Empire Offshore Wind LLC

Empire Wind 1 Project

Article VII Application

Exhibit E-3
Underground Construction

June 2021

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ACRONYMS AND ABBREVIATIONS

ac	acre
BOEM	Bureau of Ocean Energy Management
EM&CP	Environmental Management & Construction Plan
Empire, the Applicant	Empire Offshore Wind LLC
EW 1	Empire Wind 1
ft	foot
ft/min	feet per minute
HDD	horizontal directional drilling
HVAC	high-voltage alternating-current
in	inch
in^2	square-inch
km	kilometer
kV	kilovolt
Lease Area	Bureau of Ocean Energy Management-designated Renewable Energy Lease Area OCS-A 0512
m	meter
m/min	meters per minute
mi	mile
mm	millimeter
mm^2	square millimeter
MLLW	Mean Lower Low Water
nm	nautical mile
NYISO	New York Independent System Operator, Inc.
NYSPSC or Commission	New York State Public Service Commission
O&M	operations and maintenance
OCS	Outer Continental Shelf
POI	Point of Interconnection at the Gowanus 345-kV Substation
Project	EW 1 Project transmission facilities in New York
PSL	New York Public Service Law
SBMT	South Brooklyn Marine Terminal
USACE	U.S. Army Corps of Engineers
UXO	unexploded ordnance
XLPE	cross-linked polyethylene

EXHIBIT E-3: UNDERGROUND CONSTRUCTION

E-3.1 Introduction

Empire Offshore Wind LLC (Empire, or the Applicant) proposes to construct and operate the Empire Wind 1 (EW 1) Project as one of two separate offshore wind projects to be located within the Bureau of Ocean Energy Management (BOEM) -designated Renewable Energy Lease Area OCS-A 0512 (Lease Area). The proposed transmission system for the EW 1 Project will connect the offshore wind farm to the point of interconnection (POI), and will include 230-kilovolt (kV) export and 345-kV interconnection lines traversing a total of approximately 17.5 miles (mi) (15.2 nautical miles [nm], 28.2 kilometers [km]) within the State of New York. An electric transmission line with a design capacity of 125 kV or more, extending a distance of one mile or more, is subject to review and approval by the New York State Public Service Commission (Commission or NYSPSC) as a major electric transmission facility. This application is being submitted to the Commission pursuant to Article VII of the New York Public Service Law (PSL) for the portions of the EW 1 Project transmission system that are located within the State of New York (collectively, the Project).

The Project will interconnect to the New York State Transmission System operated by the New York Independent System Operator, Inc. (NYISO) at the Gowanus 345-kV Substation (the point of interconnection, or POI). The Gowanus 345-kV Substation is owned by the Consolidated Edison Company of New York, Inc. (ConEdison). The Project's onshore facilities, including the onshore cable route, onshore substation, and the POI, are located entirely within Brooklyn, Kings County, New York.

The Article VII components of the EW 1 Project include:

- Two three-core 230-kV high-voltage alternating-current (HVAC) submarine export cables located within an approximately 15.1-nm (27.9-km)-long, submarine export cable corridor from the boundary of New York State waters 3 nm (5.6 km) offshore to the cable landfall in Brooklyn, New York;
- A 0.2-mi (0.3-km)-long onshore cable route and substation including:
  - Two three-core 230-kV HVAC EW 1 onshore export cables buried underground from the cable landfall either directly to the cable terminations or to a vault within the onshore substation;
  - An onshore substation located at the South Brooklyn Marine Terminal (SBMT), which will increase the voltage to 345 kV for the onshore interconnection cables; and
  - Two 345-kV cable circuits, each with three single-core HVAC onshore interconnection cables, buried underground from the onshore substation to the POI.

This Exhibit addresses the requirements of 16 New York Codes, Rules and Regulations § 88.3 for the Project facilities, including a description of the cable system to be used, applicable design standards and the number and size of conductors. The cable profile, including the cable depth and locations of vaults, is provided in **Exhibit 5: Design Drawings**.

E-3.2 Cable System Design

The submarine export cable corridor for the Project begins where the cable route crosses the state boundary 3 nm (3.5 mi, 5.6 km) offshore, which occurs approximately 3.4 nm (3.9 mi, 6.2 km) southeast of Rockaway Point at the southwestern corner of Long Island, and 4.8 nm (5.5 mi, 8.8 km) east of the tip of Sandy Hook in New

Jersey. From there, the submarine cable route travels northwest into Lower New York Bay, under the Verrazzano-Narrows Bridge between Brooklyn and Staten Island, and north to the cable landfall at SBMT in Brooklyn, New York, on the east side of Upper New York Bay. The length of the submarine export cable route in New York state waters is approximately 15.1 nm (17.3 mi, 27.9 km).

From the landfall at SBMT, the submarine export cables will be pulled directly into cable terminations or to a vault within the proposed onshore substation at SBMT. The proposed onshore substation will increase the voltage for interconnection into the existing Gowanus POI. From the proposed onshore substation, the onshore interconnection cable route is approximately 0.2 mi (0.3 km), travelling along 2nd Avenue to reach the Gowanus POI.

All of the Project's transmission facilities are located underground or underwater, with the exception of a short segment of export cable that will be located in an aboveground housing at the top of the bulkhead at the cable landfall.

The Project's transmission system, including the submarine export cables, onshore substation and onshore cables will be designed and installed to meet or exceed applicable industry standards and electrical codes, including but not limited to applicable standards of the:

- International Electrotechnical Commission;
- Insulated Cable Engineers Association;
- National Electric Safety Code;
- American National Standards Institute/Institute of Electrical and Electronics Engineers;
- International Council on Large Electric Systems;
- North America Electric Reliability Corporation;
- Northeast Power Coordinating Council;
- Reliability Rules of the New York State Reliability Council;
- Underwriters Laboratories;
- National Electrical Manufacturers Association; and
- National Fire Protection Association.

E-3.2.1 Submarine Export Cables

The submarine export cables will be HVAC. Each of the two HVAC submarine export cables will consist of 230-kV three-core solid dielectric cable with up to two integrated fiber optic cables. Each three-core 230-kV submarine export cable will measure a total of 11.8 inches (in) (300 millimeters [mm]) in outer diameter. **Figure E-3.2-1** provides a typical cross-section of a submarine export cable. A description of the onshore segment of the submarine export cables (i.e., EW 1 onshore export cables) is provided in Section E-3.2.2, and installation methods for the submarine export cables are described in Section E.3.3-1.

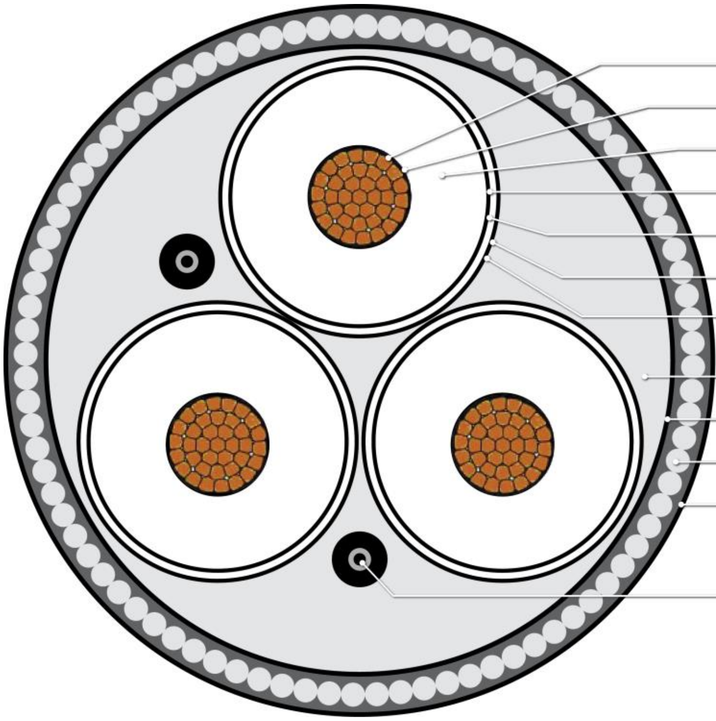

Figure E-3.2-1 Representative Cross-Section of Submarine Export Cable

E-3.2.1.1 Conductor Design

Each of the 3.1-square inch (in^2) (2,000 square millimeter [mm^2]) bundled copper power conductors will be within insulated power cores. The conductors will be made of stranded copper wires and will be protected against longitudinal water ingress by mean of a water-blocking compound, yarns, and/or tapes.

