971 Noise From Construction Equipment and Operations, Building Equipment, and Home Appliances". US Environmental Protection Agency Office of Noise Abatement and Control; prepared by Bolt, Beranek, and Newman, December 31, 1971.

Bellman, M.A., A. May, T. Wendt, S. Gerlach, P. Remmers, and J. Brinkmann. 2020. Underwater noise during percussive pile driving: Influencing factors on pile-driving noise and technical possibilities to comply with noise mitigation values. Report edited by the itap GmbH for the

Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie) and supported by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit).

Pile Dynamics, Inc. 2010. GRLWEAP. [accessed January 2021]. https://www.pile.com/.

9.0 Public Health and Safety

[BOEM] Bureau of Ocean Energy Management. 2012. Commercial Wind Lease Issuance and Site Characterization Activities on the Atlantic Outer Continental Shelf Offshore New Jersey, Delaware, Maryland, and Virginia Final Environmental Assessment. OCS Study BOEM 2012-003. U.S. Department of the Interior, Bureau of Ocean Energy Management, Herndon, VA. 366 pp. [published January 2012; accessed January 2021] https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Mid-Atlantic-Final-EA-2012.pdf.

Bureau of Transportation Statistics. 2020. Petroleum oil spills impacting navigable U.S. waterways. [accessed January 2021]. https://www.bts.gov/content/petroleum-oil-spills-impacting-navigable-us-waters.

11.0 LIST OF PREPARERS

The key preparers of and contributors to the Atlantic Shores Construction and Operations Plan (COP) are listed in Table 11-1.

Table 11-1 List of Preparers

Company Name	Role/Resources
Atlantic Shores Offshore Wind, LLC	Project Development
Environmental Design & Research, Landscape Architecture, Engineering & Environmental Services, D.P.C. (EDR)	COP Development and Production Volume I Project Description Volume II Affected Environment: Benthic Resources, Physical Oceanography and Meteorology, Water Quality, Wetlands and Waterbodies, Coastal and Terrestrial Habitat and Fauna, Other Marine Uses and Military Activities, Coastal Zone Management Consistency, Marine Mammals, Sea Turtles, Birds, Recreation and Tourism, Visual Resources, Terrestrial Archaeology, Historic Properties, Marine Archaeology, Demographics, Employment and Economics, Environmental Justice
Epsilon Associates, Inc.	COP Development Volume I Project Description Volume II Affected Environment: Air Quality, Air Emissions, Geology, Benthic Resources and Report, Oil Spill Response Plan (OSRP), Physical Oceanography and Meteorology, Fisheries, Navigation and Vessel Traffic, Commercial Fisheries and For-Hire Recreational Fishing, Recreation and Tourism, Public Health and Safety, Underwater Noise, Marine Mammals, Sea Turtles, In-air Noise
Biodiversity Research Institute (BR)	Bird, Bats
Normandeau Associates, Inc.	Avian Survey Plan

Table 11-1 List of Preparers

Company Name	Role/Resources
W.F. Baird & Associates Coastal Engineers Ltd	Navigation and Vessel Traffic
Capital Airspace Group, Inc.	Aviation and Radar
Westslope Consulting	Radar
JASCO Applied Sciences (USA) Inc.	Underwater Noise, Hydroacoustic Modeling, Marine Mammals, Sea Turtles
RPS Group, Inc./Tetra Tech, Inc.	Sediment Dispersion Modeling, Benthic Resources, OSRP, Oil Spill Modeling Report
SNC-Lavalin Group, Inc.	Electric and Magnetic Fields (EMF)
Fugro	Geophysical and Geotechnical
CATHIE	Geophysical and Geotechnical
SEARCH, Inc.	Marine Archaeology