Empire Offshore Wind LLC

Empire Wind 1 Project

Article VII Application

Exhibit 3

Alternatives

October 2021

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ACRONYMS AND ABBREVIATIONS

ac	acre
AIS	Automatic Identification System
BOEM	Bureau of Ocean Energy Management
CLCPA	Climate Leadership and Community Protection Act
ConEdison	Consolidated Edison Company of New York, Inc.
COP	Construction and Operations Plan
Equinor Wind, the Applicant	Equinor Wind US LLC
EW 1 Project	Empire Wind 1 Project
ft	foot
ha	hectare
HDD	horizontal directional drilling
HRG	High Resolution Geophysical (survey data)
HVAC	high-voltage alternating-current
HVDC	high-voltage direct-current
km	kilometer
km/h	kilometers per hour
knot	nautical miles per hour
kV	kilovolt
Lease	Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf OCS-A 0512
Lease Area	BOEM-designated Renewable Energy Lease Area OCS-A 0512
m	meter
mi	mile
MLLW	Mean Lower Low Water
MTBM	Microtunneling Boring Machine
MW	megawatt
NYCDPR	New York City Department of Parks and Recreation
nm	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NYCDEP	New York City Department of Environmental Protection
NYCEDC	New York City Economic Development Council
NYISO	New York Independent System Operator, Inc.
NYSERDA	New York State Energy Research and Development Authority

NYSPSC or Commission	New York State Public Service Commission
POI	Point of Interconnection at the Gowanus 345-kV Substation
PANYNJ	Port Authority of New York and New Jersey
Project	EW 1 Project transmission facilities in New York
PSA	Purchase and Sale Agreement
PSL	New York Public Service Law
ROW	right-of-way
SBMT	South Brooklyn Marine Terminal
SEC	Submarine Export Cable Route Alternative
SSBMT	Sustainable South Brooklyn Marine Terminal
TSS	Traffic Separation Scheme
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
UXO	Unexploded Ordnance

EXHIBIT 3: ALTERNATIVES

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 provide a description of Project alternatives that were considered, along with associated mapping, in accordance with the requirements of 16 New York Codes, Rules and Regulations § 86.4.

3.2 Purpose and Need

In August 2016, the Commission adopted the Clean Energy Standard.[1] Under this standard, 50 percent of New York State's electricity must come from renewable sources of energy by 2030. In 2017, Governor Cuomo set a

[1] Case 15-E-0302, *Large-Scale Renewable Program and Clean Energy Standard*, Order Adopting a Clean Energy Standard (Issued and Effective August 1, 2016).

goal of having 2.4 gigawatts of energy generated by offshore wind by 2030, which the Commission adopted as a supplementary goal for its Clean Energy Standard by order dated July 12, 2018.[2] On November 8, 2018, the New York State Energy Research and Development Authority (NYSERDA) issued its first competitive solicitation for 800 megawatts (MW) or more of new offshore wind projects. On July 18, 2019, Governor Cuomo announced the Applicant and the 816-MW EW 1 Project as a winner of that first state solicitation. On the same day, Governor Cuomo signed the Climate Leadership and Community Protection Act (CLCPA) into law. The CLCPA requires that the State obtain 70 percent of its electricity from renewable sources by 2030 and 100 percent by 2040, and that New York have 9,000 MW of offshore wind capacity by 2035. Equinor Wind US LLC and NYSERDA entered into the Offshore Wind Renewable Energy Certificate Purchase and Sale Agreement (PSA) on October 23, 2019. Equinor Wind US LLC subsequently entered a 50-50 partnership with BP in 2020, known as Empire Offshore Wind LLC. The PSA requires Applicant to design, obtain permitting/approvals for, build and operate the Project and to sell the Offshore Renewable Energy Certificates generated to NYSERDA.

The purpose of the Project is to meet the Applicant's obligation to NYSERDA to generate approximately 816 MW of clean, renewable electricity from an offshore wind farm located in the Lease Area for delivery into the New York State power grid via ConEdison's existing Gowanus 345-kV Substation. The Project is an essential element in addressing the need identified by the New York Legislature and the NYSPSC for renewable energy and will help the State achieve its CLCPA mandate and other renewable energy goals.

3.3 Alternatives Analysis Methodology

The Applicant conducted a detailed analysis of Project alternatives to connect the offshore Lease Area to the POI. The Applicant evaluated siting alternatives for the submarine export cable route, onshore substation location, export cable landfall, and onshore cable route to interconnect with the POI relative to constructability, reliability, environmental resources, and stakeholder impact criteria. Although each component is discussed separately, the siting process was completed holistically relative to submarine and terrestrial constraints to identify the most feasible and reasonable overall solution to deliver energy from the Lease Area to the grid, with the fewest negative impacts. The evaluation is informed by several factors, including desktop assessments, site-specific surveys, supply chain capacity, commercial availability, and engagement with regulators and stakeholders (a summary of stakeholder outreach and engagement is provided in **Appendix A: Agency Outreach and Correspondence**).

A high-level assessment of offshore constraints was conducted based on GIS data to identify the most feasible potential submarine export cable routes between the Lease Area and the area of Gowanus Bay, New York. A siting comparison of the potential submarine export cable routes was then conducted. Section 3.5 summarizes the analysis and results for the identified submarine export cable alternatives within the boundaries of New York State waters. Submarine export cable route alternatives within federal waters are also considered as part of the Applicant's Construction and Operations Plan (COP) for the development of the Lease Area and associated facilities in filed in January 2020, and subsequent revisions in response to agency comments in September 2020 and April 2021. The COP became publicly available following BOEM's issuance of a Notice of Intent to prepare an environmental impact statement in June 2021.

The Applicant also assessed the suitability of parcels near the POI for the development of a new onshore substation, which is required to step up the voltage for interconnection from the 230-kV submarine export cables to 345 kV. Installing 345-kV submarine export cables to shore is not practicable. The number and spacing

[2] Case 18-E-0071, *In the Matter of Offshore Wind Energy*, Order Establishing Offshore Wind Standard And Framework For Phase 1 Procurement (Issued and Effective July 12, 2018).

requirements of single-core cables would make the required installation corridor width impracticable for the submarine export cable installation along this route. Moreover, because the reactive power produced by the offshore cable is a function of both the length of the cable and the square of its operating voltage, using 345-kV cables over the entire route from the Lease Area to the cable landfall (approximately 44 mi [70 km]) would result in the creation of a large amount of additional reactive power. This excessive reactive power would either require substantial additional equipment to control or would limit the amount of energy and capacity that could be delivered from the offshore wind farm to the POI. Additionally, because of the interconnection requirements, even if the cable voltage were the same as the interconnecting substation, onshore equipment would be required to connect into the POI. High-voltage direct-current (HVDC) cables (discussed further in Section 3.8.1) would also require an onshore substation and a converter station to convert direct current to alternating current. For these reasons, an onshore substation is required.

The Applicant's preference is to locate the onshore substation within or immediately adjacent to the existing POI, in order to minimize disturbance associated with the installation of the onshore interconnection cables and associated fiber optic cables between the onshore substation and the POI and to maintain consistency with existing land uses in the vicinity.

To identify the potential cable landfall alternatives for the submarine export cable route, the Applicant conducted a coastal and waterfront engineering analysis of the risks and benefits of potential cable landfall locations at sites in the vicinity of the POI. This analysis was also informed by the submarine export cable routing analysis, which included geophysical, geotechnical and benthic surveys.

Once the submarine export cables make landfall, they either extend directly to the onshore substation (in the case of the proposed EW 1 onshore export cable route, see Section 3.7.3) or they transition to onshore export cables to transport power from the cable landfall to the onshore substation (in the case of most evaluated alternatives). Interconnection cables leave the onshore substation underground to deliver power to the POI. The onshore cable route refers to the complete route traversed by the onshore export and interconnection cables between the submarine cable landfall and the POI. Because installation methods and construction corridor impacts are similar for the onshore export and interconnection cable installation, no distinction is made between the onshore cable types and segments for the purpose of evaluating the onshore cable route alternatives.

Within each of the assessments for submarine export cable alternatives, onshore substation alternatives, cable landfall alternatives and onshore cable route alternatives, the Applicant defined selection criteria and then compared the alternatives to determine the best overall, preferred alternative.

In addition to evaluating Project siting alternatives, the Applicant also considered the use of alternative technologies. This analysis considered alternative technologies for substation design, submarine export cable current type, cable landfall installation, submarine asset crossing methodology and onshore transmission (overhead versus underground). These alternative technologies were assessed relative to factors of technological feasibility, cost, and environmental impact, where applicable.

3.4 No Action Alternative

Under the No Action Alternative, the Project would not be built, the PSA contract between Applicant and NYSERDA would not be fulfilled, and the Project's purpose to provide renewable energy generation from offshore wind in furtherance of New York's renewable energy mandates and goals would not be met. The Project is designed to contribute to meeting the CLCPA's mandate that 70 percent of New York State's electricity come from renewable sources, including 2.4 gigawatts from offshore wind by 2030, and 9,000 MW of offshore wind capacity by 2035. In the absence of the Project, New York's energy generation requirements would need to be met with other energy sources, potentially including more expensive renewable resources or even non-renewable energy options inconsistent with the CLCPA's mandate and New York's other clean energy goals. Additional information on the various economic benefits of the Project that would not be realized under a No Action Alternative are detailed in **Exhibit 6: Economic Effects of Proposed Facility**. Because it does not meet the Project purpose, the No Action Alternative is not a reasonable alternative and is eliminated from further consideration.

3.5 Submarine Export Cable Route Alternatives

Based on the location of the POI, an analysis of offshore routing constraints was the first step in submarine export cable route assessment to identify potential submarine export cable routes between the Lease Area and the POI, to assess feasibility, and to understand potentially significant challenges along each route. After establishing potential alternative submarine export cable routes based on the constraints analysis, alternatives were further evaluated against selection criteria based on data from geophysical and geotechnical survey results and stakeholder input (e.g., United States Coast Guard [USCG], New York Harbor Operations Committee, United States Army Corps of Engineers [USACE], National Oceanic and Atmospheric Administration's [NOAA's] National Marine Fisheries Service, and commercial fishing). Further route refinements were made as detailed data were acquired along the potential submarine export cable routes.

The submarine export cable route begins where the route crosses into state waters 3 nm (5.6 km) offshore, approximately 3.9 mi (6.2 km) southeast of Rockaway Point at the southwestern corner of Long Island, and 5.5 mi (8.8 km) east of the tip of Sandy Hook in New Jersey. The portions of the EW 1 Project outside of New York waters will be separately reviewed by BOEM and other agencies/stakeholders as part of the Applicant's COP. Alternatives described in the remainder of this Exhibit are limited to Project facilities (i.e., within New York).

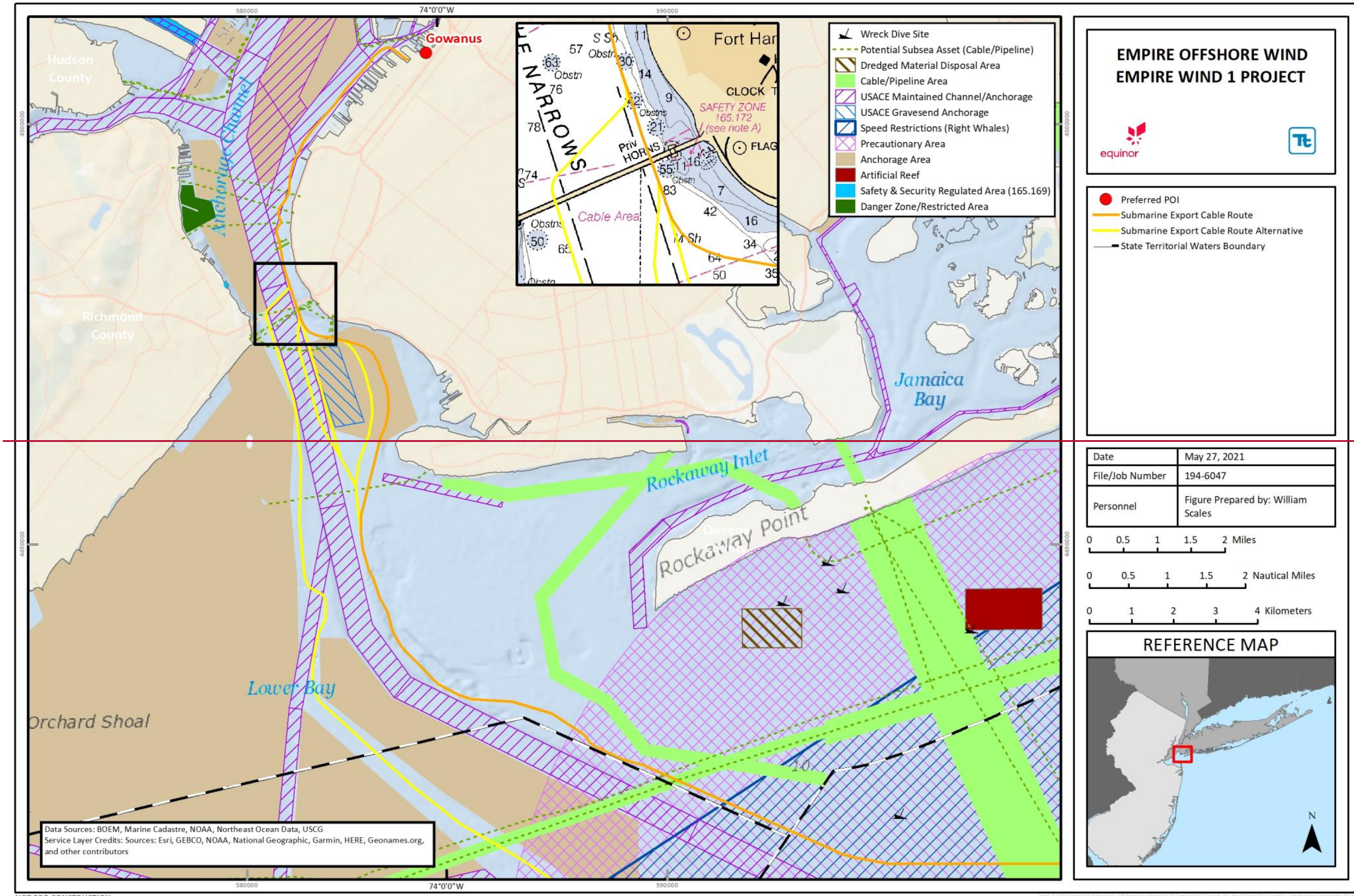
3.5.1 Offshore Constraints Analysis

The Applicant compiled data on available constraints and plotted this data along with information on the seabed from past surveys. **Figure 3.5-1** provides an overview of the offshore constraints analysis conducted for the Project's submarine export cable route.

The offshore routing constraints considered in the identification of potential Project route alternatives include:

- Segment length;
- Installation constraints and complexity, including water depth, slopes, and seabed features;
- Ability to adequately bury and protect the cable;
- Avoidance or minimization of anthropogenic hazards to cable installation and operations, and use conflicts (e.g., existing utility crossings, dredged and maintained channels, anchorages and de facto anchoring areas, vessel traffic separation schemes (TSSs), precautionary areas, safety and security regulated areas, charted danger zones, disposal areas, sand borrow areas);
- Avoidance of biological and cultural resources (e.g., eelgrass, shipwrecks); and
- Avoidance of high-use commercial and recreational fishing grounds.

Fairways and unexploded ordinance (UXO) areas were also considered in the offshore constraints analysis, although these are not present as mapped areas along the route alternatives in **Figure 3.5-1**.