E-3.2.1.2 Insulation System

Copper conductors will be enclosed in cross-linked polyethylene (XLPE) insulation. The insulation system will be rated for 245 kV. The Applicant does not anticipate any oils or insulating fluid as part of the cable insulation system.

E-3.2.1.3 Longitudinal Water Barrier

The longitudinal water barrier will consist of water-blocking tapes to prevent longitudinal water ingress under the lead sheath.

E-3.2.1.4 Metal Sheath

The power cores will incorporate a lead sheath extruded over the longitudinal water barrier. The lead sheath will prevent radial water ingress into the power cores.

E-3.2.1.5 Semi-conductive Sheath

A semi-conductive polymeric sheath will be extruded over the lead sheath to act as a mechanical reinforcement and a corrosion protection for the metal sheath.

E-3.2.1.6 Fillers

The three insulated power cores will be helically laid in a trefoil formation, together with fiber optic element for communications and monitoring. Extruded polymeric fillers will be applied in the interstices to give a round shape to the bundle.

E-3.2.1.7 Armoring

An armoring package made of an armoring bedding and a layer of either steel or a combination of steel and polymeric armor wires flushed with bitumen will be applied over the bundle.

E-3.2.1.8 Outer Serving

An outer serving, which protects the sheath/armoring from corrosion, made of black polypropylene yarns will be applied over the armoring package. Colored polypropylene yarns will be applied helically over the outer serving; the cable will be marked at specified lengths every 0.62 mi (1 km), as well as every 328 feet (ft) (100 meters [m]) of the last kilometer.

E-3.2.2 EW 1 Onshore Export Cables

The EW 1 onshore export cables will consist of the onshore part of the submarine export cables and are not expected to differ from the submarine export cables. These cables will extend from the shoreline either directly to the cable terminations or to a vault within the onshore substation. Therefore, the EW 1 onshore export cable system for this segment of the Project route will be the same as the system described in Section E-3.2.1. Pending final routing, design and cable pulling analysis, if necessary, a vault/joint pit may be installed, and single core onshore cables would extend into the onshore substation past the vault.

E-3.2.3 Onshore Interconnection Cables

The interconnection between the onshore substation at SBMT and the Gowanus POI will consist of two 345-kV circuits. Each circuit will comprise three single-core XLPE solid dielectric cables. Each dielectric cable will be approximately 5.2 in. (132 mm) in outer diameter. **Figure E-3.2-2** provides a cross-section of the single-core onshore interconnection cable. Two separate fiber optic cables will be used for communication and temperature measurements and will be installed alongside the interconnection cables.

The onshore interconnection cables will be housed in one common or two separate concrete duct banks, which will be buried to a minimum target depth of 3 ft (0.9 m) beneath the surface. The configuration of the six interconnection cables and two fiber optic cables within the duct banks may vary along the installation corridor (see conceptual drawings in **Figure E-3.2-3**). Each of the concrete duct banks will be approximately 3 feet (0.9 m) high by 3 ft (0.9 m) wide for a total width of 6 ft (1.2 m). Up to two joint pits (manholes) will be located along the interconnection cable corridor to provide access; however, one or both of these may be determined to be unnecessary and omitted in the final design. The need for a jointing location will be determined pending detailed cable routing design and evaluation of cable pulling limitations, and if a jointing location is needed, the final location will be provided in the Environmental Management and Construction Plan (EM&CP). Direct buried installation may also be used instead of an accessible chamber, depending on the final evaluation.

Joint pits, if used, will generally be in-situ or pre-cast concrete boxes with approximate dimensions of 40 ft by 15 ft (12.2 m by 14.6 m) to a depth of approximately 14 ft (4.3 m). A cast iron cover may be present at ground level for access by maintenance personnel. Although both the circuits will pass through manholes, each circuit will be spliced in a manhole dedicated to a single circuit splice such that no manhole includes splices of both circuits. The cables will be separated with a firewall in each manhole.

A profile view of the onshore interconnection cable, including anticipated location of manholes, as well as cross sections of duct bank configurations and joint pits, is provided in **Exhibit 5**. Since the proposed interconnection cables will be solid dielectric, no dielectric fluid or insulating oil is needed and no oil pumping stations are proposed.

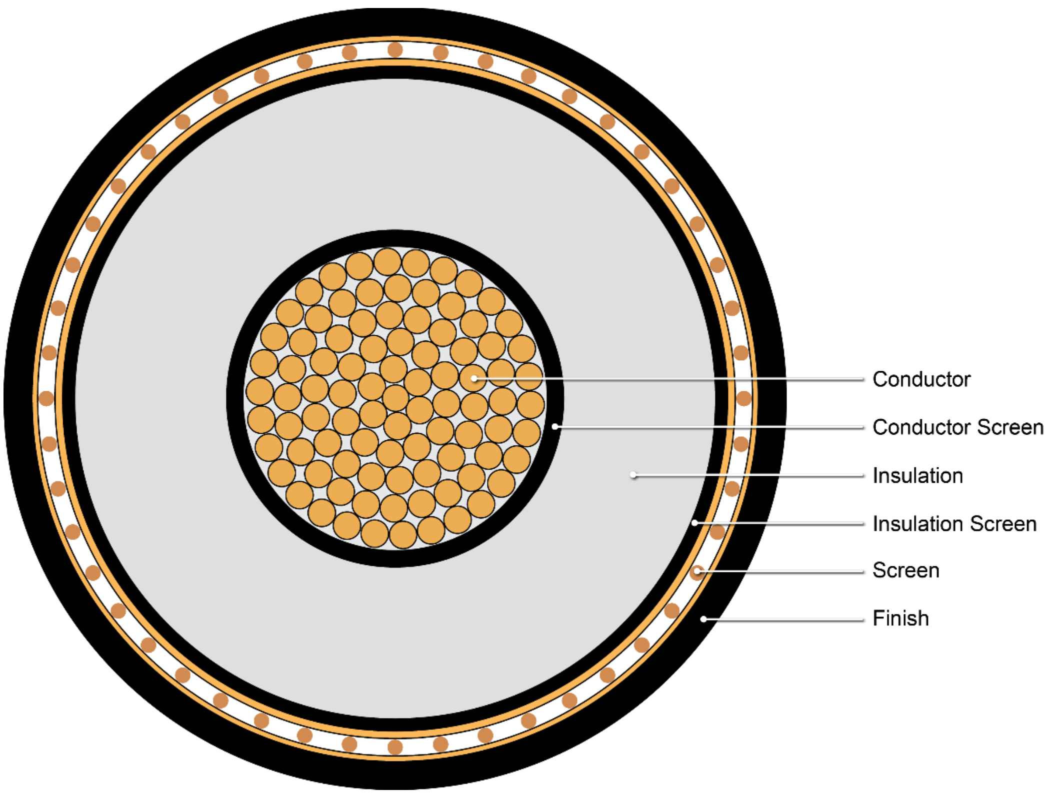

Figure E-3.2-2 Representative Cross-Section of Onshore Interconnection Cable

E-3.2.3.1 Conductor Design

The copper power conductors within each of the three insulated conductor cables will made of round stranded or segmented copper wires with a cross-sectional area of up to 3.9 in^2 (2,535 mm^2).

E-3.2.3.2 Insulation System

Copper conductors will be enclosed in an XLPE insulation system, rated for 362 kV. The Applicant does not anticipate any oils or insulating fluid as part of the cable insulation system.

E-3.2.3.3 Longitudinal Water Barrier

Semi-conductive swelling tape will be applied over the insulation screen.

E-3.2.3.4 Metal Sheath

The conductor cables will incorporate copper wires and a metallic laminated or lead sheath over the longitudinal water barrier.

E-3.2.3.5 Outer Sheath

An insulating polymeric sheath will be extruded over the metal sheath to act as mechanical reinforcement and corrosion protection for the metal sheath. A semiconductive skin will be extruded over the sheath for testing purposes.