EMPIRE OFFSHORE WIND
EMPIRE WIND 1 PROJECT
equinor
Wreck Dive Site
Potential Subsea Asset (Cable/Pipeline)
Dredged Material Disposal Area
Cable/Pipeline Area
USACE Maintained Channel/Anchorage
USACE Gravesend Anchorage
Speed Restrictions (Right Whales)
Precautionary Area
Anchorage Area
Artificial Reef
Safety & Security Regulated Area (165.169)
Danger Zone/Restricted Area
Preferred POI
Submarine Export Cable Route
Submarine Export Cable Route Alternative
State Territorial Waters Boundary
Date
May 27, 2021
File/Job Number
194-6047
Personnel
Figure Prepared by: William Scales
0 0.5 1 1.5 2 Miles
0 0.5 1 1.5 2 Nautical Miles
0 1 2 3 4 Kilometers
REFERENCE MAP
N
Gowanus
Hudson County
Richmond County
Anchorage Channel
Jamaica Bay
Rockaway Inlet
Rockaway Point
Lower Bay
Orchard Shoal
Fort Han
CLOCK
SAFETY ZONE 165.172 (see note A)
FLAG
NARROWS
Cable Area
74°0'0"W
Data Sources: BOEM, Marine Cadastre, NOAA, Northeast Ocean Data, USCG
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors
NOT FOR CONSTRUCTION

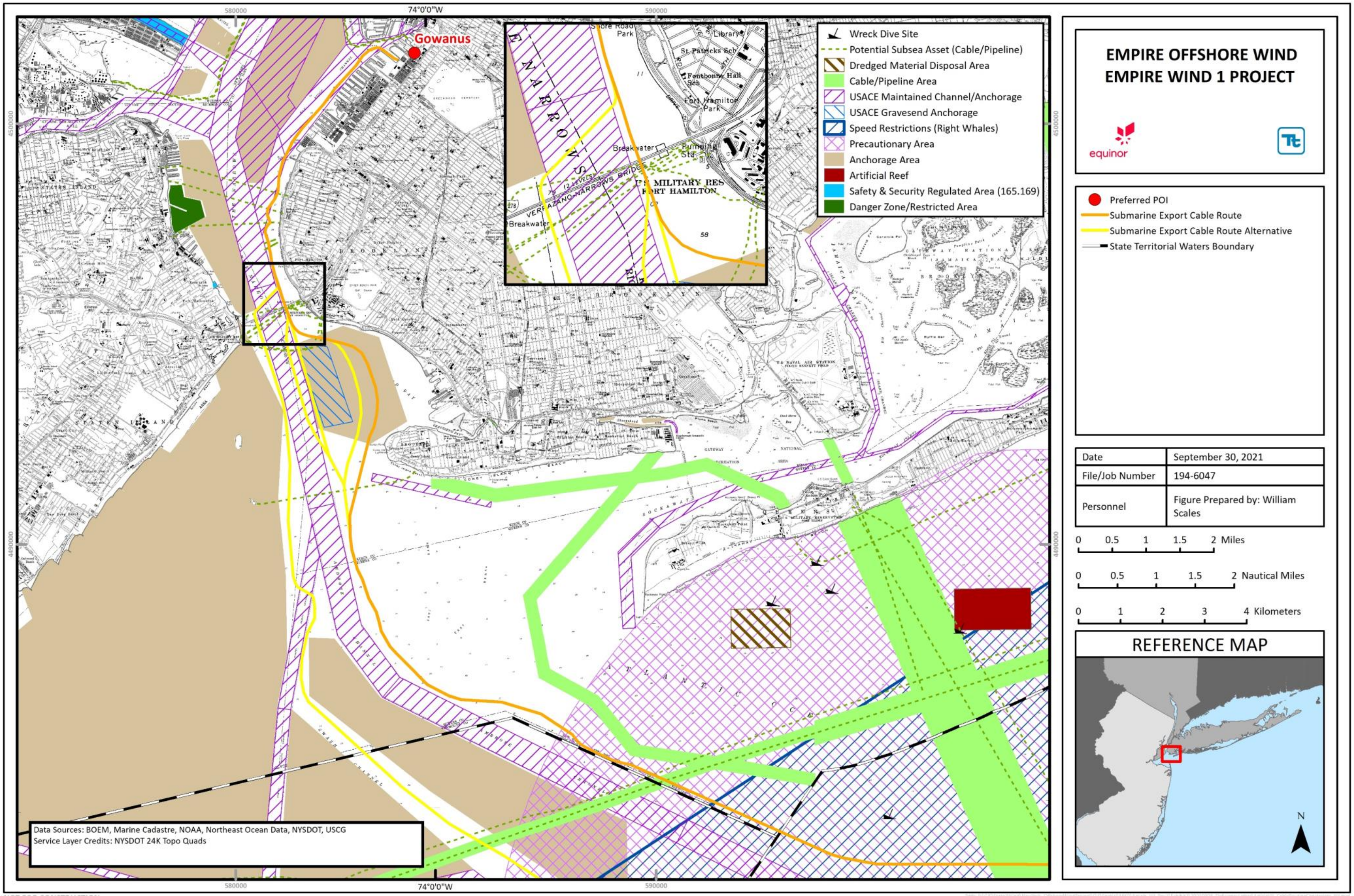


Figure 3.5-1 Submarine Export Cable Routing Constraints Analysis

In considering segment length, the most direct submarine export cable route served as the starting point in developing the export cable route. This is driven by technical constraints and costs, including cable costs, installation time, and limits associated with efficient HVAC transmission. Discussion regarding HVDC as an alternative for cable technology is provided in Section 3.8.

3.5.1.1 Installation Complexity and Cable Burial

Both regional bathymetry datasets (NOAA 2015) and Project-specific high-resolution geophysical (HRG) survey data were collected to analyze general seabed conditions and specific seabed-related risks along the potential submarine export cable routes. These have allowed for routing to minimize traversing steeper seabed slopes and areas of complex seabed due to scour, mobile seabed, potential hardgrounds, or anthropogenic dredged channels. Steep slopes and abrupt changes in depth can pose a risk to cable installation and burial, as seabed burial tools, such as cable plows, are susceptible to stability issues and decreased burial potential as slopes increase. Areas of very shallow water also pose a challenge to the installation because a cable vessel suitable to install this type of cable typically requires an adequate draft to safely maneuver.

3.5.1.2 Cable and Pipeline Crossings

Existing utilities and other assets pose several challenges and risks with respect to the submarine export cables and may limit the methods and depth of burial available for a cable installation at the crossing. This may add cost and complexity to the installation, as well as residual risks to the installed cable from reduced burial in the area, the installation of external protection, and/or from maintenance activities for the existing asset. As such, cable crossings and close parallels are avoided to the extent feasible by the routing (see **Exhibit E-5: Effect on Communications** and **Exhibit E-6: Effect on Transportation** for additional information on existing offshore infrastructure).

3.5.1.3 Dredged and Maintained Channels

Dredged and maintained channels are under the purview of the USACE. The location and depths of navigation channels are authorized by the federal government, and the USACE periodically performs condition surveys to identify when maintenance dredging may be needed to keep the channel available at the authorized depth.

Should a cable route cross a maintained channel, the cable must be buried deep enough below the authorized depth to ensure that the channel can be safely maintained and to ensure that there is no risk to the cable (see **Exhibit E-6** for additional information). Although few vessels anchor in maintained channels, there is some risk that in an emergency, large vessels transiting the area may need to anchor there. Large vessels have greater anchor penetration. Maintained channels also may be subject to potential future maintenance dredging or deepening of the channel to allow use by larger vessels. To mitigate risk of impact to the submarine export cables from emergency anchoring, target burial depth in these areas will be informed by cable burial risk assessment (CBRA). While cable burial depth can be used to mitigate risks of external aggression due to anchoring, the increase in depth required greatly increases installation time, complexity and cost. Very deep cable burial can be impractical as it leads to thermal issues and potential overheating of the cable, as well as causing greatly increased installation time and complexity. As such, although routing within maintained channels is required along some portions of the submarine export cable route and will be mitigated appropriately as indicated by the CBRA, the intersection with federally maintained channels is avoided to the extent practicable by the submarine export cable routing.

3.5.1.4 Anchorages

Some anchorages are federally designated and under the purview of the USACE. Other anchorages are managed by the USCG and the Port Authority of New York and New Jersey (PANYNJ). Anchoring areas may also exist in areas where vessels await their turn in the queue to enter the New York harbor area or are on standby for orders on the next destination. Vessel captains may anchor in a location out of habit rather than per specific instruction, making these "de-facto anchorages" difficult to fully regulate. Automatic Identification System (AIS) data from the vicinity of the Project gives an indication of the frequency and distribution of anchoring across the area and provides a first-order constraint on these risks. The USACE may directly require increased cable burial depths within federally designated anchorages; the USCG or PANYNJ may also make recommendations for anchorage crossings.

Anchorages may be used primarily by smaller vessels, where anchor penetration is expected to be less than that of the large vessels more common within maintained channel areas. Other vessels, including articulated tub and barge vessels, may also anchor in anchorages. To mitigate risk of impact to the submarine export cables from anchor strike, target burial depth within anchorages will be informed by the CBRA considering anchor penetration depth. Although the Applicant can mitigate anchoring risk through the appropriate target burial depth, the increase in depth required in these areas by the CBRA typically results in greater installation complexity, duration and cost. Some of these areas may also be subject to potential future maintenance dredging or deepening to allow use by larger vessels. Therefore, crossing either designated anchorages or de-facto anchoring areas is avoided to the extent feasible in siting the submarine export cable route. If traversing known or potential de-facto anchorage areas is necessary, the Applicant may implement deeper burial based on the CBRA and/or as required by applicable agencies.

3.5.1.5 Traffic Separation Schemes

Traffic Separation Schemes are commonly used to identify and constrain inbound and outbound traffic lanes, typically with a separation zone between, to minimize the likelihood of vessel collisions. These traffic lanes are considered from a cable routing perspective for two reasons. First, there is an increased level of activity in these areas, so the risk of an anchor drag or other mishap causing external aggression to the cable is greater. Second, the increased vessel traffic poses a concern and potential complication during cable installation operations.

Although the identified TSSs in the vicinity of the Project are located outside of New York State territorial waters, the presence of TSSs between the Lease Area and the cable landfall area provide a constraint on the submarine cable route in federal waters that also limits the potential locations where the route can cross the New York boundary.

Charted Danger Zones, Restricted Areas, and Warning Areas exist for a variety of reasons and serve to advise mariners and other users of the risks of navigating an area or conducting some type of bottom contacting activity, such as fishing or cable laying. For these reasons, traversing charted danger zones is avoided to the extent practicable. Where avoidance is not entirely possible, residual risk is analyzed and mitigated.

3.5.1.6 Ocean and Dredged Material Disposal Areas

Similarly, charted Disposal Areas warn of the risk associated with traversing an area of seabed. While some areas may contain relatively harmless material such as dredged spoils from maintained channels, others may contain "Acid Wastes" (an industrial byproduct), "Municipal Waste" (a sewage treatment product), or munitions. Additionally, material removed to maintain navigable channels may be deposited within ocean disposal sites, some of which may be later utilized for beach nourishment projects depending on the material and need. For these reasons, the traverse of ocean disposal and dredged material disposal areas is avoided by the submarine export cable routing.

3.5.1.7 Sand Borrow Areas

Sand borrow areas serve as source regions for beach nourishment projects, which are part of coastal resiliency measures. BOEM's Marine Minerals Program works to manage sources of material to mitigate and replenish coastline and related terrain lost to erosion. Additionally, both New York and New Jersey have identified Sand Resource Areas, which are areas deemed to have some likelihood to be used as a sand resource (MMIS 2019). Sand Resource Areas are leased or authorized for use by BOEM in federal waters and by the USACE in state waters, as necessary, for mitigation of coastal erosion and storm damage restoration. Major damage from the impact of Superstorm Sandy brought attention to the need for sand resources off New York State (BOEM 2014). The submarine export cable route avoids known active sand borrow areas and avoids potential sand resource areas to the extent practicable.

The waters in the vicinity of the submarine export cable route also contain evidence of areas formerly used for offshore sand and aggregate dredging for fill and construction. Other locations have been used for placement of materials, including Hoffman and Swinburne Island, which were both built using fill placed on natural shoals (NPS 2021a). Some of these areas of historic fill or material extraction are no longer charted as such, but historic use has impacted the modern seabed features (USACE 1983). These areas are avoided to the extent practicable, as previous disturbances of the seabed often cause locally steeper slopes, enhance the formation of mobile seabed, and may expose underlying soils more challenging to cable burial.

3.5.1.8 Shipwrecks and Obstructions

Shipwrecks and other obstructions are cataloged in the NOAA Nautical Charts and within the NOAA Automated Wreck and Obstruction Information System database. These features may represent physical hazards to installation as well as being potentially historically or culturally significant. These features are avoided to the extent practicable by the submarine export cable routing. Where such features must be closely approached, the HRG survey provides insight into the location and nature of the feature through acoustic and magnetic datasets. Known and suspected shipwrecks and obstructions have been avoided to the extent practicable during pre-survey routing and subsequently refined following the acquisition of HRG survey data. Identified features and recommended buffer distances will be defined through review of the HRG survey data by a qualified marine archaeologist (see Section 4.8 of **Exhibit 4: Environmental Impact**) and the routes will be further microsited, if needed.

3.5.1.9 Biological Resources

The Applicant has minimized traversing sensitive habitats along the submarine export cable route to the extent feasible, including benthic habitats such as seagrasses and habitats supporting protected and commercially important species (see Sections 4.6 and 4.7 of **Exhibit 4**). The submarine cable route will be required to cross a Seasonal Management Area for Right Whales, where vessel speed restrictions are in place. Project-related vessels will comply with NOAA National Marine Fisheries Service speed restrictions as described in Sections 4.6 and 4.7 of **Exhibit 4.**

3.5.1.10 Commercial and Recreational Fishing

Fishing areas, artificial reefs, and regions of sensitive benthic habitat (see Sections 4.6 of **Exhibit 4**) are also avoided by the submarine export cable routing to the extent practicable. Areas of increased fishing effort are often difficult to identify and quantify, due to the transient nature of the activity. The Applicant has incorporated information from marine stakeholders in the submarine export cable route selection. Artificial reefs and fish havens are charted and are avoided by the submarine export cable route to the extent practicable, due to their potential to be a seabed hazard and out of a desire to minimize impacts on other seabed users.

3.5.2 Submarine Export Cable Route Alternatives Analysis

Based on results of the offshore constraints analysis, the Applicant evaluated five submarine cable route alternatives in New York State waters for the Project (**Figure 3.5-2**). A portion of one of the five routing alternatives is located in New Jersey State waters. The other four routing alternatives do not enter New Jersey State waters and involve different routes in the area of Gravesend Bay.

3.5.2.1 Submarine Export Cable Route Alternatives Description

The five submarine cable route alternatives are described in this section. Each of the routes is described relative to the cable landfall at the preferred EW 1 landfall at SBMT; nearshore constraints associated with other landfall locations are described in Section 3.8.

The Applicant reviewed characteristics of the submarine export cable route alternatives (SECs) SEC 1, SEC 2, SEC 3, SEC 4, and SEC 5) relative to the potential occurrence of fishing grounds, protected species, eelgrass, benthic resources, and marine mammalsWhile the Applicant assessed criteria related to fishing grounds, protected species, eelgrass, benthic resources, and marine mammals for these submarine export cable routes, and it was determined that these resources do not differ significantly between routes. Therefore, because these resources did not influence the assessment of submarine export cable route alternatives, they are not discussed furtherindividually for each of the submarine export cable route alternatives.

Generally, effects on fishing grounds, benthic, and pelagic resources are expected to be localized, temporary, and reversible along any of the submarine export cable route alternatives. Water column habitats within the export cable corridor would be temporarily affected during construction of the Project. The most likely construction-related effect on open water near the bottom would be the temporary and localized increase in turbidity resulting from equipment disturbing softbottom substrates during pre-lay dredging and when cables are installed. Chemical stressors related to inadvertent releases of fuels and fluids from vessels would be minimized through compliance with applicable U.S. regulatory requirements and the implementation of an agency-approved Oil Spill Response Plan and Emergency Response Plan. Sessile benthic organisms within or adjacent to the submarine export cable corridor would be exposed temporarily to increased turbidity and subsequent sedimentation. Once the subsea cables are installed, no significant turbidity effects would be expected, and sand waves and ripples would reform; epifauna and shallow infauna then would begin recolonizing the softbottom areas, followed by bivalves and other burrowing organisms. Encrusting and attaching species would colonize the cable protection material (e.g., rock or mattresses), forming small artificial reefs. Mobile species would move into the hardbottom area to forage or take shelter. These impacts to benthic resources would be general and similar in scale for submarine export cable route installation and operations along any of the submarine export cable route alternatives. Impacts would not differ substantively among submarine export cable route alternatives.

Fishing Grounds

The Applicant reviewed fishing effort (otter trawling, squid trawling, scallop dredging, hydraulic clam dredging, etc.) based on AIS, Vessel Monitoring System Transit Counts, Vessel Trip Reports, as well as fishing vessel transit data supplied by the commercial fishing industry as part of the NYSERDA-sponsored Fisheries Transit Workshop in Port Jefferson, New York.

Based on mapping of the most recent publicly available Vessel Monitoring System data (2015-2016) and Vessel Trip Report Data (2011-2015) on the Mid-Atlantic Regional Council on the Ocean portal, none of the submarine export cable route alternatives within New York state waters cross areas used as:

- Multi-species Groundfish Otter Trawling (vessels larger than 65 ft) at < 4 nautical miles per hour (knots, 7.4 kilometers per hour [km/h]),
- Squid Trawling at < 4 knots (7.4 km/h),
- Scallop fishing activity at < 5 knots (9.3 km/h),
- Pelagics (herring/mackerel/squid) fishing activity at < 4 knots (7.4 km/h),
- Monkfish fishing activity at < 4 knots (7.4 km/h),
- Longline fishing activity, or
- Surfclam/Quahog dredge fishing activity at < 4 knots (7.4 km/h).

Based on mapping of the same Mid-Atlantic Regional Council on the Ocean data, all of the submarine export cable route alternatives within New York State waters would cross areas of:

- Bottom trawl fishing activity (vessels smaller than 65 ft) at < 4 knots (7.4 km/h),
- Pots/traps fishing activity, and
- Sportfishing activity within New York State waters.

Areas that have had Squid Trawling activity at less than 4 knots (7.4 km/h) would be crossed outside of New York State waters along all of the submarine export cable route alternatives, but this would not affect the analysis of the submarine export cable routes in New York State.

In addition to the datasets described above, and in order to better understand the level of commercial and recreational fishing effort that takes place within the Project Area, Offshore Fisheries Liaison Representatives were typically onboard survey vessels during the geophysical surveys, assisted by scout boats, to document fishing activity along the submarine cable route alternatives. The Applicant has also obtained information from extensive outreach with fishermen and fishery agencies, with a focus on those who travel or fish in or near the Empire Wind Lease Area and submarine export cable routes.

Minimal commercial fishing activity was observed along the submarine cable route during survey efforts. Frequent communications during construction activities between the Offshore Fisheries Liaison Representatives, fishermen, and the installation vessel crew will ensure that this mitigation remains effective to minimize potential gear conflicts.

Based on these data and the low-intensity of commercial fishing activity along the submarine export cable routes in New York State, fishing grounds are not considered to be a differentiator between the submarine export cable route alternatives.

Protected Species and Marine Mammals

Protected species potentially present along the submarine cable route alternatives include marine mammals, sea turtles, and sturgeons as described in Section 4.7.2.1 of **Exhibit 4**. Marine mammals and sea turtles that occur in the vicinity of the submarine export cable route alternatives are highly mobile species, which utilize large areas of habitat (up and down the East Coast of the United States), well beyond the spatial extent of the various submarine export cable route alternatives. Therefore, the submarine export cable route alternatives all constitute a small percentage of the available habitat for these species. As highly mobile species, marine mammals and sea turtles will likely temporarily (for the duration of route clearance and installation activities) leave the vicinity of the work to use nearby habitat for any of the submarine export cable route alternatives. Similarly, Atlantic and shortnose sturgeons have the potential to be present along any of the submarine export cable route alternatives. The Applicant has proposed seasonal timing windows for seabed disturbance to minimize potential impacts. Based on the potential for these species to occur in any of the marine habitat in the vicinity, the potential impacts along submarine export cable route alternatives are not expected to differ.

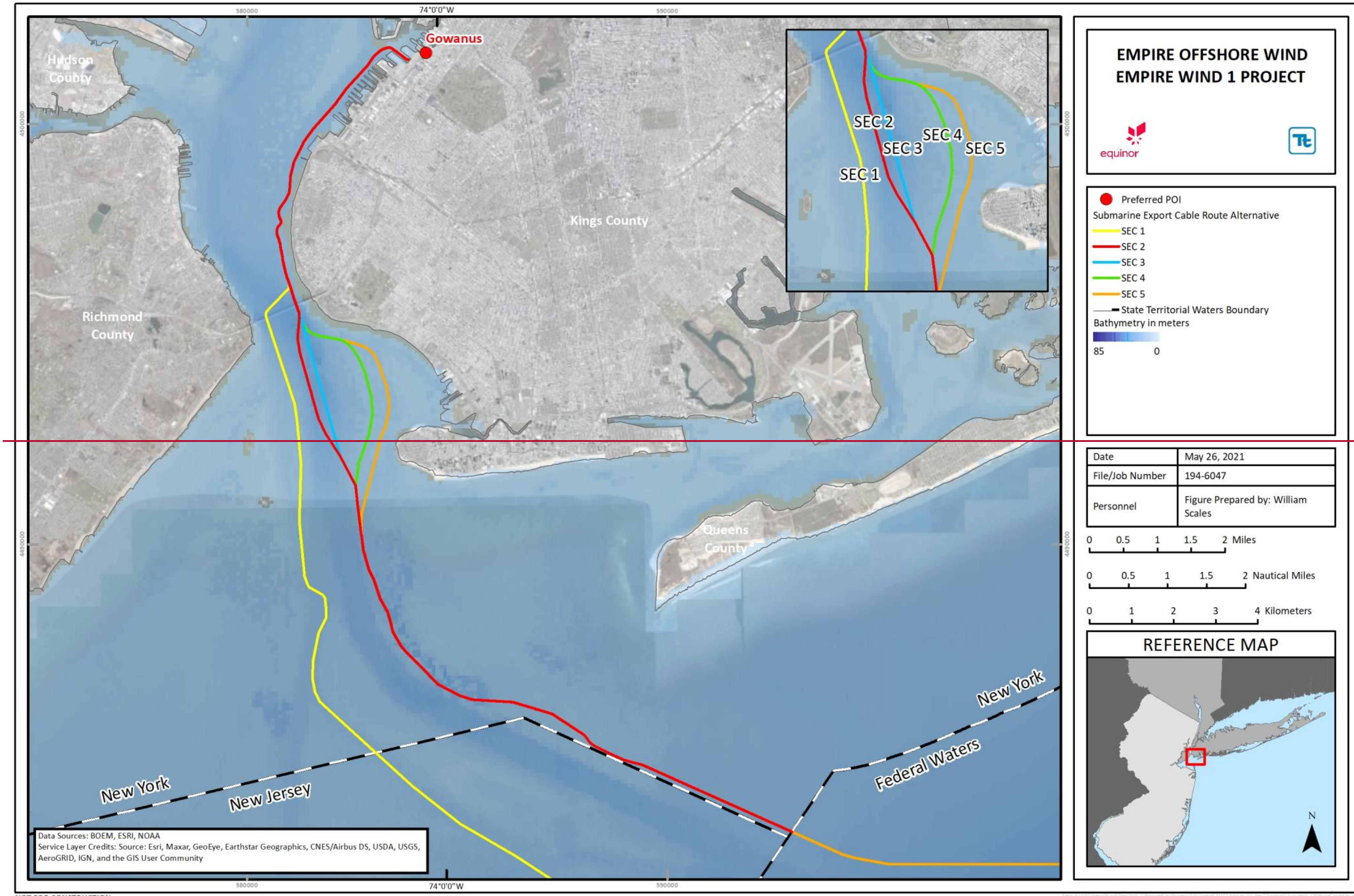
Eelgrass and Benthic Resources

No soft coral, lobster, seagrass, or squid eggs were observed during the benthic surveys. The nearest mapped eelgrass is located inshore of the barrier islands off Long Island, which is approximately 11 miles from the Project (NYSDEC 2021). Based on a combination of publicly available information and the Applicant's site-specific data, benthic habitats along the submarine export cable route alternatives are similar, and no rare or sensitive habitats are known to occur along any of the submarine export cable route alternatives. Therefore, impacts to benthic habitats and resources are expected to be similar for all alternate routes.

Submarine Export Cable Route Alternative SEC 1

Submarine Export Cable Route Alternative ~~(SEC)~~ 1 crosses New York State waters on the western side of the Ambrose Channel by traversing from New Jersey State waters to the south. The route then avoids charted shipwrecks as it heads northwest, entering the Swash Channel in order to avoid the charted anchorage areas on both sides of the channel. SEC 1 continues to site around charted wrecks and obstructions as it traverses the Swash Channel. As the Swash Channel turns towards the north, SEC 1 follows it towards the north as well, optimizing the crossing angle with the planned Transco Raritan Bay Loop (gas) Pipeline. This turn to the north allows Transco's pipeline to be crossed at an almost 90-degree angle. The route then parallels the eastern side of the Chapel Hill channel, veers slightly east to avoid a small area of harder seabed, and then makes an almost 90-degree angle traverse across the Chapel Hill Channel.

SEC 1 flanks the western side of Ambrose Channel as it heads up into the Narrows. Just north of a cluster of cable crossings that would be required, north of the Gravesend Bay on the eastern side of Ambrose Channel, SEC 1 makes a cut across the Ambrose Channel.


Gowanus
Hudson County
Richmond County
Kings County
Queens County
New York
New Jersey
New York
Federal Waters
SEC 1
SEC 2
SEC 3
SEC 4
SEC 5
74°0'0"W
EMPIRE OFFSHORE WIND
EMPIRE WIND 1 PROJECT
equinor
Preferred POI
Submarine Export Cable Route Alternative
SEC 1
SEC 2
SEC 3
SEC 4
SEC 5
State Territorial Waters Boundary
Bathymetry in meters
85
0
Date
May 26, 2021
File/Job Number
194-6047
Personnel
Figure Prepared by: William Scales
0 0.5 1 1.5 2 Miles
0 0.5 1 1.5 2 Nautical Miles
0 1 2 3 4 Kilometers
REFERENCE MAP
N
Data Sources: BOEM, ESRI, NOAA
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
NOT FOR CONSTRUCTION

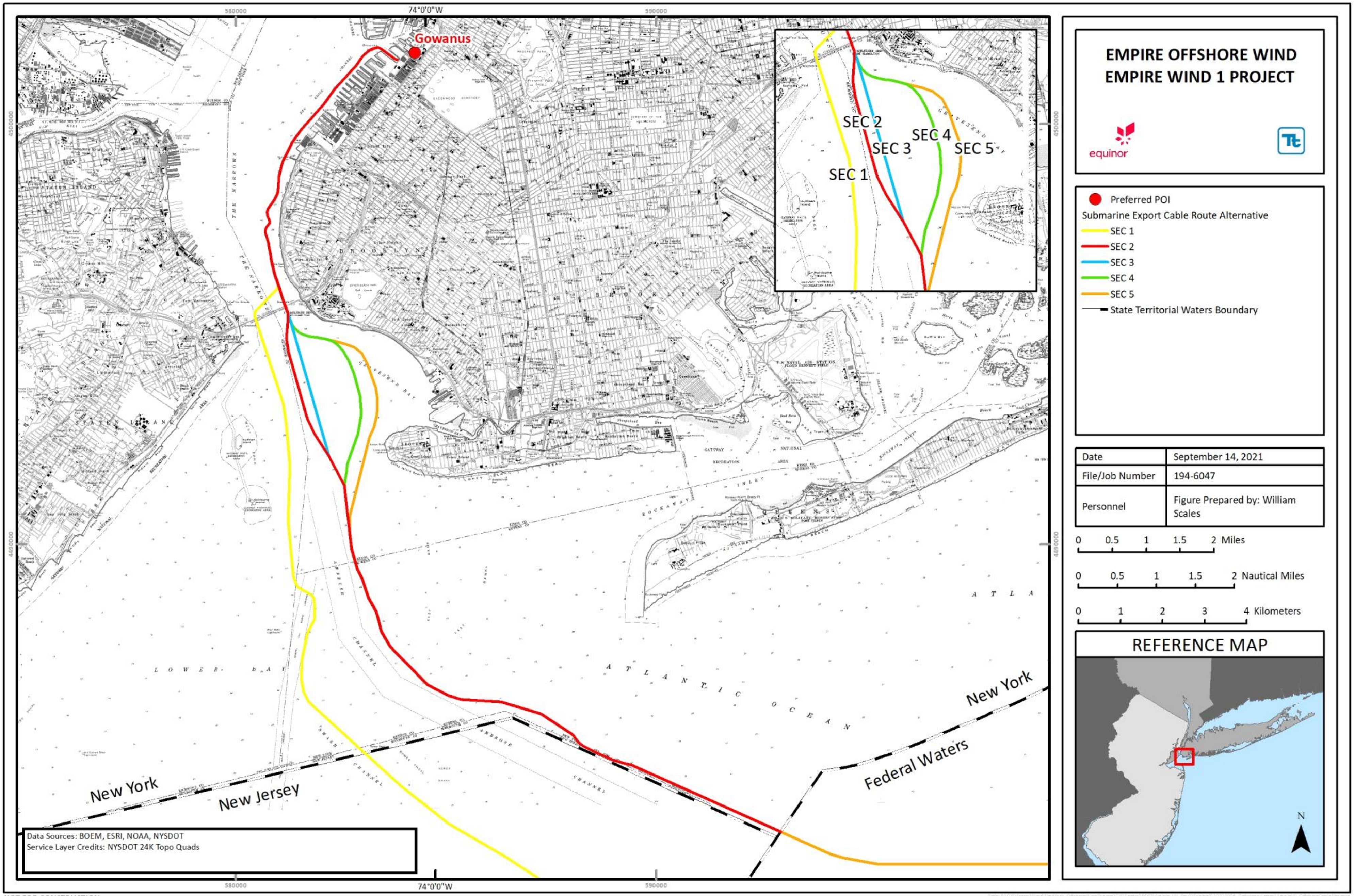


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Figure 3.5-2 Submarine Export Cable Route Alternatives

Once on the eastern side of Ambrose Channel, the route turns to the northeast and follows the eastern side of the Bay Ridge Channel. The Bay Ridge Channel is authorized to a depth of 40 feet (ft, 12.2 meters [m]) and recent surveyed depths are generally 41 to 45 ft (12.5 to 13.7 m) in the southern portion of the channel and shoal to 29 to 36 ft (8.8 to 11 m) along the central axis of the northern end of the channel. Within the Bay Ridge Channel, the route turns to the northeast and then east to land at the EW 1 landfall at SBMT. The route avoids parallels or close approaches with the Bayonne-Gowanus Power Transmission (Bayonne Transmission) cables, which approach Gowanus Bay from the north through the Red Hook Channel.