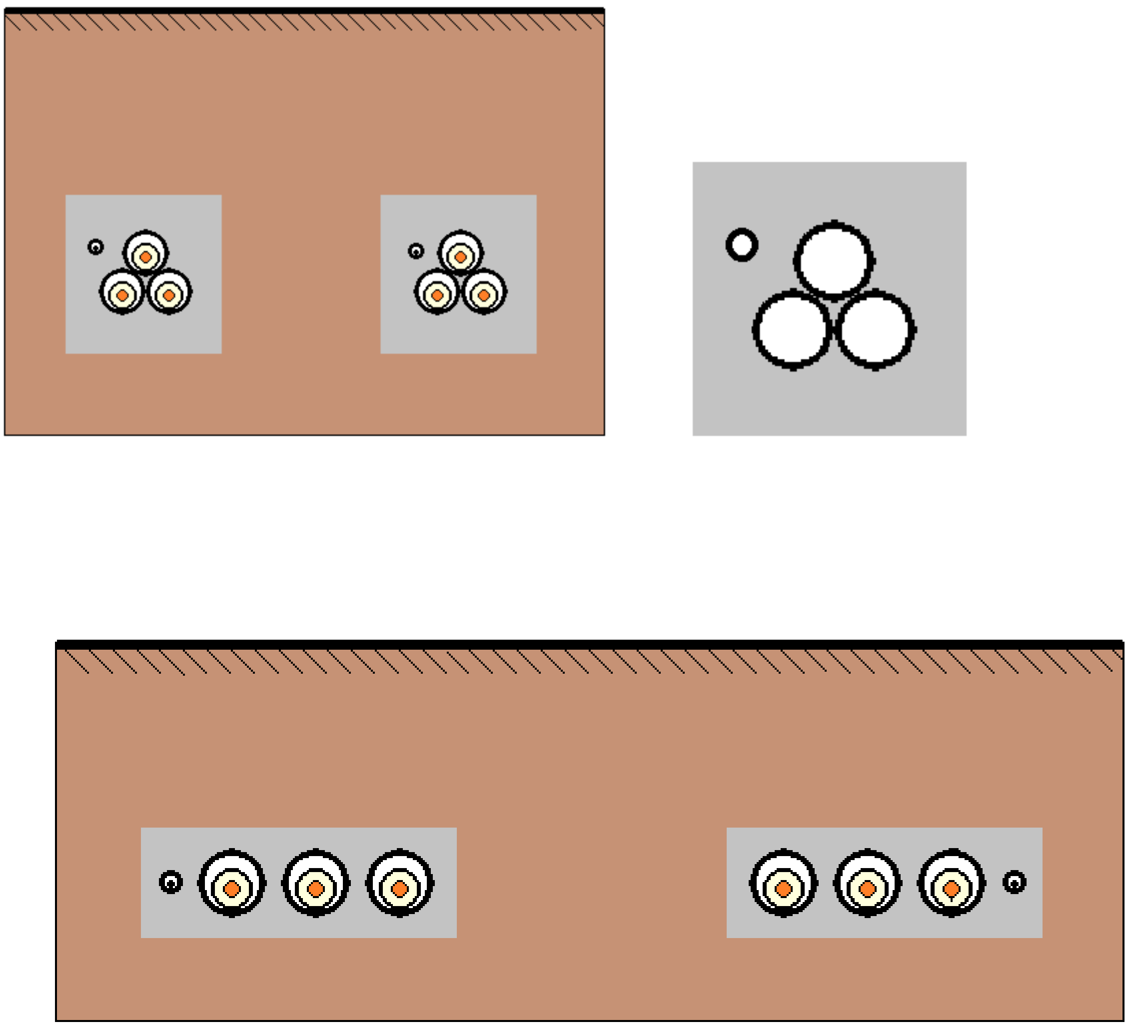

Figure E-3.2-3 Typical Duct Bank Configurations

E-3.2.3.6 Bending Radius

The onshore interconnection cables will not be installed with less than the manufacturer's minimum recommended bending radii. Typical minimum bending radii for the onshore interconnection cable are 20 times the outer diameter during installation and 15 times the outer diameter during operations.

E-3.2.3.7 Bonding

Bonding at regular intervals limits the induced voltage. Pending final onshore interconnection design, bonding points will be located at joint pit/manhole locations with a typical distance of 500 ft (152 m) and will be contained within link boxes. Final detail on the bonding and grounding will provided in the EM&CP.

E-3.2.3.8 Link Boxes

Pending final onshore interconnection design, link boxes are anticipated to be up to approximately 3 ft by 3 ft (0.9 m by 0.9 m) and located at joint pit/manhole locations. A typical link box is provided in the conceptual onshore drawings in **Exhibit 5**.

E-3.2.3.9 Fiber Optic Cable

One fiber optic cable with an approximate diameter of 1.2 in (30 mm) will be installed with each circuit.

E-3.3 Cable System Installation

This section describes the underground cable installation methods for the submarine export cables, cable landfall, EW 1 onshore export cables and onshore interconnection cables to the POI.

E-3.3.1 Submarine Export Cable Installation

Offshore infrastructure within New York State waters will consist of the submarine export cables and cable protection. The submarine export cables will be installed from a specialized vessel which will install the cables from a turntable on the lay vessel. One or several vessels might be used for the installation of the cables depending on a number of factors, such as seabed depth, depth of cable protection, distance to shore, installation methodology, and the type of cable protection method to be used. The submarine export cable installation methodology selected will also depend upon a variety of factors, including seabed characteristics and target burial depth. Installation methods that may be used along different portions of the submarine export cable route are described in subsection Section E-3.3.1.2.

The submarine export cables will be buried to a minimum target depth of 6 ft (1.2 m), or in federally maintained channels and anchorages, to a minimum of 15 ft (4.6 m) below authorized depths or depth of existing seabed (whichever is deeper), if feasible. The burial depth may vary from the target depth due to a variety of factors including seafloor conditions, previously installed utilities, other existing uses, and planned and future uses

Other factors that will influence minimum target burial depth will be determined through cable burial risk assessments and could include activities such as non-regulated anchoring (e.g. unofficial Ambrose Anchorage) and seabed impacting fishing (e.g. hydraulic clam dredging). For example, in areas of hydraulic clam dredging, a target burial depth of at least 6 ft (1.8 m) may be appropriate. A conceptual submarine export cable plan and profile is provided in **Exhibit 5**. A complete cable burial risk assessment will be conducted to inform the final design. Additional information on target burial depths will be provided with the EM&CP.

In areas where the target burial depth cannot be achieved due to existing seabed conditions or the presence of existing utilities (cables and/or pipeline), it is anticipated that protection measures will be required (see Section E-3.3.1.5 for additional information on cable protection).

The typical key stages of submarine export cable installation have been defined as:

1. Unexploded ordnance (UXO) clearance and pre-installation activities[1],
2. Pre-sweeping (if needed),
3. Pre-trenching activities,
4. Cable lay and burial,
5. Cable and pipeline crossings,
6. Post-installation survey,
7. Post-crossing cable protection, and
8. Remedial cable protection (if needed).

The installation of the submarine export cables including pre-installation activities is expected to take up to approximately three months per cable for the submarine export cable route in New York. Pre-installation activities are expected to be conducted prior to the start of the cable lay. The actual installation schedule will be subject to seabed characteristics, installation vessel availability, other vessel traffic and weather.

E-3.3.1.1 UXO Clearance and Pre-Installation Activities

Prior to the installation of cables, survey campaigns including debris clearance, UXO clearance, pre-lay grapnel run, and pre-installation surveys may be completed. This is to ensure that the submarine export cable and burial equipment will not be impacted by any debris or hazards, either natural or artificial, during the cable lay and burial process and avoid the potential for equipment damage and/or delays. This work also serves to ensure sufficient cable burial depth.

It is anticipated that portions of the submarine export cable route will be surveyed for UXO and may, if required, be cleared. The submarine export cable will be micro-sited within the surveyed cable corridor to avoid potentially hazardous features; where re-routing is deemed unfeasible, these features will be managed in accordance with applicable regulations. A pre-lay grapnel run may be completed to remove seabed debris (abandoned fishing gear, wires, etc.) from the cable corridor, where feasible.

In some areas, existing, out-of-service cables and pipelines may be cut away and removed in order to install the submarine export cables. This removal will only be completed as part of pre-installation activities for pre-determined cables and pipelines for which written agreement is received from the owners and/or appropriate agencies (see Section E-3.3.1.6 for additional information on submarine cable and pipeline crossings).