Submarine Export Cable Route Alternative SEC 2

From where the submarine export cable route crosses the New York State boundary 3 nm (5.6 km) offshore from federal waters, this route alternative continues parallel to the east of the maintained Ambrose Channel and then crosses the Transco Lower New York Bay Lateral gas (Transco) pipeline, which is buried in this area. Approximately 1,060 ft (323 m) northwest of the Transco pipeline crossing is the HVDC Neptune Regional Transmission System (Neptune cable), which is also indicated as buried in this area. The proposed Poseidon Transmission (Poseidon) cable is documented to closely follow the Neptune cable route and would also be crossed in a similar orientation, if the Poseidon cable is installed before the Project's submarine export cables. Approximately 0.4 nm (0.7 km) to the northwest, the route crosses the location of the planned Transco Raritan Bay Loop natural gas pipeline (Raritan Bay Loop) project. The status of the Raritan Bay Loop project will be monitored throughout its permitting and design, to determine if the Raritan Bay Loop will be installed before the Project's submarine export cables.

SEC 2 continues to parallel the Ambrose Channel across some areas of charted shoals, as well as harder seabed as indicated on the present nautical charts and available survey data. SEC 2 then traverses an area of deeper seabed, while maintaining appropriate distance from the Ambrose Channel. The route will then traverse a retired communications cable running from Coney Island to Swinburne Island.

Instead of turning east into Gravesend Bay past Coney Island, SEC 2 turns slightly west into the eastern portion of Ambrose Channel. It then exits Ambrose Channel on the north end of Gravesend Bay. Immediately north of Gravesend Bay, the route enters a charted cable area. SEC 2 encroaches to within approximately 82 ft (25 m) of the designated channel boundary due to the seabed constraints. A Safety Zone is depicted on NOAA Chart 12334 between the bridge footing and shore, which is understood to be related to a UXO area located on the seabed. This area is avoided by the routing.

As the route turns to the north, it crosses a charted pipeline area. The route turns to the northeast and enters the Bay Ridge Channel, where it crosses a second charted pipeline area. These assets include additional retired communications cables, water siphons and oil pipelines, which cross from Staten Island to Brooklyn (see **Exhibit 2: Location of Facilities** and **Exhibit E-5**). A third charted pipeline area is crossed by the route and is understood to contain the second of two out of service water siphons.

The route turns to the northeast and follows the eastern side of the Bay Ridge Channel. Within the Bay Ridge Channel, Submarine Export Cable Route SEC 2 follows the same route as SEC 1, turning to the northeast and then east to land at the EW 1 landfall at SBMT. The route avoids parallels or close approaches with the Bayonne Transmission cables, which approach Gowanus Bay from the north through the Red Hook Channel.

Submarine Export Cable Route Alternative SEC 3

Submarine Export Cable Route Alternative SEC 3 follows the same route as SEC 2 until Gravesend Bay, where it continues straight along the east side of the Ambrose Channel, crossing the USACE Gravesend Anchorage and USCG Anchorage #25. It then converges with SEC 2 at the north end of Gravesend Bay and follows the same route to the north of the Verrazzano-Narrows Bridge.

Submarine Export Cable Route Alternative SEC 4

Submarine Export Cable Route Alternative SEC 4 follows the same route as SEC 2, then enters Gravesend Bay past Coney Island and crosses USCG Anchorage #25. SEC 4 then converges with SEC 2 at the north end of Gravesend Bay and follows the same route to the north of the Verrazzano-Narrows Bridge.

Submarine Export Cable Route Alternative SEC 5 (Preferred)

Submarine Export Cable Route Alternative SEC 5 follows the same route as SEC 2. After passing around the end of Coney Island, the route traverses northeast closer to the shoreline of Coney Island and then enters into Gravesend Bay, closer to the shoreline than SEC 4. SEC 5 then converges with SEC 2 at the north end of Gravesend Bay and follows the same route to the north of the Verrazzano-Narrows Bridge.

3.5.2.2 Submarine Export Cable Preferred Route

A summary comparison of the submarine export cable route for selected evaluation criteria is provided in **Table 3.5-1**. As described below, based on assessment of evaluation criteria, including physical route characteristics, the presence of seabed and human constructed hazards and/or use conflicts, biological resources, cultural resources, and high-impact fishing areas, the Applicant selected SEC 5 as the preferred submarine export cable route alternative for the Project. A brief summary of the key criteria for each alternative evaluated is provided in the remainder of this section.

Submarine Export Cable Route SEC 1 is shorter than other routes within New York State waters, but the total length of the route, including New Jersey and federal waters, is longer. The primary advantage of this route is that it avoids areas of the shallowest water; however, it is associated with a number of potential challenges. It requires routing within maintained channels, including Swash Channel, and crossing the Ambrose Channel, which are associated with deeper burial requirements, significant additional cost and duration of construction, additional maintenance requirements, and potential use conflicts. Avoidance of crossing Ambrose Channel, where possible, was determined by the Applicant to be a priority due to the importance of the channel and the potential for future channel deepening.

Because SEC 1 requires crossing through New Jersey State waters, there are additional regulatory and permitting requirements associated with this route that do not exist along the other alternatives. This would include additional permitting requirements from the New Jersey Department of Environmental Protection and obtaining a license from their Bureau of Tidelands, which would add cost and complexity to the regulatory process, as well as potential schedule risk. Thus, the significant additional time, cost, logistical complexity, and potential use conflicts associated with this route through Ambrose Channel and New Jersey waters mean that Submarine Cable Route SEC 1 is not a reasonable alternative.

Table 3.5-1 Submarine Export Cable Route Alternative Comparison

Assessment Criteria	Alternative SEC 1	Alternative SEC 2	Alternative SEC 3	Alternative SEC 4	Alternative SEC 5
Total Route Submarine Export Cable Route Length	45.2 mi (72.8 km)	43.1mi (69.3 km)	43.0 mi (69.3 km)	43.5 mi (70.0 km)	43.7 mi (70.4 km)
Submarine Export Cable Route Length (New York boundary to landfall)	12.2 mi (19.6 km)	16.7 mi (26.9 km)	16.7mi (26.8 km)	17.1 mi (27.5 km)	17.3 mi (27.9 km)

Assessment Criteria	Alternative SEC 1	Alternative SEC 2	Alternative SEC 3	Alternative SEC 4	Alternative SEC 5
Maximum Water Depth, ft (m) a/	94.1 ft (28.7 m)	103.0 ft (31.4 m)	108.4 ft (33.0 m)	44.9 ft (13.7 m)	102.7 ft (31.3 m)
Minimum Water Depth, ft (m) a/	22.5 ft (6.9 m)	34.8 ft (10.6 m)	42.0 ft (12.8 m)	26.6 ft (8.1 m)	18.3 ft (5.6 m)
Number of dredged/maintained channel reaches crossed b/	5	4	4	3	3
Distance across Bay Ridge and Red Hook Channels	*2.9 mi (4.6 km)*	*2.9 mi (4.6 km)*	*2.9 mi (4.6 km)*	*2.9 mi (4.6 km)*	*2.9 mi (4.6 km)*
Distance across Main Ship Channel	*0.2 mi (0.3 km)*				
Distance across Ambrose Channel	*0.4 mi (0.7 km)*	*1.9 mi (3.0 km)*			
Total distance of dredged/maintained channel crossed b/	3.5 mi (5.6 km)	4.7 mi (7.6 km)	2.9 mi (4.6 km)	2.9 mi (4.6 km)	2.9 mi (4.6 km)
Distance crossing USCG Anchorage 25 c/	N/A	N/A	1.3 mi (2.1 km)	1.9 mi (3.0 km)	2.2 mi (3.5 km)
Number of existing utility crossings d/	19	19	19	19	19
Number of disposal areas crossed e/	0	0	0	0	0
Number of Sand Borrow Areas crossed f/	0	0	0	0	0
Wrecks and obstructions within the cable corridor g/	1	0	1	0	0

Notes:
a/ Bathymetry is measured for the submarine cable corridor where it enters state waters, from NOAA's Continuously Updated Digital Elevation Model.
b/ Based on USACE Maintained Channel Quarter Reach (USACE 2007); however, USACE Gravesend Anchorage is excluded.
c/ Based on NOAA Anchorage Areas (NOAA 2017) and USACE Maintained Channel Quarter Reach (USACE 2007). SEC 3 also crosses 0.37 mi (0.60 km) of the USACE Gravesend Anchorage in the same area.
d/ Does not planned utilities.
e/ Based on NOAA ocean disposal sites (NOAA 2020)
f/ Based on BOEM sand and gravel lease areas (BOEM 2020)
g/ Based on NOAA Automated Wrecks and Obstruction Information System (NOAA 2009) mapped locations within a 500-ft (152-m) corridor of the submarine cable route alternative.

Submarine Export Cable Route Alternative SEC 2 enters the eastern portion of Ambrose Channel in order to avoid areas of anchoring activity in the USACE Gravesend Anchorage and USCG Anchorage #25, as well as future potential expansion of the USACE anchorage included in the New York and New Jersey Harbor Federal Navigation Project (USACE 2020). This routing avoids the anchorages (USACE 2020) and targets deeper water but coincides with the highest level of transiting vessel traffic based on review of available AIS data. Few vessels have reason to intentionally deploy an anchor in the channel; vessel anchoring would typically only be associated with accidental deployment or intentional emergency anchoring. As such, anchoring along SEC 2 is less frequent than that associated with SEC 3. However, during construction within Ambrose Channel, the channel would be partially to completely blocked for several days for the submarine export cable installation. Because the SEC 2 route is within the maintained channel, it is also subject to potential future maintenance dredging during Project operations or deepening of the channel to allow use by larger vessels, which need to be considered for cable installation. However, this portion is naturally deeper than areas currently requiring maintenance, so it is not expected to require dredging in the near future.

Although the Applicant considers avoidance of installing the cable within Ambrose Channel to be a priority, the avoidance of crossing the anchorage area was determined to be an even greater priority when considering this route compared to SEC 3. SEC 2 is considered a reasonable alternative, but it is not preferred due to the high level of marine navigation and associated potential impacts during construction, as well as the additional target depth regulatory requirements for cable burial expected in this area.

SEC 3 runs just east of and parallel to Ambrose Channel and lies partly within an anchorage planned for deepening and/or widening to allow additional anchorage of large vessels (USACE 2020). It is the shortest route in the Gravesend Bay area, but closest route to the Ambrose Channel besides SEC 2 and is close to the northbound movement of large ships (observed in 2019 to include up to approximately 180,000 deadweight tons). This area has exposure from large vessels both intentionally anchoring near the channel and transiting the channel itself. Therefore, SEC 3 involves the most potential anchoring from large vessels. Compared to SEC 2, cable burial along SEC 3 would therefore need to mitigate for significantly more frequent and intentional anchoring by large vessels. Input from USACE and maritime stakeholders relative to SEC 3 indicated concern over routing in this area.

If the proposed anchorage expansion results in dredging along the cable route prior to the installation of the Project, it could also result in more compacted sediments at the seabed at the time of cable installation, which could in turn make cable installation to the required burial depth more challenging. SEC 3 also is more sensitive to the ability to achieve target burial depth than the other considered routes, because installation of cable protection measures over the submarine export cables may not be considered acceptable in this area based on the existing and future additional anchorage use. In contrast, the use of cable protection along SEC 2, if necessary, is expected to be less problematic due to the greater water depths within the channel and lower frequency of anchoring. All of these factors result in increased submarine export cable installation time and complexity for SEC 3, in an area with a high level of maritime use and potential impacts to maritime stakeholders. Based on the complexity of installation, planned anchorage deepening/widening, potential marine stakeholder impacts, and stakeholder feedback received by the Applicant, SEC 3 is not a reasonable alternative.

SEC 4 curves to the east through the mid-section of the USCG Anchorage #25 and avoids the deeper USACE Gravesend Anchorage and the potential anchorage expansion. It lies in a frequently used portion of Anchorage #25 that is mainly used by tugs, barges, small tankers, cargo vessels, and other work boats. Since much of the traffic across SEC 4 is related to smaller vessels, anchor penetration is expected to be less than that of the large ships more common along alternatives SEC 2 and SEC 3. However, this area also serves as an anchorage for articulated tug and barge vessels. Some of these barges carry anchors almost as large as the much deeper draft vessels transiting Ambrose Channel. This route would cause additional concern if target burial were not achieved due to geological conditions or if this deep burial was untenable due to thermal issues related to the deep burial. In stakeholder meetings with agencies including the USCG and USACE, and in discussion with maritime stakeholders, this route was one of the least preferred due to the anchoring activity and working vessels. Based on cable burial depth required to mitigate risks and stakeholder input, SEC 4 is not considered to be a reasonable alternative.

SEC 5 traverses the easternmost route in Gravesend Bay and the shallower water approximately 1,150 ft (350 m) eastward of Alternative SEC 4. It is designed to avoid the USACE Gravesend Anchorage, the potential anchorage expansion area, and the higher used area (informed by AIS data) of USCG Anchorage #25 that is traversed by SEC 4. Based on review of 2019 AIS records for all vessels travelling at less than 0.5 knots and a more general view of prior years, anchoring along SEC 5 was infrequent in comparison to other alternatives considered, and such anchoring was mainly by pleasure craft and one USCG vessel. Anchor drag risk associated with transiting vessels would also be reduced along SEC 5, as very few vessels transit through the bay so far to the east. Thus, SEC 5 is a reasonable and Applicant's preferred alternative.

In comparing the alternatives in the Gravesend Bay area, although SEC 5 is slightly longer than the other alternatives, there were no significant differences in environmental impacts between routes. SEC 5 does traverse closest to potential winter flounder spawning habitat, which consists of sandy bottom areas in water depths of 20 ft (6 m) or less. However, the Applicant's commitment to following recommended timing windows during cable installation (see **Exhibit 4**) will minimize potential impact to this resource. Although there is some commercial and recreational fishing in the Gravesend Bay area, information from commercial fishing outreach indicates this mostly consists of small vessels using pots/traps for fish and crabs tied to lines laid along the seabed. Small dredges are also employed for crab harvesting in the Lower Bay during certain months. Both of these methods have minimal seabed penetration compared to ship anchors. Input from maritime users (see **Appendix A**) indicated a preference for route SEC 5. Thus, given all of the considerations described above, SEC 5 is the preferred submarine export cable route.

3.6 Onshore Substation Alternatives Analysis

Evaluation of the POI at the Gowanus 345-kV Substation indicated that an additional site would be required for an onshore substation to support the Project's 230/345 kV transformers and related equipment, due to insufficient space within the existing Gowanus 345-kV Substation. The Applicant assessed several potential parcels along the Brooklyn waterfront in Sunset Park for their feasibility and suitability for the development of a new onshore substation. Parcels for a potential onshore substation site were initially screened based on sufficient size for substation development, location to the south and west of the POI (to minimize the combined length of the submarine export and onshore cable routes), proximity to the POI, possible availability, and consistency with existing land uses/zoning (i.e., eliminating public open space). Based on this screening, four sites were then considered for onshore substation development as depicted in **Figure 3.6-1.** The Applicant assessed suitability of parcels based on the following criteria:

- Availability (i.e., on the market for lease or sale);
- Distance from the POI;
- Flood hazard elevations;
- Zoning compatibility;
- Setback requirements;
- Existing land use;
- Available space;
- Proximity to environmental and cultural resources;
- Constructability factors (e.g., extent of site grading needed, access);
- Existing redevelopment plans; and
- Proximity to suitable cable landfall (see Section 3.7 for cable landfall alternatives analysis).


EMPIRE OFFSHORE WIND
EMPIRE WIND 1 PROJECT
equinor
Gowanus POI
Onshore Substation Alternative
Preferred Onshore Substation
Date May 12, 2021
File/Job Number 194-6047
Personnel Figure Prepared by: William Scales
0 250 500 750 1,000 Feet
0 100 200 300 400 Meters
REFERENCE MAP
N
EW 1
Narrows Generating Station
Sunset Park Pier
65th St. Railyard
74°1'0"W
74°0'0"W
40°39'0"N
Data Sources: ESRI
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
NOT FOR CONSTRUCTION

Figure 3.6-1 Onshore Substation Alternatives

3.6.1 Onshore Substation Alternatives Description

This section describes the four onshore substation sites that the Applicant selected for detailed evaluation: the 65th Street Railyard site, the Sunset Park Pier, the Narrows Generating Station site and the EW 1 site at SBMT.

3.6.1.1 65th Street Railyard Onshore Substation Alternative

The 65th Street Railyard site is an approximately 53.4-acre (ac) (21.6-hectare [ha]) tax parcel containing a railyard located on the Brooklyn waterfront between 65th and 63rd Streets. Formerly the Long Island Rail Road's Bay Ridge Yard, it was renovated by the New York City Economic Development Council (NYCEDC) in 2000. The railyard is now maintained and operated by the New York New Jersey Railroad, which also provides rail service along 1st Avenue in Sunset Park to SBMT. It consists of nine body tracks and two float bridges and is intended for use as a railcar float facility. In 2016, approximately 3,500 loaded railcars used the New York New Jersey Railroad carload float system between Greenville Yard in Jersey City and 65th Street Railyard, and the PANYNJ was awarded a FASTLANE grant to improve the transload capabilities of the 65th Street Railyard (NYCEDC 2017). The distance from the 65th Street Railyard to the site boundary of the POI is approximately 1.9 mi (3.0 km).

3.6.1.2 Sunset Park Pier Onshore Substation Alternative

The Sunset Park Pier site was evaluated as a waterfront development opportunity for a new pier north of the Brooklyn Army Terminal between 57th and 58th Streets. Development rights extend from the pierhead line to the shoreline, a distance of approximately 1,400 ft (427 m) with a lot frontage of approximately 315 ft (96 m), providing a total area of approximately 10 ac (4 ha); however, the tax parcel size is currently only 1.5 ac (0.6 ha). Review of historic aerial photographs indicated that a former pier was removed from this location, indicating prior disturbance of this benthic habitat and possible remains of the former structure below water. The former pier structure was a small boat facility constructed sometime prior to 1920, which was rebuilt as a ship berth and warehouse before 1932. The pier collapsed over time, and additional demolition of pier components occurred between 2004 and 2007. The distance from the Sunset Park Pier site to the site boundary of the POI is approximately 1.6 mi (2.5 km).

3.6.1.3 Narrows Generating Station Onshore Substation Alternative

The Astoria Generating Company, L.P., a wholly owned subsidiary of Eastern Generation, LLC, operates two electric generating stations in the Gowanus/Sunset Park area of Brooklyn, namely the Gowanus Generating Station and the Narrows Generating Station. The onshore substation site evaluated is at the Narrows Generating Station facility, which serves about 352 MW of existing generation. As currently operated by Eastern Generation, LLC, this existing generation consists of 16 simple-cycle combustion turbine units on two floating power barges, located in Sunset Park adjacent to 1st Avenue between 54th and 53rd Streets. In 2018, Eastern Generation, LLC filed plans with the Commission to retire the generating units at the Narrows facility upon the commencement of operation of the repowered Gowanus Generating Station interconnecting into the Gowanus 345-kV Substation (DPS Case # 18-F-0758, Astoria Generating Company, LP 2019), which introduces timing considerations with potential schedule constraints for the Project. The overall tax parcel size is approximately 5.8 ac (2.3 ha), where approximately 3 ac (1.2 ha) would be available for an onshore substation after demolition of existing facilities associated with the facility (e.g., above ground storage tanks). The distance from the Narrows Generating Station to the site boundary of the POI is approximately 1.4 mi (2.2 km).

3.6.1.4 EW 1 Onshore Substation Alternative (Preferred)

The preferred EW 1 Onshore Substation Alternative uses a portion of SBMT for the new onshore substation. SBMT is located in Sunset Park, Brooklyn adjacent to 1st Avenue/2nd Avenue between 29th and 39th Streets.

The Applicant looked at an approximately 9.0-ac (3.6-ha) portion of the 92.8-ac (37.6-ha) SBMT parcel for the potential to site the onshore substation. SBMT is owned by New York City and leased to the NYCEDC. The Sustainable South Brooklyn Marine Terminal (SSBMT) holds a sub-lease with NYCEDC. Although the marine terminal has been largely inactive for maritime transport in recent years, the Sims Municipal Recycling Facility is located on the 29th Street Pier within SBMT, and there are plans to reactivate the remainder of SBMT as a marine shipping facility, as well as plans to upgrade the port facility to allow offshore wind developers to utilize the facility as a construction and staging area. The terminal contains several recently constructed (2011) rail infrastructure features, including a rail spur for break-bulk along the 39th Street shed, two new rail sidings for auto rack loading and unloading, and a rail connection to the Sims Municipal Recycling Facility. SBMT is less than 0.1 mi (0.2 km) from the site boundary of the POI.

3.6.2 Onshore Substation Preferred Alternative

Following assessment of the selection criteria, the Applicant determined that the EW 1 site at SBMT is the most suitable, preferred alternative for construction of the new onshore substation for the Project. All other sites are farther from the POI and have additional challenges associated with site use or redevelopment plan compatibility, available space, land acquisition, constructability, and/or environmental impacts.

The 65th Street Railyard is being developed as a significant transportation hub along the Brooklyn waterfront. In 2014, the PANYNJ published a draft Tier I Environmental Impact Statement for the Cross Harbor Freight Program to study cross harbor transportation options to alleviate truck traffic. A Record of Decision was issued in 2016, which included a rail tunnel alternative crossing the 65th Street Railyard as one of the preferred alternatives advanced for further study. Under all operating scenarios for the rail tunnel, the 65th Street Railyard would process carload freight moving to and from Brooklyn, parts of Queens, and southern Long Island (FHWA and PANYNJ 2014). Enhanced waterborne transportation alternatives from the 65th Street Railyard were also part of this study. On May 5, 2017, the Port Authority issued a request for proposals for a Tier II Environmental Impact Statement of the preferred alternatives for the Cross Harbor Freight Program. The FASTLANE grant from the Federal Highway Administration for 65th Street Railyard funds additional improvements beyond those contemplated in the Tier II study (FHWA and PANYNJ 2014).

The Applicant's discussions with New York City stakeholders indicated that plans for the 65th Street Railyard, including improvements associated with the Cross Harbor Freight Program, would not be compatible with development of an onshore substation at the site. Given the focus of maintaining and expanding rail operations and trans-harbor freight movement through the 65th Street Railyard and the priorities for the site, the Applicant determined that there would be significant potential use conflict and challenges in obtaining a lease agreement for an onshore substation. As such, the 65th Street Railyard Onshore Substation Alternative is not a reasonable alternative for the Project.

The Applicant evaluated the Sunset Park Pier Onshore Substation Alternative as an opportunity to develop a new pier as a location for the onshore substation within the development rights associated with a former pier that is no longer present. Despite the existence of development rights, the permitting associated with a new pier structure to support a substation would be challenging. Building a pier for the onshore substation site would result in construction-related water quality impacts and permanent shading, dredge, and fill impacts, which would add significant regulatory challenges compared to the use of an existing, onshore industrial site for siting the onshore substation facility. In addition, there may be additional construction complexity and environmental impacts associated with removal of previously existing pier structure components in this area, if such components still exist below the mudline. Due to the logistical complexity, cost and regulatory challenges, as well as the additional environmental resource impacts associated with permanent shading of the benthic habitat, the Sunset Park Pier Alternative is not a reasonable alternative for the Project.

Potential redevelopment areas that comprise the Narrows Generating Station were also evaluated for the onshore substation; however, current space availability is constrained by the presence of existing structures that would have to be removed prior to onshore substation construction, as well as the presence of existing rights-of-way. The removal of those existing structures in turn is dependent upon the decommissioning and remediation of the facility prior to the start of Project construction. As of the date of this filing, the plans for decommissioning the Narrows facilities have not yet been filed for the Gowanus Repowering Project (NYSDPS Case # 18-F-0758)

The Applicant had not been able to secure an agreement for use of the Narrows Generating Station site, while lease agreement discussions advanced with SBMT for the preferred EW 1 Onshore Substation Alternative. Therefore, the Narrows Generating Station Onshore Substation Alternative is not a reasonable alternative for the proposed Project, due to the existing site constraints, lack of ability to secure an agreement, and the potential scheduling risks.

The EW 1 Onshore Substation Alternative at SBMT was determined to be the preferred alternative based on space availability and the fact that it is the closest sufficiently sized parcel to the POI. SBMT is less than 0.1 mi (0.2 km) from the POI and would result in an interconnection cable route that is only approximately 0.2 mi (0.3 km). Because the site is already developed for industrial use, no major environmental or cultural resource issues are expected for development of an onshore substation at SBMT. In addition, the Applicant is in the process of securing a lease agreement for the site, confirming that it is commercially available. Moreover, siting of the onshore substation at SBMT directly adjacent to the cable landfall (see Section 3.7) is expected to minimize impacts to the onshore and human environments during construction and operation of the Project.

3.7 Cable Landfall and Onshore Cable Route Alternatives Analysis

To identify the preferred cable landfall site, the Applicant conducted coastal and waterfront engineering analyses of the risks and benefits of potential cable landfall locations at multiple sites in New York. Depending on the distance to the onshore substation, the submarine export cables may transition to onshore export cables between the cable landfall and the onshore substation, or in the case of the EW 1 Cable Landfall Alternative at SBMT, the submarine export cables may be pulled directly into the onshore substation (hereafter, EW 1 onshore export cables). Interconnection cables leave the onshore substation to deliver power to the POI. The onshore cable route refers to the complete route traversed by the onshore export and interconnection cables between the submarine cable landfall and the POI. Because installation methods and construction corridor impacts are similar for the onshore export and interconnection cable installation, no distinction was made between the onshore cable types and segments for the purposes of evaluating the onshore cable route alternatives.

The locations of potential cable landfalls were also informed based on the submarine export cable routing analysis (Section 3.5), and the onshore substation site selection (Section 3.6).

3.7.1 Selection of Conceptual Cable Landfall and Onshore Cable Route Alternatives

Based on the location of the POI and the preferred EW 1 Onshore Substation Alternative at SBMT (see Section 3.6), the study area for a potential submarine export cable landfall includes the Brooklyn shoreline between Coney Island to the south, and the Sunset Park and Red Hook neighborhoods to the north. For much of this highly developed area, which borders the upper part of the Lower Bay of New York Harbor, Gravesend Bay, and Upper Bay, the shoreline typically consists of bulkheads, steel sheet piles, seawalls, wood piles, riprap, concrete and other debris, or a combination thereof. In some areas, relic structures and marine debris remain from former shoreline developments. Cable and other asset crossings are present across the navigation channels. Potential shoreline locations of adequate size for the submarine export cables to make landfall are limited, due to the highly developed nature of the area.

With the selection of the preferred EW 1 onshore substation site at SBMT, landfalls to the north of SBMT and ConEdison's Gowanus 345-kV Substation were eliminated. Potential landfall sites further north would lengthen the overall transmission system from the offshore substation to the POI (thereby increasing cost, time and potential impacts) and would need to represent substantial benefit to offset these undesirable attributes. Furthermore, routes making landfall north of the Gowanus 345-kV Substation add significant complexity due to challenges of constructing within or across the Gowanus Canal, currently a U.S. Environmental Protection Agency Superfund site. Therefore, the concept of landfall north of the Gowanus 345-kV Substation was not explored further. The concept of a direct landfall to the Gowanus 345-kV Substation was also eliminated, due to the potential complexities associated with an existing cable landfall (Bayonne Transmission) at that location. It was also recognized that the need to construct an onshore substation on a separate parcel would negate potential benefits of direct landfall to the Gowanus 345-kV Substation, because a land route would still be required to connect to the proposed onshore substation site.

In response to stakeholder feedback, the Applicant evaluated cable landfall alternatives as far south as Coney Island and within Gravesend Bay, and associated onshore routes to the POI. The remaining conceptual landfall alternatives selected for detailed evaluation were located along the Brooklyn waterfront to the north of the Verrazzano-Narrows Bridge. From each cable landfall alternative, the goal of the onshore cable routing was to develop a constructible route that is largely sited within public rights-of-way (ROWs) and minimizes impacts to the environment and the public. Conceptual routes developed for further analysis incorporate the following objectives, to the extent practicable: maximize use of public ROWs; minimize in-street work; avoid existing utilities; allow sufficient space for construction by routing in wider corridors; and maintain construction flexibility.

Siting the onshore cable routes to use public ROWs, where possible, is advantageous because the area is congested and highly developed, and is generally made up of small, privately-owned lots with insufficient space for constructing the Project. Public ROWs limit the number of stakeholders directly impacted and the number of new landowner easements that must be acquired for the onshore cable route.

Minimizing in-street work reduces impacts on traffic, enhances safety during construction, and typically shortens the duration of installation. It is also preferable to avoid roadways where possible because they typically contain gas, sewer, water, telecommunications, and electric utilities, which add routing and workspace constraints, construction logistics and complexity.

During conceptual routing, the route alternatives that had some construction flexibility for siting refinement were preferred. For example, roadway corridors with available shoulders or space on both sides of the roadway were preferred. Wide corridors are needed to allow for adequate construction workspace and access for installation of the Project and to minimize the potential need for road closures. By routing the Project along wider ROW corridors, constraints during the route assessment and development process can more easily be avoided with minor modification of the route alignment and/or construction workspace.