E-3.3.1.2 Pre-Sweeping

In certain limited areas of the submarine export cable corridor, where underwater megaripples and sandwaves are present on the seafloor, pre-sweeping activities may be necessary prior to cable lay activities in order to achieve cable burial to the target depth. Pre-sweeping involves smoothing the seafloor by removing ridges and edges, where present. The primary pre-sweeping method will involve using a suction hopper dredge vessel and/or mass flow excavator from a construction vessel to remove the excess sediment on the seafloor along the footprint of the cable lay; however, other types of dredging equipment may be used depending on environmental conditions and equipment availability.

Where required, pre-sweeping activities will occur in an area of up to 164 ft (50 m) width along the length of the megaripples and sandwaves; the length of clearance will vary along the submarine export cable route, ranging from approximately 197 ft (60 m) to 5,577.4 ft (1,700 m). Removal in an area approximately 65.6 ft

[1] A separate pre-survey and route clearance might be performed prior to the pre-installation grapnel run and survey if there are expected to be large quantities of debris along the route.

(20 m) by 49 ft (15 m) may be required to facilitate cable burial in these transition areas. Megaripple and sandwave height vary depending on localized seabed and current characteristics.

Should a suction hopper dredge vessel or similar equipment be used to complete these activities, the Applicant anticipates that dredged material will either be sidecasted near the site of installation or removed for reuse or proper disposal. The actual method of dredged material management will be based on sediment sampling and consultation with regulatory agencies. Additional information on dredged material management and/or disposal will be provided as part of the EM&CP.

Mass flow excavation equipment, if used for pre-sweeping, will not generate dredge material requiring disposal; rather, the material will be sidecasted. Within areas subject to pre-sweeping by either dredging or mass flow excavation, the submarine export cables will be subsequently installed to the target depth via jetting or other cable burial techniques (e.g., jetting, plowing, etc.).

E-3.3.1.3 Pre-trenching

Pre-trenching activities may be required in select locations along the submarine export cable route in areas where deeper burial depths may be required and/or seabed conditions would not be suitable for traditional cable burial methods without prior seabed preparation. Pre-trenching involves running the cable burial equipment over portions of the route in order to soften the seabed prior to cable burial and/or the use of a suction hopper dredge to excavate additional sediment. This activity helps facilitate an easier burial process in areas of greater depth. The impacts associated with this pre-trenching method are anticipated to be the same as those for cable lay and burial. Pre-trenching would be conducted as a separate activity prior to cable lay, such that sediments suspended during pre-trenching would be expected to settle out of the water column prior to the start of cable installation.

E-3.3.1.4 Dredging

Dredging is used to excavate, remove, and/or relocate sediment from the seabed in order to increase water depth and alter existing conditions; this can be completed through clamshell dredging, suction dredging, and/or hydraulic dredging. The dredging of sediment allows for deep draft vessels to safely navigate over shallow areas, as well as allowing for adequate burial of the submarine export cables in areas where deeper burial is required.

For cable installation along the submarine export cable corridor approaching the landfall at SBMT, depths below the existing bathymetry are expected to be required because of cable installation vessel draft requirements (**Figure E-3.3-1**). An area of approximately 7.5 ac (3.0 ha) along the 1,500 ft (457 m) of the submarine export cable route approaching the cable landfall (Area C in **Figure E-3.3-1**), between existing piers at SBMT, will require dredging up to approximately 26.5 ft (8 m) below Mean Lower Low Water (MLLW) for the access by the cable installation vessel. Additionally, Area D (0.6 ac [0.2 ha]) at the base of the cable landfall may need to be dredged to -26 ft (-7.0 m) MLLW. To reach the required depths, approximately 22,060 cubic yards (16,860 cubic meters), of sediment will need to be dredged, including assumed sideslopes and overdredge.

Additionally, within an approximately 17.6 ac (7.1 ha) area (Areas A and B on **Figure E-3.3-1**) that overlaps Reaches B and C of the U.S. Army Corps of Engineers (USACE)-managed Bay Ridge Channel, the bathymetry will need to be lower than the current condition in order to bury the submarine export cables a minimum of 15 ft (4.6 m) below the federally authorized maintenance depth (40 ft [12.2 m] below MLLW) and for cable lay vessel access. On March 11, 2021, the USACE issued a Public Notice for maintenance dredging of shoal areas adjacent to SBMT and the approach to the Gowanus Creek Federal Navigation Channel (USACE 2021), in an area that is partially overlapping the Applicant's anticipated work areas. The Applicant is currently consulting with the USACE on the anticipated channel maintenance activities.

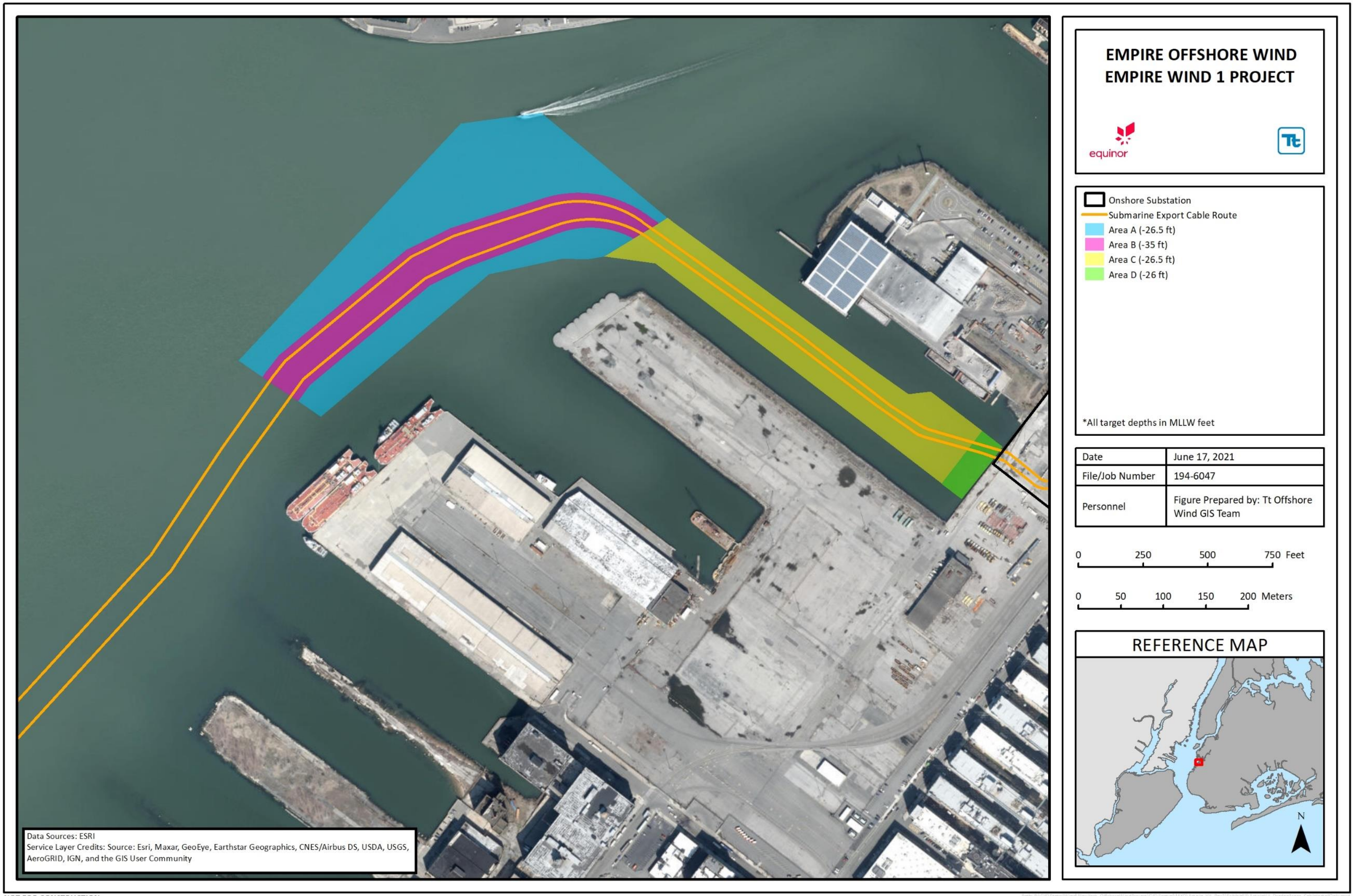

Figure E-3.3-1 Potential Dredging for Cable Installation in the Vicinity of SBMT

Based on the USACE Public Notice, the Applicant does not anticipate conducting additional dredging within Areas A and B (which are within the USACE-managed channel reaches) prior to Project construction. However, dredging in this area could be required if sedimentation or shoaling decreases the water depth prior to construction. Sedimentation over the cables during operations may also result in an exceedance of the depth limitations of the cables over time. In that case, maintenance dredging may also be required during operations.