3.7.2 Cable Landfall and Onshore Cable Route Evaluation Criteria

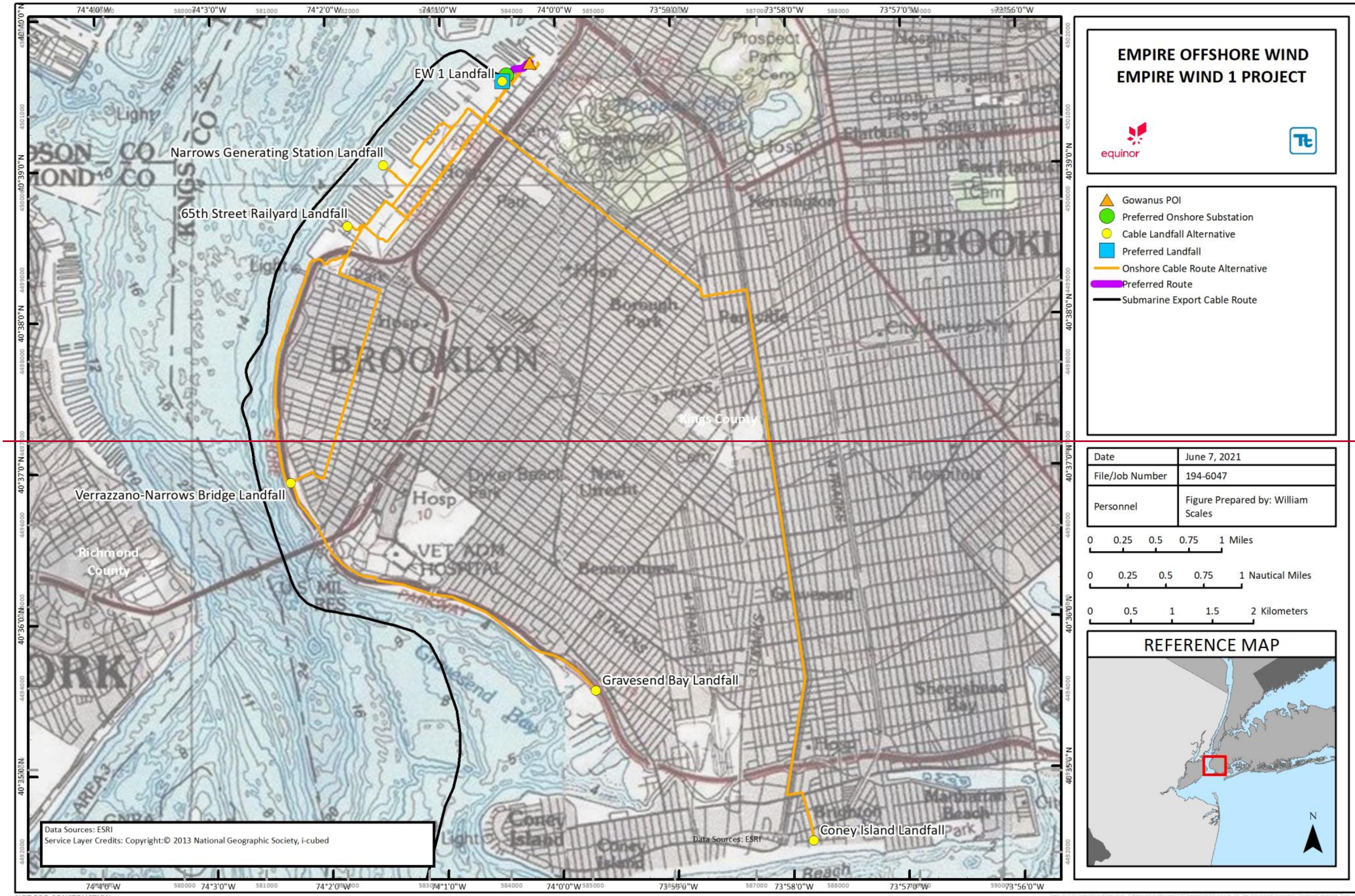
The evaluation of cable landfall and onshore cable route alternatives was conducted as an iterative process that involved multiple steps of evaluation of the offshore and onshore cables routes, constraints on potential landfall locations, and the feasibility of landfall installation methodologies at potentially suitable landfall sites. Each of these Project components, although described as separate evaluations, were considered in concert for the selection of the overall preferred solution for the Project.

3.7.2.1 Cable Landfall Evaluation Criteria

Cable landfall and associated onshore cable route alternatives that were evaluated in detail are shown in **Figure 3.7-1**. Each landfall was evaluated relative to the following constructability and logistical, environmental resource, and stakeholder criteria:

- Proximity to the preferred POI (e.g., onshore route length);
- Prior subsea cable landfall success in nearby areas;
- Staging area size/options (e.g., preferably land without permanent structures, with a minimum size to allow for adequate staging);
- Hydrodynamics and sediment dynamics (e.g., erosion);
- Artificial interferences (e.g., fish trap area, pipelines, dredging);
- Environmental, wildlife habitat, and cultural considerations (e.g., eelgrass, dunes, wetlands, buried and/or submerged cultural resources);
- Constructability complexities (e.g., long additional water crossings); and
- Land use (consistency of existing uses, minimizing impacts to public lands).

Cable landfalls were evaluated relative to the use of horizontal directional drilling (HDD) installation methodology as well as open cut methodology. A description of these installation methods is provided in this section; an evaluation of potential installation methods for the Project is provided in Section 3.8.2.2.


EMPIRE OFFSHORE WIND
EMPIRE WIND 1 PROJECT
Gowanus POI
Preferred Onshore Substation
Cable Landfall Alternative
Preferred Landfall
Onshore Cable Route Alternative
Preferred Route
Submarine Export Cable Route
Date
June 7, 2021
File/Job Number
194-6047
Personnel
Figure Prepared by: William Scales
0 0.25 0.5 0.75 1 Miles
0 0.25 0.5 0.75 1 Nautical Miles
0 0.5 1 1.5 2 Kilometers
REFERENCE MAP
EW 1 Landfall
Narrows Generating Station Landfall
65th Street Railyard Landfall
Verrazzano-Narrows Bridge Landfall
Gravesend Bay Landfall
Coney Island Landfall
Kings County
Richmond County
BROOKLYN
Data Sources: ESRI
Service Layer Credits: Copyright:© 2013 National Geographic Society, i-cubed
NOT FOR CONSTRUCTION

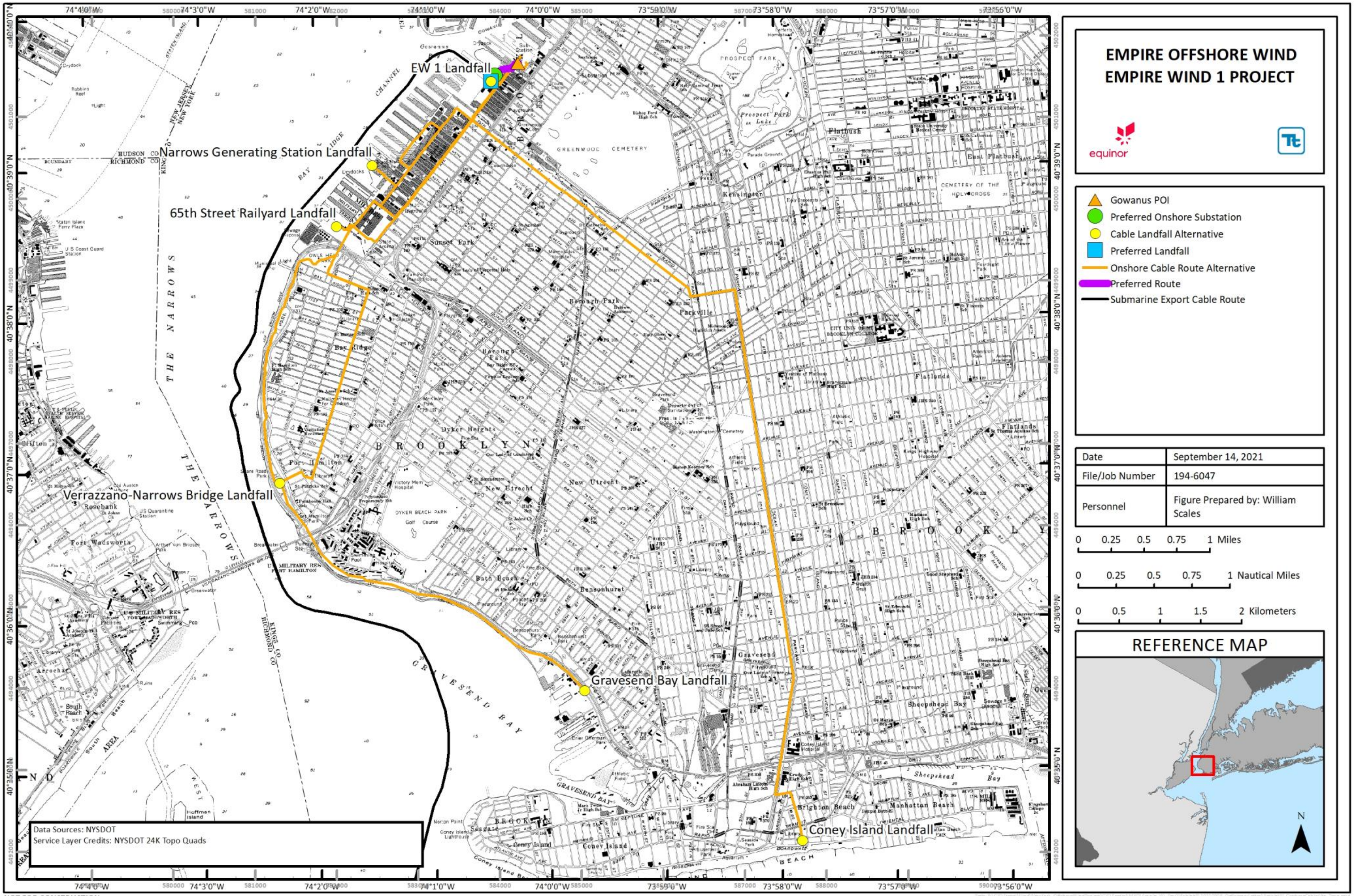


Figure 3.7-1 Cable Landfall and Onshore Cable Route Alternatives

HDD Installation

Horizontal directional drilling is a trenchless installation method often used to install cables in ducts under sensitive coastal and nearshore habitats, such as dunes, beaches, waterways, and submerged aquatic vegetation. HDD can also be used to cross under major infrastructure, including railroads and highways. Typically, HDD operations for an export cable landfall originate from an onshore landfall location and exit a certain distance offshore, determined by the water depth contour and total HDD length considerations. To support this installation, both onshore and offshore work areas are required.

The onshore work areas are typically located within the cable landfall parcel, supporting a drilling rig containment pit for drilling mud, a drill control cab, and staging of the drill stem and drilling mud production/recycling. Once the onshore work area is set up, the HDD activities commence using a rig that drills a borehole underneath the surface. The drill begins with a pilot bore that consists of advancing a steerable, rotary drill bit along the design alignment from the drill rig entry location to the exit location. Once the pilot bore is completed, the drilling assembly is removed and replaced with a reaming assembly. Reaming involves enlarging the pilot bore to a larger diameter to accommodate the conduits. Depending upon the required diameter, multiple passes with reamers of increasing diameter may be required to incrementally enlarge the pilot bore to its final diameter.

Upon completion of the reaming pass(es), the condition of the HDD bore is assessed by completing a swab pass through the bore. This pass consists of pushing or pulling a slightly smaller diameter barrel or ball reamer through the fully reamed bore from start to finish. Once the drill for the HDD exits onto the seafloor, the duct in which the submarine cable will be installed is pulled back onshore within the drilled borehole from the exit side.

The offshore exit location requires some seafloor preparation in order to collect any drilling fluids that localize during HDD completion. Typically, a temporary steel casing is installed on the exit side from a jack-up barge to below the mudline. This jack-up barge would also house a drill rig. The Applicant assumes that preparation would also require excavation of a pit or installation of a cofferdam at most sites. A pit would be excavated or material within the cofferdam would be dredged prior to installation of the conductor casing. The offshore work area for HDD installation would require approximately 10,000 square feet (930 square meters), and siting consideration is needed to avoid impact to marine traffic.

Onshore, the entry side of the HDD installation requires an approximate workspace of 200 by 200 ft (61 by 61 m). The entry side staging area is required to locate equipment necessary for the installation, which includes the drill rig, stacks of drill pipe, operator control cabin, tooling trailers, crane or excavator, separation plant, mud tanks, mud pumps, water storage tanks, office trailer, and support trailers. In addition to the entry and exit staging areas, a staging area is also required for fabricating sections of the pipe or conduit string. Typically, the conduit or pipe string is fully fabricated into a single pipe with a length equivalent to the approximately length of the HDD installation (additional length may be necessary to account for geometry). This results in a pipe stringing area requirement for a single conduit pipe string that is typically 20 to 25 ft (6.1 to 8.2 m) wide by the length of the pipe string.

Another consideration for HDD landfall is that the soil thermal resistivity, a critical factor for the cable design, limits the burial depth for the installation. Important design parameters are the submarine export cable length from the offshore substation to shore, electrical current, and submarine export cable installation depth. The cable landfall will typically consist of pre-installed conduits (steel or high-density polyethylene) ready for the submarine export cables to be pulled through. Due to the long cable routing and electrical parameters of this Project, landfall is the most critical location for the cable design, where burial depth poses most risk of derating the export cable due to the cable heat limitations. Derating is a reduction in the cable's rated capacity to carry current, to prevent degradation of the cable insulation due to heat. In case of an HDD, the maximum cover will be located on the shore side of the drill alignment. This maximum cover will typically be measured from ground level onshore to the safe distance below any existing structures or existing piles along the shoreline. A 49-ft (15-m) burial depth is the critical depth limit based on information provided by cable suppliers.

HDD installations also require the overlying soils to possess sufficient strength to resist the required drilling fluid pressures during the installation and to allow the fluids to flow through the bore path created by the drilling equipment and back to the drill rig location. Sands, silts, and clays, when in a very soft or very loose state, may not provide sufficient strength to resist the required fluid pressures necessary to complete an HDD installation. It is important to note that longer installations typically require greater depths of cover to allow for sufficient overlying strength to resist the drilling fluid pressures.

Inadvertent returns occur when drilling fluid pressures exceed the strength of the overlying geotechnical material, and pressure causes the drilling fluids to follow a path that flows upwards and outwards until the pressure is relieved. Drilling fluids reaching the sediment surface may pond on the ground surface in uplands or be released on the seabed as inadvertent returns. All HDD installations carry some risk of an inadvertent drilling fluid return, especially during the exit curve and exit tangent, as the drill bit is steered upwards toward the ground surface. Inadvertent return risks can be reduced along the majority of an HDD alignment by selecting an appropriate depth of cover that provides sufficient overlying strength to resist the required fluid pressures; however, near the entry and exit points an HDD will need to cross shallow sediments.

Geotechnical conditions, HDD geometry, and bending radii dictate HDD installation depth, which may be driven by a combination of factors, including sediment characteristics that are unfavorable to a shallower HDD installation, the required HDD entry angle, avoidance of existing shoreline infrastructure, and limitations on the length of the drill and location of the offshore HDD exit due to maritime traffic. Another consideration for some cable landfall sites is the need to maintain required spacing between the submarine export cables, as well as offsets from other existing infrastructure.

Open Cut Installation

Open cut alternatives and other non-trenchless installation methods would use standard submarine cable installation methods to facilitate installation at target burial for approach to landside. These methods may include open cut trenching/dredging or jetting to bury the cables up to the landfall conduits. Jetting involves the use of pressurized water jets into the seabed, creating a trench. As the trench is created, the submarine export cable is able to sink into the seabed/waterway. The displaced sediment then resettles, naturally backfilling the trench.

Dredging is used to excavate, remove, and/or relocate sediment from the seabed/waterway in order to allow for the cable to make landfall at the target installation depth. Dredging can be completed through clamshell dredging, suction hopper dredging, and/or hydraulic dredging. During dredging activities, the material will be collected in an appropriate manner for either re-use or disposal (depending on the nature of the material) and in accordance with applicable regulations.

A typical open cut method would involve installation of a sheet pile cofferdam to isolate the area of the shoreline at the landfall, dewatering within the area of the cofferdam, and excavating a trench within the dry cofferdam. The cable conduits would then be installed within the trench and the trench would be backfilled. Following installation of the conduits across the shoreline, the cables would be pulled through the conduits for final installation.

Additional non-trenchless installation methodologies are also considered at the interface of a developed shoreline for landfall (e.g., rip rap, bulkhead or sheet pile) and include installation "through the bulkhead" or "over the bulkhead," which would involve trenching/dredging or jet plowing the submarine export cables to the target burial depth along the approach to landside. These methods use conduits to install the cables over or through the developed shoreline feature, rather than trenching across such features.

3.7.2.2 Onshore Cable Route Evaluation Criteria

Onshore cable route alternatives from each of the cable landfall alternatives are shown in **Figure 3.7-1**. To identify the preferred cable route, the Applicant conducted a comparative analysis to assess the benefits and risks of several route options. The analysis considered the following criteria:

- Route length;
- Land use;
- Constructability;
- Presence of utilities;
- Prioritizing existing rights-of-way;
- Easement acquisition; and
- Environmental aspects such as wetlands and water bodies, historic and cultural resources, sensitive species habitat, potential for contamination, and potential community opposition, among others.

3.7.3 Cable Landfall and Onshore Cable Route Alternative Descriptions

The cable landfall and associated onshore route alternatives are described in this section. Note that the route lengths described in Section 3.7 include the complete onshore cable route from the cable landfall to the POI, and therefore may differ from lengths described in Section 3.6 for routes from onshore substation sites. The Applicant considered potential landfall alternatives in Coney Island and along Gravesend Bay, as well as four sites to the north of the Verrazzano-Narrows Bridge. Three of these northern landfall alternatives are immediately adjacent to the onshore substation alternatives evaluated in Section 3.6.

None of the alternative cable landfall or onshore routing alternatives evaluated for the Project involve expansion of an existing ROW. Based on the location of the onshore Project within a densely developed urban area of Brooklyn, New York, options for co-location of the cable landfall and onshore cable route alternatives along existing ROWs predominantly consist of existing public road ROWs. The public road ROWs are constrained by existing urban development and infrastructure such that expansion of the ROW in these areas is not possible or practicable. As such, cable landfall and onshore cable route alternatives along public ROWs were evaluated on the basis of the available space within the existing ROW, without ROW expansion. However, new ROWs within municipal parklands would be required for the onshore cable route alternatives originating at the Gravesend Bay and Verrazzano-Narrows cable landfall alternatives. All other onshore cable route alternatives are predominantly routed along public road ROWs but will require ROWs across municipal or private property, primarily in the vicinity of the cable landfall.

3.7.3.1 Coney Island Alternatives

Coney Island Cable Landfall Alternative

In evaluating the potential for a cable landfall on Coney Island, the Applicant considered waterfront parcels along the southern shore with sufficient space to stage and construct the cable landfall. The Applicant also evaluated nearshore water depths, sediment type, and the presence of submarine constraints. In general, the waters to the south of Coney Island are shallow, and geophysical and geotechnical characteristics (i.e., non-cohesive soils), add complexity, risk, and cost to a cable landfall, including an increased risk of inadvertent returns during an HDD and associated environmental impacts. Nearshore conditions adjacent to potential landfall parcels on the south side of Coney Island were generally similar in these characteristics.

The Applicant evaluated a large public parking area on the north side of Brighton Beach as a potential Coney Island Cable Landfall Alternative. This parking lot represents one of relatively few large parcels without structures directly adjacent to the beach, with a relatively unobstructed approach for landfall. Other open parcels along the south side of Coney Island are generally more obstructed and/or consist of public parkland in recreational use, with the exception of similar large parking areas associated with Steeplechase Park and the Abe Stark Sports Center to the west, or Manhattan Beach parking towards the eastern end of Coney Island.

The Brighton Beach public parking area is located immediately to the south of Brightwater Circuit, opposite Brighton 3rd Street. The parking area covers approximately 2 ac (0.8 ha), and it is bounded by the Rieglemann Boardwalk to the south and Brighton Beach Playground to the west. Otherwise, the surrounding area consists largely of high-rise buildings with mixed residential and commercial developments.

Coney Island Onshore Cable Route Alternative

From the cable landfall alternative on the south shore of Coney Island, the onshore export cable route alternative maximizes use of Ocean Parkway, which is the widest north-south roadway corridor in the vicinity. Ocean Parkway is a divided 6-lane road, edged by trees, and with additional carriage lanes on either side. Space-related considerations for construction and utility congestion are greater along other north-south corridors in the vicinity. From the cable landfall at the Brighton Beach public parking area, this route alternative proceeds north up Brighton 3rd Street to Neptune Avenue, and then north along Ocean Parkway. After entering the Kensington neighborhood, the route turns west along Ditmas Avenue, briefly north along Dahill Road and then continues northwest along 39th Street to the south of the Green-Wood Cemetery until it reaches 2nd Avenue at the southeast corner of the SBMT. This route is approximately 7.4 mi (11.9 km) long.

3.7.3.2 Gravesend Bay Alternatives

Gravesend Bay Cable Landfall Alternative

The Applicant also considered a route that would make landfall to the north of Coney Island, within the southern portion of Gravesend Bay. Similar to Coney Island, there are a number of constraints for selecting potential cable landfalls within Gravesend Bay. There are very few parcels of sufficient-sized, open land areas that are not already dedicated as public parklands. For the Gravesend Bay Cable Landfall Alternative, the Applicant evaluated a private car lot located to the north of the New York City Sanitation Department BK11 garage along 25th Avenue, adjacent to Shore Parkway. To the south of this location, landfalls are constrained by shallow waters, public open space and/or piers and other obstructions. Another similar parking lot space, and a park/open space area exist immediately to the north. These are not described separately in detail because considerations for the cable landfall and associated onshore cable route would be highly similar to those discussed for the evaluated Gravesend Bay Cable Landfall Alternative. Due to the Shore Parkway and adjacent high-rise development, no potential sites for cable landfall exist farther north until the area near Fort Hamilton, discussed further below, at the very north end of Gravesend Bay.

The Gravesend Bay Cable Landfall Alternative evaluated is presently a car lot located along the waterfront, between 25th Avenue to the south and Bay 38th Street to the north. The lot occupies approximately 3 ac (1.2 ha). The approach and shoreline are partially obstructed, with evidence of old piers and shallow riprap along the shoreline. A seawall appears to bound the area to the north and west.

Gravesend Bay Onshore Cable Route Alternatives

The Applicant evaluated a route from the Gravesend Bay Cable Landfall Alternative that follows 25th Avenue to Shore Parkway, and then turns northwest, following along a relatively narrow vegetated margin on the west side of Shore Parkway, crossing Bensonhurst Park and continuing along the narrow shoreline to Dyker Beach Park. At that point, the route crosses Shore Parkway and continues along the northeast side of Shore Parkway adjacent to Fort Hamilton, due to the very limited space between the Shore Parkway and the seawall along the shoreline. Crossing under the Verrazzano-Narrows Bridge, this onshore cable route alternative continues along the north side of Shore Parkway to Shore Road Park. From there, this route can either continue along Shore Road Park or follow an inland along the 3rd Avenue Onshore Cable Route Alternative, as described in Section 3.7.3.3 for the Verrazzano-Narrows Bridge Onshore Cable Route Alternatives. Routes from the Gravesend Bay Cable Landfall Alternative are approximately 7.3 mi (11.7 km) long.

3.7.3.3 Verrazzano-Narrows Alternatives

Verrazzano-Narrows Cable Landfall Alternative

The parcel at the Verrazzano-Narrows Bridge Landfall Alternative consists of open park space (Shore Road Park) under the control of New York City Department of Parks and Recreation adjacent to Shore Road and the Belt Parkway, on the northwest side of the Verrazzano-Narrows Bridge. This site represents one of the few areas of open space available along the waterfront with adequate space for staging landfall installation equipment (e.g., HDD rig). Within Shore Road Park, the Verrazzano-Narrows Cable Landfall Alternative is located in an area consisting of playing fields and a baseball diamond, identified as Bobby Bello Field, located immediately south of the Shore Road Field House. The Bay Ridge Promenade runs south to north along New York Harbor on the opposite side of Shore Parkway from this location. The Applicant evaluated a route from the Gravesend Bay Cable Landfall Alternative that follows 25th Avenue to Shore Parkway, and then turns northwest, following along a relatively narrow vegetated margin on the west side of Shore Parkway, crossing Bensonhurst Park and continuing along the narrow shoreline to Dyker Beach Park. At that point, the route crosses Shore Parkway and continues along the northeast side of Shore Parkway adjacent to Fort Hamilton, due to the very limited space between the Shore Parkway and the seawall along the shoreline. Crossing under the Verrazzano-Narrows Bridge, this onshore cable route alternative continues along the north side of Shore Parkway to Shore Road Park. From there, this route can either continue along Shore Road Park or follow an inland along the 3rd Avenue Onshore Cable Route Alternative, as described in Section 3.7.3.3 for the Verrazzano-Narrows Bridge Onshore Cable Route Alternatives. Routes from the Verrazzano-Narrows Cable Landfall Alternative are approximately 4.4 to 4.5 mi (7.1 to 7.2 km) long.

Verrazzano-Narrows Onshore Cable Route Alternatives

The initial route that was evaluated (the Shore Road Park Onshore Cable Route Alternative) from the Verrazzano-Narrows Bridge Cable Landfall Alternative would run north and slightly west from the cable landfall through Shore Road Park and along the Belt Parkway to Owl's Head Park. From there, the route would require an HDD crossing of the Belt Parkway and the 65th Street Railyard. To the north of the 65th Street Railyard, this alternative would continue north along the west side of the Brooklyn Army Terminal and then turn east along 58th Street. The Shore Road Park Onshore Cable Route Alternative would then turn north along 2nd Avenue to SBMT and eventually to the POI, similar to other route alternatives described in this section. This route is approximately 4.4 mi (7.1 km) long.

The Applicant also evaluated a second route (the 3rd Avenue Onshore Cable Route Alternative) from the Verrazzano-Narrows Bridge Cable Landfall Alternative. From the cable landfall in Shore Road Park, this route goes directly north across Shore Road and follows 96th Street to the northeast. The route cuts over to the 3rd

Avenue corridor with a jog to the south along Marine Avenue and then east on 97th Street. After continuing north along 3rd Avenue, it turns west along Bay Ridge Avenue to Owl's Head Park, then crosses the Belt Parkway and 65th Street Railyard, following a similar alignment to the Shore Road Park Onshore Cable Route Alternative described above. This route is approximately 4.5 mi (7.2 km) long. The 3rd Avenue Onshore Cable Route Alternative was selected for the evaluation of a north-south corridor that substantially avoids a significant portion (but not all) of the parkland impacts along the waterfront, but instead it requires extensive in-street work in the densely developed Bay Ridge neighborhood.

3.7.3.4 65th Street Railyard Alternatives

65th Street Railyard Cable Landfall Alternative

The parcel at the 65th Street Railyard Cable Landfall Alternative consists of rail tracks and open industrial land adjacent to the Owls Head Wastewater Treatment Plant and north of the Belt Parkway. This site is adjacent to the 65th Street Railyard substation site that was considered by the Applicant (see Section 3.6).

65th Street Railyard Onshore Cable Route Alternatives

From the 65th Street Railyard, one onshore cable route alternative would exit the site to 2nd Avenue and travel northeast to 28th Street, following it to the entrance of the substation at the Gowanus POI. The Applicant also evaluated a route from the 65th Street Railyard that follows 1st Avenue to 39th Street, traveling east along 39th Street to 2nd Avenue, and continuing to the Gowanus POI along routes previously described from there. These routes are approximately 2.2 to 2.3 mi (3.5 to 3.7 km).

3.7.3.5 Narrows Generating Station Alternatives

Narrows Generating Station Cable Landfall Alternative

The Narrows Generating Station Cable Landfall Alternative is located at Astoria Generating Company, LP's Narrows Generating Station parcel, which was also considered by the Applicants for locating the new onshore substation (see Section 3.6). The existing site contains floating platforms for the generation facility extending into the bay. The generation float and other upland surface obstructions would have to be removed for the site to be used. The landfall would be located on the pier with a deep bulkhead sheet pile wall, which would require cable burial depths of 30 to 50 ft (10 to 15 m).

Narrows Generating Station Onshore Cable Route Alternatives

From the Narrows Generating Station landfall, two major route alternatives were considered:

1. The Bush Pier Terminal Park Onshore Cable Route Alternative runs northwest from Narrows Generating Station site along 1st Avenue from the intersection with 54th Street to the intersection of 51st Street. The route heads west then north, along a right-of-way adjacent to the Bush Pier Terminal Park, until reaching 43rd Street. Here the route runs southeast along 43rd Street to 2nd Avenue. From there, the route continues along the same path as the route from the EW 1 landfall, travelling northeast along 2nd Avenue to 28th Street where it enters the existing substation at the Gowanus POI. This route is approximately 2.0 mi (3.2 km).

2. The 1st Avenue Onshore Cable Route Alternative runs north from the Narrows Generating Station Cable Landfall Alternative at the intersection of 54th Street and 1st Avenue to the intersection at 43rd Street. The route then turns southeast on 43rd Street to 2nd Avenue. From here, the route continues along the same path as the route from the EW 1 Cable Landfall Alternative (Section 3.7.3.6), travelling

northeast along 2nd Avenue to 28th Street where it enters the existing substation at the Gowanus POI. This route is approximately 1.8 mi (2.9 km).

3.7.3.6 EW 1 Alternative

EW 1 Cable Landfall Alternative

The EW 1 Cable Landfall Alternative is located at SBMT. As described further in Section 3.6, SBMT is a New York City-owned parcel under lease by NYCEDC, which subleases to SSBMT. This site was determined by the Applicant to be the preferred site for the onshore substation (Section 3.6).

EW 1 Onshore Cable Route Alternative

The onshore cable route from the EW 1 Cable Landfall Alternative at SBMT to the Gowanus POI is approximately 0.2 mi (0.3 km) long. This route runs northeast from the proposed EW 1 onshore substation site to a parking lot along the northwestern side of 2nd Avenue. It then continues north along 2nd Avenue to 28th Street and turns east along 28th Street where it enters the existing substation at the Gowanus POI.

3.7.4 Analysis of Cable Landfall and Onshore Cable Route Alternatives

Cable landfall and onshore cable route alternatives were evaluated relative to the criteria listed in Section 3.7.2. The cable landfall and associated onshore cable route alternatives are considered together, since they are interdependent (i.e., a viable onshore cable route alternative needs a viable cable landfall alternative and vice versa).

3.7.4.1 Coney Island Alternatives

Coney Island Cable Landfall Alternative

The Coney Island Cable Landfall Alternative is a large public parking area along Brighton Beach. That site provides sufficient space without permanent structures for landfall construction, although offsite staging could still be required. Access is provided directly off of Brightwater Circuit, from Brighton 2nd Street to the west and Brighton 4th Street to the east, so additional access road construction would not be anticipated.

Water depths in the vicinity of a south shore Coney Island cable landfall alternative will likely present a significant challenge for construction of an HDD cable landfall. Nearshore waters are predominantly less than 16 ft (5 m) deep at 3,000 ft (914 m) from the shoreline, which is the approximate technical limit of HDD installation. This does not achieve the 33 ft (10 m) depth that is typically required for the submarine export cable installation vessel. The result is that an HDD cable landfall to the southern shore of Coney Island would result in a longer, riskier, and significantly more expensive HDD, due to the additional cost and complexity of using specialized vessels and techniques typically required for a landfall installation in shallower water. The relatively shallow water depth at the HDD exit offshore would also mean potential concern for seabed mobility, since there would be increased risk of the cable becoming unburied or requiring burial mitigation during operations of the system in these shallow water areas.