At locations where the submarine export cable crosses other assets, local dredging may also be needed in order to reduce the shoaling of the crossing design. This method is described in Section E-3.3.1.6.

The Applicant anticipates that dredged material generated from the Project will be removed for either beneficial reuse or proper disposal at a licensed facility. The actual method of dredged material management will be based on sediment sampling and consultation with regulatory agencies. Additional information on dredged material management and/or disposal will be provided as part of the EM&CP.

E-3.3.1.5 Cable Lay and Burial

Following pre-burial activities, the submarine export cables will be brought to the appropriate section of the cable corridor. From there, the submarine export cables will be laid onto the seabed and either buried directly and simultaneously via jet plow or mechanical plow, or a second vessel will follow the cable lay vessel to bury the submarine export cables with a jetting sled. Mechanical plowing and trenching also may be used if required by site-specific seabed conditions and burial requirements.

In shallow areas, specifically along the Rockaway sandbank in New York Harbor, the submarine export cable may need to be floated into place for burial, because water depths along this stretch are inadequate for the cable lay vessel. Should this floating installation method be implemented, the cable lay vessel will be located in deeper waters up to approximately 1,312 ft (400 m) from the burial location. The cable burial machine will then assist in lowering and burying the submarine export cable in place, as it moves along these shallower areas. The burial machine may also be run out of a separate construction vessel or barge.

Throughout the submarine export cable corridor, the two 230-kV submarine export cables are anticipated to be spaced approximately 98 ft (30 m) apart in New York State waters. Direct disturbance for installation will be up to approximately 26-ft (8-m)-wide per cable, including approximately 5 ft (1.5 m) for the width of the burial tool penetrating the seafloor, plus the additional width of seafloor contact and sediment sidecast. This will be located within the 500-ft (152 m) submarine cable siting corridor. The submarine export cable installation rate is dependent on seabed characteristics, installation vessel availability and weather.

The submarine export cables will be installed via jetting, plowing or trenching methods, as described below.

Jetting

Jetting will be the primary method for cable installation. Jetting may be conducted via a towed device that travels along the seafloor surface. Jetting may also be conducted with a vertical injector fixed to the side of a vessel or barge. These methods inject high pressure water into the sediment through a blade that is inserted into the seafloor to create a trench. Simultaneously, the cable is fed from the cable ship down through the device and laid into the trench. Post-lay burial with a jetting tool may also be utilized. With this method, the cable would first be laid along the seafloor, and then the post-lay jetting tool would follow and may attempt multiple passes of the area for burial.

The high-pressure water from the jetting tool sufficiently softens the sediment such that the cable can be pushed down through the sediment to the desired burial depth. The adjacent sediment and displaced sediment then resettles into the trench. Jetting with simultaneous cable lay, using either a jet plow or vertical injector, is considered the most efficient method of submarine cable installation in many soil types. It minimizes the extent and duration of bottom disturbance for the significant length and water depths along the submarine export cable route.

Cable installation production rates for any method will vary based on depth requirements, sediment types, installation vessel type, and conditions at the time of construction, so that the expected range of production rates for jetting methods may range from 3 to 52 feet per minute (ft/min) (1 to 16 meters per minute [m/min]). However, average rates expected for jetting methods are from approximately 20 to 26 ft/min (6 to 8 m/min).

Plowing or Mechanical Plowing

Plowing is conducted with a "mechanical" (i.e., non-jetting) cable plow that is pulled along the seabed, creating a narrow trench. Simultaneously, the cable is fed from the cable ship down to the plow, with the cable laid into the trench by the plow device. Gravity causes the displaced sediment to return to the trench, covering the cable. In general, material backfills naturally under wave action and tidal currents, but if necessary, additional sediment is mechanically returned to the trench using a backfill plow. Similar to a jet plow, the cable is installed and buried in a single pass. Plowing also results in direct seafloor disturbance with the potential to impact benthic infauna and epifauna from the action of the plowing machine, and to impact water quality from suspended sediment. Plowing is generally less efficient than jetting methods but may be used in limited site-specific conditions. Mechanical plowing may be used for harder soils, where jetting is determined to be problematic. These impacts are discussed in more detail in Section 4.2. As described above, cable installation production rates are variable for different target depths, sediment types, installation vessel type, and conditions at the time of construction; rates for mechanical plowing are expected to range from 3 to 33 ft/min (1 to 10 m/min), with average rates of approximately 20 ft/min (6 m/min).

Trenching (Cutting)

Trenching is used on seabed containing hard materials not suitable for jetting or plowing. For those areas containing hard materials, the trenching machine mechanically cuts through the hard materials using a chain or wheel cutter fitted with picks or teeth. The cutter creates a trench that the submarine export cable is laid into, and backfill is mechanically returned to the trench using a backfill plow. Trenching produces direct seafloor disturbance similar to jetting and plowing, with the potential to impact benthic infauna and epifauna from the action of the trenching machine, and to impact water quality from suspended sediment. As described above, cable installation production rates are variable for different target depths, sediment types, installation vessel type, and conditions at the time of construction; installation rates expected for trenching are up to 16 ft/min (5 m/min), with an average of approximately 7 ft/min (2 m/min).

E-3.3.1.6 Cable Protection Installation

Cable burial is the preferred protection technique, and the submarine export cables will be buried to the target burial depth wherever it is technically and commercially feasible to do so. Additional or alternative protection measures only will be used if determined to be necessary after an assessment of cable burial risk. In areas where burial of the cable is not feasible or where sufficient burial depth is not achieved, remedial cable protection will be installed to protect the cables. The locations requiring protection, the type of protection selected, and the amount placed around each submarine export cable will be based on a variety of factors, including water flow and substrate type (hydrodynamic scour modeling) and potential other uses (e.g., commercial fishing or other maritime activities). Alternative measures to burial may include:

- Rock: the installation of crushed rock or boulders over a cable;

- Rock Bags: the placement of pre-filled bags containing crushed rock over a cable; and/or
- Concrete or Rock-filled Mattresses: the placement of concrete blocks, or mats, made of connected segments over a cable.

In addition, at certain cable and pipeline crossings, tubular sections may be installed on the submarine export cable as a protection layer prior to the placement of the cable protection measures. With the exception of certain asset crossings discussed below, surficial use of concrete mattresses is not a favored method of cable protection based on feedback during the consultation process; however, this approach may be the preferred solution at certain asset crossings in order to reduce shoaling in areas where cable burial is not feasible or target burial depth cannot be achieved.

Cable protection may be placed around appropriate sections of exposed or at risk cables, where the amount and type is dependent on the cable type and position, residual burial depth (if partially buried) and subject to the results of the geophysical and geotechnical surveys, hydrodynamic modelling and the cable burial risk assessment. It is estimated that up to 10 percent of the length of the submarine export cable route will require cable protection.

Table E-3.3-1 details the parameters for the proposed cable protection measures.

Table E-3.3-1 Summary of Cable Protection Maximum Parameters

Cable Protection Parameters	Maximum Representative Protection Measures a/
Submarine Export Cables	
Width at Base	15 ft (4.5 m)
Width at Top	5 ft (1.5 m)
Depth	5 ft (1.5 m)
Cable and Pipeline Crossings	
Width at Base	46 ft (14 m)
Width at Top	6.6 ft (2 m)
Depth	6.6 ft (2 m)

Note:
a/ Provided per cable within each installation corridor.

E-3.3.1.7 Cable and Pipeline Crossings

Within New York Harbor, there are a number of existing cables and pipelines, both in-service and out-of-service (see **Exhibit E-6: Effect on Transportation** for detailed information on asset crossings). Where the submarine export cable route requires the crossing of such assets, specific crossing designs will be developed and engineered. Cable crossing methodologies will be based on a variety of factors, including the type of asset to be crossed (i.e., material), the depth of the existing buried cable or pipeline, and whether the assets are in-service or out-of-service. These crossing methods will be detailed further in the EM&CP. Additional detail for cable and pipeline crossings and cable protection measures are provided in **Exhibit 5**.

A typical sequence for submarine export cables crossing other cable and pipeline assets is as follows:

- Once the precise location of the infrastructure to be crossed is determined, usually by survey, a layer of protection is installed on the seabed (if needed). Localized dredging may be required in order to minimize potential shoaling on the seabed before cable protection is installed.

- Cable burial will terminate before the cable protection, at a predetermined distance documented in the crossing agreements and based on cable route, water depth and seabed conditions.
- The submarine export cable may have a casing installed prior to placement, as an additional layer of protection.
- The submarine export cable is laid over the first layer of protection.
- A second layer of protection is installed over the submarine export cable.
- Subject to burial depth, a final layer of protection may be installed over the crossing for further stabilization and additional scour protection; any remaining voids in the seabed at the installation site will be allowed to backfill naturally.

The Applicant has evaluated a variety of submarine export cable crossing methods for cable and pipeline assets (see **Exhibit 3: Alternatives**). This included evaluation of in-water trenchless crossing methods, pile-supported bridges, artificial reef crossings and traditional crossings with cable protection measures including rock installation or concrete mattresses. In evaluating these methods, the Applicant considered technical feasibility and potential to reduce impacts to marine navigation from shoaling. Based on challenges associated with other methods, traditional crossings (**Figure E-3.3-2**), with either rock or mattress protection, are the preferred asset crossing methods.

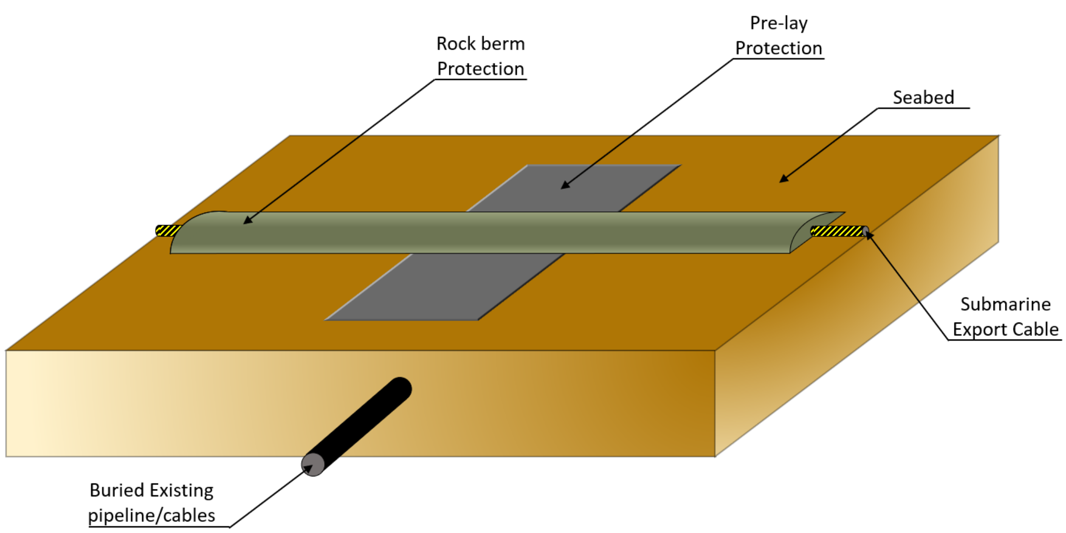

Figure E-3.3-2 Typical Cable Crossing Design

A traditional asset crossing with crushed rock installation or a rock berm (**Figure E-3.3-3**) would consist of installation of rock at the base, cable lay, followed by another layer of rock protection over the top. Rock installation provides protection for the cable against anchor drags or other external impacts. This method results in approximately 4 to 6 ft (1.2 to 1.8 m) of shoaling on the seafloor.

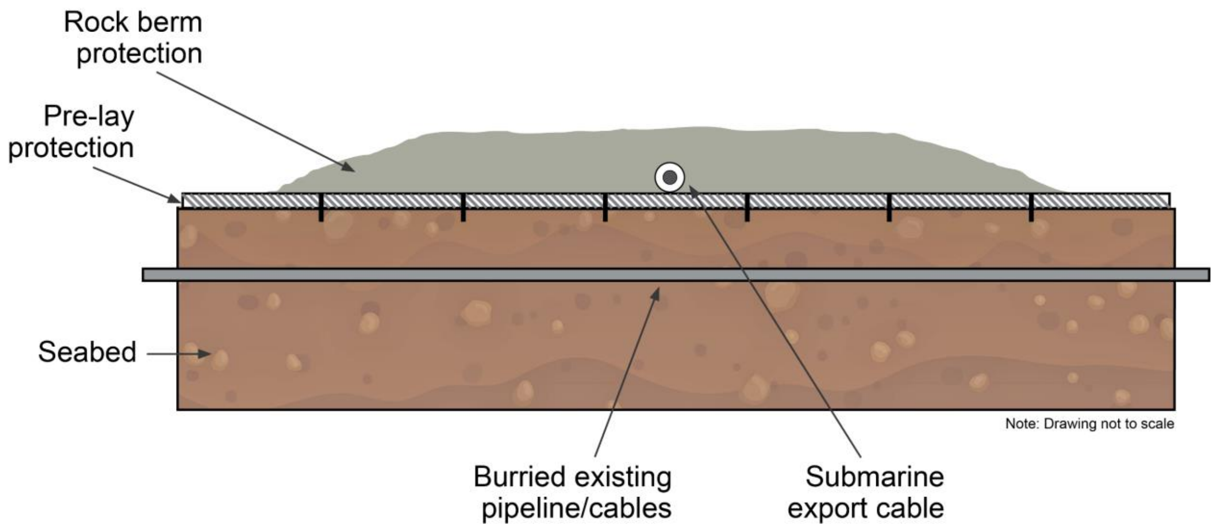

Figure E-3.3-3 Traditional Asset Crossing Installation with Rock Berm

For certain crossings, the Applicant is also evaluating the use of traditional asset crossing measures protected with mattresses filled with either rock or concrete (**Figure E-3.3-4**). Potential methods include either laying the cable directly on the seafloor with a protective mattress on top or laying the cable on top of a layer of protective mattress on the seafloor, and then adding a second protective mattress over the top of the cable. These solutions do not cause significant shoaling, resulting in a less than 3 ft (0.9 m) reduction in water depth.

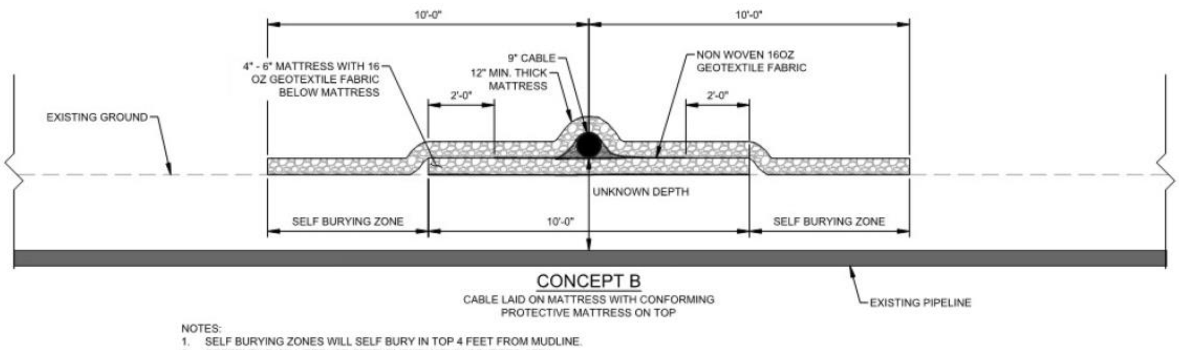

Figure E-3.3-4 Conceptual Diagram of Traditional Asset Crossing Installation with Mattresses

Excavation of material at crossings of identified assets to facilitate installation may be conducted before the crossing installation (**Figure E-3.3-5**) to allow for sufficient burial of the submarine export cables and reduce the need for supplemental cable protection material or shoaling on the seabed. This method may not be feasible due to the likely prohibitions or limitations on dredging in the vicinity of existing assets. However, if used, this crossing design could include the removal of approximately the top 4 ft (1.2 m) of seabed within a 33-ft by 52.5-ft (10-m by 16-m) area at each crossing; utilizing a 3:1 side slope, the upper bounds of this area will be approximately 59 ft by 79 ft (18 m by 24 m). Approximately 679 cubic yards (519 cubic meters) of material is anticipated to be removed by suction hopper dredge at each crossing. The final depth of the dredged area will be governed by the vertical distance between the natural seabed and the assets to be crossed.

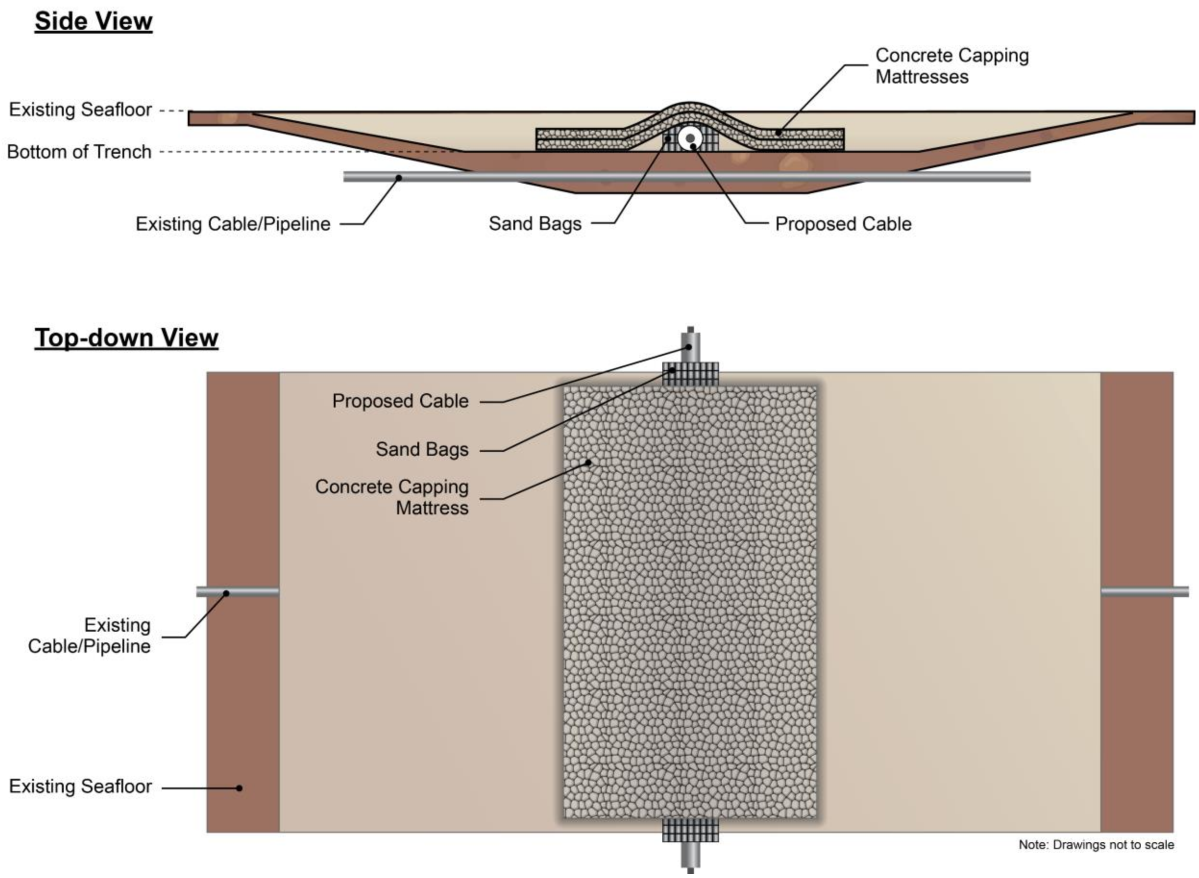

Figure E-3.3-5 Representative Option for Locally Dredged Asset Crossing Methodology

E-3.3.1.8 Post-installation Survey

After cable burial, a post-installation survey will be completed to determine the as-built conditions of the submarine export cables and the levels of burial achieved. At this time, areas requiring remedial cable protection will be identified.

E-3.3.2 Cable Landfall Installation

The Applicant will replace the existing bulkhead at the landfall as part of site preparation activities. Due to the condition of the existing bulkhead, upgrade/replacement is needed in order to stabilize the site. The new bulkhead structure at the cable landfall will incorporate vertical conduits (or J-tubes) through the bulkhead for landfall of the submarine export cables (see **Exhibit 5** for bulkhead drawings). The existing bulkhead consists of timber and steel sheet pile with concrete and/or rip-rap armor stone. The existing bulkhead at the cable landfall will be upgraded with new steel sheet piles and wales (horizontal supports).

A distance of approximately 60 ft (18 m) behind the existing bulkhead will be temporarily excavated for installation of a sheet pile anchor wall and perpendicular tie-backs to support the pipe and sheet pile bulkhead wall at the shoreline. New sheet pile will be installed up to approximately 4 ft (1.2 m) in front of the existing wall. Pile driving will be conducted along the length of the bulkhead and the anchor wall behind it. This area will then be backfilled to design elevations and paving or a concrete cap will be installed over the proposed bulkhead structure.

Around the cable landfall itself, a permanent sheet pile cofferdam approximately 15 ft (4.6 m) by 30 ft (9.1 m) will surround the J-tubes, supported by concrete wales on the upland side of the bulkhead. Temporary sheet piling will also be installed in the water at the 24-inch (in) diameter conduit openings during the bulkhead replacement activities, which will stay in place and will be excavated prior to the cable pull. The temporary sheet pile at the conduit openings will be removed as part of cable landfall activities.

Conduit openings will be installed at the bottom of the bulkhead with approximately 4 ft (1.2 m) depth of cover below the mudline. Steel structure supports for the cable conduits may also be installed within the cofferdam area to support the ends of the conduits, depending on conduit length and the need for stability. Alternatively, sandbags may be placed below and around the conduit to assist in supporting and securing the ends of the conduits.

A temporary dredge pit approximately 80 ft (24 m) by 70 ft (21 m) will be dredged at the base of the bulkhead adjacent to the conduit openings, to a local dredge depth of -32.5 ft (-9.9 m) MLLW, which will be approximately 6 ft (1.8 m) below the final contour. Following the installation of any supports at the conduit openings, the temporary sheet piles seaward of the conduit openings in the water will be removed. Export cable installation will then commence by pulling the end of each cable from the cable-laying vessel through the conduits and temporarily anchoring them on shore. The jet plow will then be lowered to the seabed in the area of the dredge pit, each cable will be placed within the jet plow, and the cable-laying vessel will start installing the cable through jetting, as described in Section E-3.3.1, moving out of the inter-pier space and into the inner harbor. The cables may also be post-trenched after cable lay in order to achieve target burial depth.

After the cable lay, the temporary dredge pit will be backfilled. Backfill will consist of native dredge material if suitable; otherwise, dredged material will be taken to an authorized facility for disposal, and suitable clean backfill material will be used. Once the cables are in place, scour protection will be installed at the toe of the bulkhead around the end of the conduit. Armor stone and bedding will be placed a minimum of 4 ft (1.2 m) above the submarine export cables out to approximately 80 ft (24 m) in front of the cable landfall.

On the landside above the bulkhead, upland excavation along the EW 1 onshore export cable route will be conducted to create a transition trench for the conduit and export cables. Due to the acceptable bending radii, approximately 37 ft (11 m) of the EW 1 onshore export cables at the top of the bulkhead, where they exit the vertical conduits, will be aboveground and enclosed in a concrete vault or steel structure for protection. From there, the EW 1 onshore export cables will transition belowground into a precast trench box approximately 36 in (91 centimeters deep and 75 in (191 centimeters) wide, where they will go either directly to the cable terminations or to a vault within the onshore substation.

To support the installation, both onshore and offshore work areas will be required. The onshore work area for cable landfall will be located within the substation construction workspace at SBMT. The offshore work will be located within the submarine export cable corridor adjacent to the bulkhead.

E-3.3.3 Onshore Cable Installation

Based on the existing conditions along the onshore cable route, both trenchless (e.g., horizontal directional drilling [HDD] and jack and bore) and trenched (open cut trench) methods are proposed for installation of onshore cables. The EW 1 onshore export cables will be buried underground from the cable landfall either directly to the cable terminations or to a vault within the onshore substation. It is anticipated that EW 1 onshore export cables will be installed within a pre-cast trench box inside the substation site. Because the same export cables will connect directly into the proposed onshore substation, transition splicing may not be needed at the cable landfall. Pending final routing design and cable pulling analysis, if necessary a vault/joint pit may be installed, and single core onshore cables will extend into the onshore substation past the vault.

The Applicant anticipates that ground-disturbing activities for onshore cable installation will take approximately 3 months. Work within the public roadway will be coordinated with the New York City Department of Transportation.

E-3.3.3.1 Open Cut Cable Installation

The EW 1 onshore export and interconnection cables will be installed utilizing open-cut trench as the primary installation method, except where trenchless methodologies are necessary. Open-cut installation will typically include the following main activities:

1. Preparing the construction corridor, including safety and traffic management as necessary;
2. Excavating a trench;
3. Installing ducting;
4. Establishing jointing bays;
5. Pulling onshore cables through the ducts;
6. Joining the cables; and
7. Restoring the construction corridor.

The preparation of the construction corridor typically includes survey and corridor marking, clearing, and grading. However, clearing and grading activities are anticipated to be minimal or unnecessary because of the highly developed nature of the onshore cable corridor, which is located primarily in an existing road right-of-way and existing paved areas in an urban environment.

To install the ducting using the open-cut method, a trench will be excavated along the onshore cable route. Typically, the trench will be up to 10 ft (3 m) deep and 10 ft (3 m) wide, within a 50-ft (15-m)-wide construction corridor, including duct banks for both circuits. The duct bank will be installed with a minimum of 3 ft (0.9 m) of cover.

Existing utility and infrastructure crossings may require deeper trenching or trenchless installation segments (see Section E-3.3.3.2). A total of eight existing utility crossings have been identified to date along the onshore cable route. The Applicant continues to gather buried utility and infrastructure information. Trench shoring will be installed as needed in accordance with applicable health and safety regulations and policies.

During excavation activities, the material will be stockpiled next to the trench where possible, or within roadway. Cut pavement and other materials may be placed immediately in a container or truck for off-site disposal. Erosion and stormwater controls will be installed adjacent to work areas and around stockpiled material when left within the cable corridor, as needed; additional details will be provided as part of the EM&CP.

If groundwater is encountered during trenching, dewatering may be needed prior to installation. Dewatering discharges for the Project may be to an existing sewer or to a surface waterbody, and as necessary, will be conducted in accordance with the appropriate State Pollution Discharge Elimination System (SPDES) permit and/or New York City dewatering requirements. The Applicant will test groundwater in areas of known contamination where excavation will occur to determine if treatment may be necessary prior to discharge in order to comply with the applicable authorization (e.g., SPDES or discharge to sewer).

The onshore electrical components, including the duct banks, will then be installed within the trench. Conduits will be lowered into the trench, spacers installed, and duct banks formed with poured concrete.

Once the duct bank installation is complete, the trench will be backfilled, typically using the excavated soil, if it is suitable and approved for reuse by permitting authorities. Unsuitable or contaminated soils will be disposed of offsite in an approved manner and location, and suitable soil will be brought in and used as backfill. The area is then restored to pre-construction conditions by stabilizing with a seeding mix or re-paving as applicable.

A mandrel will be pulled through the conduit for cleaning and the conduit will be tested. Finally, the cables will be pulled through the conduits from joint bay locations and spliced. Once fully installed, the cables will be tested prior to being brought into service.

E-3.3.3.2 Jack and Bore Cable Installation

The Applicant is proposing to use trenchless construction along the onshore interconnection cable route in order to cross the existing railroad tracks within SBMT. Additional trenchless crossings may be required in areas of buried utilities and infrastructure.

The Applicant anticipates using the jack and bore trenchless installation methodology for the railroad and the sheet pile crossings. The jack and bore method is completed by installing a steel pipe or casing under existing roads, railways, or other infrastructure. This is done by excavating a bore (entry) pit and a receiving (exit) pit on either side of the crossing. An auger boring machine is then placed in the entry pit, to jack a casing pipe through the earth while at the same time removing earth spoil from the casing by means of a rotating auger inside the casing. The onshore interconnection cables are then pulled through the casing.

The jack and bore crossing installation typically requires an extra work area of approximately 50 ft by 50 ft (15 m by 15 m) alongside the onshore cable corridor. Within the cable corridor, the crossing requires a 60-ft by 20-ft (18-m by 6-m) bore pit to be excavated on one side and a 30-ft by 20-ft (9-m by 6-m) receiving pit on the other side. At this location, it is anticipated that work areas required for the jack and bore installation will be located within the larger temporary workspace and laydown area at SBMT, which will also be used for the onshore substation construction.

Excavated soil will be stockpiled next to the pits or in some cases may be placed immediately in a container or truck for disposal. Depending on groundwater levels, it is also possible that either or both pits will need dewatering. The rate of dewatering and the quality of the water will determine whether the water may be placed into frac tanks for off-site disposal, or if permissible, into the storm drain system. Impacts on water quality will be minor and short-term from dewatering, assuming dewatering best management practices are employed. Erosion and stormwater controls will be installed around stockpiled material when left within the cable corridor. Additional details for sediment and erosion control, soil stockpiling, and dewatering will be provided as part of the EM&CP. Once the installation is complete, the entry and exit pits will be returned to pre-construction conditions.

E-3.3.3.3 Other Trenchless Installation (HDD)

Additional trenchless crossings may be required, as the Applicant continues to gather buried utility and infrastructure information from the utility owners and/or municipalities in which the Project's onshore components are located. If currently unknown utilities or other infrastructure are determined to be present, the onshore cables may also be installed using HDD or other trenchless technologies. The Applicant will consider use of the HDD method in the event that jack and bore and open cut trench methodologies are not technically or commercially feasible to complete installation activities. Onshore HDD crossings utilize a drilling rig that drills a borehole underneath the ground's surface. A bentonite and water-based drilling fluid is used to lubricate the drill bit, return the cuttings to the bore pit, and maintain the borehole during drilling. Depending on the size of the borehole required, a pilot hole is advanced, followed by one or more reaming passes in order to enlarge the hole. Once the desired size borehole is achieved, a duct is pulled back within the drilled borehole and the onshore cables are pulled through the installed duct. Onshore HDD crossings require two extra onshore work areas (on the drill entry side and exit side) to support the activities. The work areas for HDD installation, if conducted, will be approximately 200 ft by 200 ft (61 m by 61 m) on each side of the HDD.

E-3.3.4 Cable System Maintenance

The Project will be designed to operate with minimal day-to-day supervisory input, with key systems monitored remotely 24 hours a day. During operations, the Project will require both planned and unplanned inspections and maintenance, which will be carried out by qualified engineers, technical specialists, and associated support staff. The Applicant will ensure that all components are maintained and operated in a safe and reliable manner, compliant with regulatory conditions, and in accordance with commercial objectives.

An Operations and Maintenance (O&M) Plan will be developed and finalized prior to the commencement of construction. An Oil Spill Response Plan (for offshore facilities); Spill Prevention, Control and Countermeasures Plan (for onshore facilities); and Safety Management System will also be developed and implemented during O&M activities.

The submarine export cables will be monitored during operations through Distributed Temperature and Distributed Vibration Sensing equipment. The Distributed Temperature Sensing system will be able to provide real time monitoring of temperature along the submarine export cable route, alerting the Applicant should the temperature change, which often is the result of scouring of material and cable exposure. The Distributed Vibration Sensing system will provide real time vibration monitoring close to the cables indicating potential dredging activities or anchor drag occurring close to the cables. Upon receiving any such alert, the Applicant would investigate the cable condition and identify any needed corrective actions. Should one of the submarine export cables fault, the portion of the cable will be spliced and replaced with a new, working segment.

During operations, maintenance dredging could be required in the vicinity of SBMT to ensure sedimentation over time does not exceed cable depth limitations. The seabed level in this area should not be higher than -27 ft (-8.2 m) below MLLW for the cable design. Excessive depth of the cable could cause thermal impacts affecting the submarine export cable rating. The Applicant is currently evaluating whether periodic maintenance dredging may be required for portions of the submarine export cable. If maintenance dredging is anticipated, additional information will be included in the Project's O&M Plan.

The onshore cables should not require regular maintenance, but occasional repair activities may be required should there be a fault or damage caused by a third party.

E-3.3.5 References

USACE (US Army Corps of Engineers). 2021. Public Notice: Bay Ridge and Red Hook Channels, NY Federal Navigation Project Maintenance Dredging. https://www.nan.usace.army.mil/Portals/37/docs/regulatory/publicnotices/Operation%20and%20Maintenance/2021/BRRH21%20Public%20Notice_Final.pdf. Accessed March 12, 2021.