Because Coney Island was formed during the last period of glaciation, its soils typically are expected to be underlain by glacial tills (unconsolidated material from boulders sand pebbles to sand and clays) and outwash deposits, which would present a significant challenge to HDD installation and result in a high likelihood of inadvertent returns (unintended discharges of drilling fluids). The Applicant could not find any record of successful HDD installation or operations in the vicinity of the south shore of Coney Island.

While an HDD cable landfall is likely to prove challenging, it is also unlikely that an open cut would be feasible or permitted, because Coney Island's shoreline is regulated as a Coastal Erosion Hazard Area. It is also a potential area of significant erosion risk in New York City (NYC Emergency Management 2019), due to the area's exposure to wave action from the Atlantic Ocean, which would require the cable landfall to be installed deep enough to avoid impacts from coastal processes. The Applicant met with the New York City Department of Parks and Recreation (NYCDPR) on November 20, 2020; NYCDPR indicated that a longstanding relationship exists between New York City, New York State Department of Conservation and the USACE for the nourishment of Coney Island's shoreline, as it is an area that provides important shoreline protection. NYCDPR indicated that this obligation and function as shoreline protection, and the known erosion risk, would need to be considered for any installation activities.

Unlike the other cable landfall alternatives considered, a cable landfall at Brighton Beach with either HDD or open cut would cross sandy beach and intertidal habitat. Although surface impacts would be avoided by an HDD, noise and disturbance adjacent to the beach could impact the use of the area by wildlife such as shorebirds, as well as public users of the beach, which is heavily used for recreation. Coney Island beaches may serve as potential habitat for federally listed species, specifically Red Knot, Piping Plover, Roseate Tern and Seabeach Amaranth, based on the U.S. Fish and Wildlife Service's Information for Planning and Consultation tool (USFWS 2021). Although Red Knot, Piping Plover and Roseate Tern are not expected to breed on Coney Island, given the proximity to other habitats and breeding areas (e.g. Breezy Point [NPS 2021b]), these species could use the area as resting or foraging habitat (USFWS 2012). Other migratory coastal birds such as Least Tern (state-threatened in New York) and American Oystercatcher are more frequently recorded on Coney Island (eBird 2021).

Per NYCDPR, an easement across Brighton Beach would require pursuit of New York State parkland alienation legislation, which would also add regulatory challenges and schedule risk. The Brighton Beach crossing is likely to require an easement, which would include certain development restrictions. Because Brighton Beach has also received federal grant money through the Land and Water Conservation Fund (e.g., Project # 36-00618 [1978]), any easement across such lands is expected to trigger a separate park conversion review process; that process requires additional time to complete and is governed by the National Park Service (NYSOPRHP 2012). The conversion process typically requires providing substitute lands of equal value and recreational opportunity. Moreover, the National Park Service rules require consideration of all practicable alternatives to the conversion, which is likely to be a significant hurdle to overcome given the existence of identified practicable alternatives for this Project (e.g., the preferred cable landfall site).

The Coney Island Cable Landfall Alternative has the advantage of reducing the submarine export cable route length (and associated disturbance to the marine environment) by approximately 9.6 mi (15.4. km) relative to the preferred alternative, and it avoids pipeline and cable asset crossings in the vicinity of the Narrows. However, based on the technical, stakeholder, regulatory, and environmental considerations, the Applicant determined that the Coney Island Landfall Alternative is not reasonable alternative for the Project. Additionally, the onshore cable route alternative associated with this landfall was also determined not to be reasonable for the Project, as discussed below.

Coney Island Onshore Cable Route Alternative

The Coney Island Onshore Cable Route Alternative was the longest onshore cable route considered and was determined to be unreasonably challenging, disruptive, and expensive in light of existing utilities, traffic diversions, development density, and space constraints. The route would involve extensive in-street work within densely developed areas of Brooklyn where street corridors already have significant existing utility congestion.

On December 11, 2020, the Applicant met with the New York City Department of Environmental Protection (NYCDEP) to better understand the potential in-street constraints and the presence of existing infrastructure. According to information provided, at minimum, the Coney Island Onshore Cable Route Alternative would expect to encounter a water main and sewer main on every block, with additional considerations needed for storm sewers as well. Water mains typically are located at 4 ft (1.2 m) depth, which means special trenchless crossing methods would need to be employed on each block. Additionally, a NYCDEP interceptor main runs east-west along the length of Coney Island, along with the New York Metropolitan Transit Authority subway lines. Given the busy, developed nature of the area, it would be necessary to maintain traffic flow during cable installation, which would increase the number of trenchless crossings required along the route and the associated installation complexity.

This existing utility and infrastructure congestion limits the available space for routing duct banks for the cables, and the number of infrastructure crossings along the roadway corridor adds significant cost. The construction duration associated with the need for additional geotechnical work; cable splice and transition vaults; HDD, jack-and-bore and other trenchless infrastructure crossings; utility relocations; and soil and water management, decontamination, and disposal is another significant factor. Extended in-street construction and multiple trenchless crossings will exacerbate the potential for noise impacts to local residents during construction, as well as traffic and transportation impacts.

In addition to these considerations, Ocean Parkway, which was selected as the widest potential north-south corridor, affording the most potential space and flexibility to deal with infrastructure challenges along the route, is designated as New York City Scenic Landmark. Stakeholder opposition, due to disruptions from construction noise, traffic, and recreational use are also highly likely to preclude the use of this route. Considerations and logistical constraints include vehicular traffic, pedestrian foot traffic, residential and commercial development density, noise impacts, business impacts, constructability, and workspace constraints due to existing infrastructure. Based on these considerations, the Applicant does not consider the Coney Island Onshore Route Alternative to be a reasonable alternative for the Project.

3.7.4.2 Gravesend Bay Alternatives

Gravesend Bay Cable Landfall Alternative

Similar to the Coney Island Cable Landfall Alternative, water depths in the vicinity of the Gravesend Bay Cable Landfall Alternative are expected to present a significant challenge for an HDD cable landfall construction. Nearshore waters are mostly shallow, with depths of 13.1 ft (4 m) or less in much of the area out to 3,000 ft (914 m), which is the approximate technical limit of HDD installation. However, bathymetry shows a deeper channel at 26 ft (8 m) that runs near the Gravesend Bay shoreline from the north, presumably providing pier access. This does not achieve the 33-ft (10-m) depth that is typically required, but it could provide enough water depth for operation and staging of HDD cable landfall equipment.

The cable landfall approach and shoreline show evidence of old piers and shallow riprap along the shoreline, and a seawall to the north and west of the landfall would need to be avoided by an HDD landfall. Assessment of a potential HDD also indicated a potential high risk for inadvertent returns of drilling fluid. Based on the fact that Coney Island and Long Island were formed during the last period of glaciation, the soils throughout the area are likely to be underlain by glacial tills. The sediment in the area is therefore expected to be loose, and likely to be underlain by glacial tills (unconsolidated material from boulders and pebbles to sands and clays). These highly variable soil conditions are not conducive to HDD operations because they make it difficult to maintain the borehole, and if large grain content (i.e., gravel, cobbles, till) is present, this may limit the technical feasibility of HDD operations and increase risks of inadvertent returns.

Because of the greater area and duration of construction within shallow waters associated with this cable landfall alternative, it is also expected to result in somewhat greater impact to habitats for species such as winter flounder and horseshoe crab than other cable landfall alternatives considered. Beaches in this area are considered locally important for horseshoe crab spawning (including Calvert Vaux and Dyker Beach Parks, NYC 2021a), and impacts to horseshoe crab spawning have been raised as a concern by environmental stakeholders for other area projects such as the NYCEDC ferry terminal project at Coney Island Creek (USACE 2021). Since the cable landfall would be installed underground to a paved parking area, however, these impacts for the Applicant's Project would be limited to temporary impacts during construction.

The Gravesend Bay Cable Landfall Alternative has the advantage of reducing the submarine export cable route length (and associated disturbance to the marine environment) by approximately 6.1 mi (9.9 km) relative to the preferred alternative, and avoids pipeline and cable asset crossings in the vicinity of the Narrows. However, the Applicant determined that the Gravesend Bay Cable Landfall Alternative is not a reasonable alternative, due to the HDD landfall constraints, including shallow water, shoreline obstructions, and risk of inadvertent returns during HDD installation. Additionally, the Gravesend Bay Onshore Cable Route Alternative is not considered reasonable, as described below; therefore, the Gravesend Bay Cable Landfall Alternative is also not reasonable.

Gravesend Bay Onshore Cable Route Alternative

This Gravesend Bay Onshore Cable Route Alternative follows approximately along the shoreline of Gravesend Bay to the Verrazzano-Narrows Bridge crossing several municipal parklands, including Bensonhurst Park, Dyker Beach Park, Shore Road Park, and Owl's Head Park. The Applicant met with the NYCDPR on November 20, 2020, to discuss considerations for onshore route alternatives crossing parklands. These crossings are likely to require easements, which would include certain development restrictions. Based on information provided, easements across these parks are expected to require parkland alienation legislation. Although it may be possible for the Applicant to obtain the parkland alienation required, the process adds significant time, complexity and risk to the Project; the existence of alternatives for the Project that reduce impacts to parkland (e.g., the preferred alternative) may be challenging to overcome within the process (NYSOPRHP 2012), and the process may face stakeholder opposition, particularly given the length and number of parks that would need to be crossed.

In addition to municipal parkland, the Gravesend Bay Onshore Cable Route Alternative would also need to cross federal land associated with Fort Hamilton, which would require coordination and easement rights obtained through the Department of the Army. Review of mapping provided by NYCDPR indicates that there would not be sufficient space to stay on municipal land through this area. Obtaining easement rights through federal lands that are under the Department of Defense, if possible, is expected to be challenging and add further risk associated with land acquisition.

Construction along portions of this route is expected to be technically challenging due to space constraints between Shore Parkway and the seawall, access, and existing infrastructure. During a meeting with the NYCDEP, the Applicant verified the density of outfall infrastructure that would need to be crossed along the Gravesend Bay shoreline. Based on mapping from the NYCDEP (Open Sewer Atlas NYC 2019a, 2019b), it appears more than 100 outfalls are located along the shoreline adjacent to this route.

It is also likely that one or more additional on-land HDD segments would be required to avoid existing roadway infrastructure and potentially deep foundations/piles, such as the on/off ramps in the area of the Verrazzano-Narrows Bridge. The Metropolitan Transit Authority is in the midst of a deck reconstruction project associated with the Verrazzano-Narrows Bridge, which included the recent completion (October 2020) of an expansion of the Fort Hamilton Parkway exit to two lanes and the addition of a fourth eastbound lane from the Verrazzano-Narrows Bridge to the Fort Hamilton Parkway exit in this area (MTA 2020).

To the north of the Verrazzano-Narrows Bridge, this route has additional disadvantages described below in Section 3.7.4.3 for the Verrazzano-Narrows Bridge Alternatives. Similar to the Verrazzano-Narrows Bridge Alternatives, the Gravesend Bay Onshore Cable Route Alternative would also result in disruption of recreational use of Shore Road Park, noise, constructability challenges, and additional regulatory challenges. The Gravesend Bay Onshore Cable Route Alternative was eliminated as not reasonable on basis of its extensive onshore impacts, regulatory and land acquisition process risks, likely stakeholder opposition, and technical challenges.

3.7.4.3 Verrazzano-Narrows Alternatives

Verrazzano-Narrows Cable Landfall Alternative

Given the need to cross an existing seawall, the Bay Ridge Promenade, and Shore Parkway/Belt Parkway in order to reach the start of the onshore cable route at this location, the Verrazzano-Narrows Cable Landfall Alternative would need to be installed via HDD (see Section 3.8.2 for evaluation of landfall installation methodologies), since trenching across any of these features is impracticable. Minimal space exists between the seawall and Bay Ridge Promenade and the adjacent parkway to allow staging a trenchless installation.

Construction of the submarine export cable landfall by HDD would be complicated by the existing seawall, which is assumed to extend 23 to 26 ft (7 to 8 m) below the mudline, built on a timber crib wall or timber piles, with riprap extending to the shoreline. Water depths adjacent to the landfall site are shallow (approximately 4 to 6 ft [1.5 to 2 m]) nearshore and extend to approximately 98+ ft (30+ m) deep in the channel. No UXO are noted, but other unidentified obstructions are present in the area on NOAA charts, including a cable area south of the bridge. Strong currents may be present in the area, but coastal processes do not appear to be a limiting constraint for a cable landfall.

Assessment of potential HDD alignments and water depths at this location determined that the drill exit on the water side, where a cofferdam and conductor casing would likely be required, would be near medium to high levels of vessel traffic on the north side of the Verrazzano-Narrows Bridge. Given the duration of HDD installation (estimated at approximately two months per drill [with one drill per circuit]), this could result in significant conflicts with and impacts to marine users. Impacts to marine traffic through the Narrows from the HDD would require additional coordination with the USCG to determine whether impact minimization or mitigation would be possible for this alternative.

The entry side of the HDD would be located within the playing fields in Shore Road Park. Since there is no direct access from public roadways adjacent to the site, and there are slopes immediately to the east of the playing fields, temporary construction access would be required within the park for vehicles and equipment. An offsite staging area for fabrication is also expected to be required.

Use of this cable landfall is expected to raise stakeholder concerns, due to potential disruptions affecting open space users, noise from HDD activities, and traffic for local residents. Local road closures are not anticipated to be required, but some tree removal within the park is likely be required for staging and access. Use of the playing fields would result in conflict with recreational use of the area for the duration of cable landfall construction activities. To the north and west of the Verrazzano-Narrows Bridge Cable Landfall Alternative, dense residential development, high-rises and sensitive noise receptors are present on the west side of Shore Road. Given the topography and absence of tree screening along portions of Shore Road to the west of the cable landfall area, temporary noise impacts during construction would likely be a concern for HDD activities. Temporary visual impacts during construction due to tree clearing, staging, and construction equipment are also a potential stakeholder concern. Because this site is not already developed for industrial use, temporary impacts to vegetation, land use, and terrestrial habitats would likely be greater than at most other cable landfall alternatives considered.

Cable landfall (and onshore routing, see below) for the Verrazzano-Narrows Bridge Cable Landfall Alternative is also expected to require parkland alienation legislation, with approval by the state legislature, which is discussed above in Section 3.7.4.1 and 2.7.4.2. Parkland alienation in New York State applies to dedicated municipal parklands. Although it may be possible to obtain alienation legislation, it represents a significant additional procedural requirement that would be needed to use this cable landfall alternative, requiring support from both the local and State legislative bodies, which introduces additional risk. As described above, the existence of reasonable alternatives for the Project that reduce impacts to parkland (e.g., the preferred alternative) likely would be challenging to overcome within the alienation process.

The Verrazzano-Narrows Cable Landfall Alternative has the advantage of reducing the submarine export cable route length (and associated disturbance to the marine environment) by approximately 4.3 mi (6.9. km) relative to the preferred alternative and avoids pipeline and cable asset crossings in the vicinity of the Narrows. However, because of the potential for conflict with marine traffic, disruption of recreational use of Shore Road Park, noise, likely stakeholder concerns during cable landfall installation activities, constructability challenges, and additional regulatory challenges, the Verrazzano-Narrows Bridge landfall was determined not to be a reasonable option for the Project. As discussed below, the potential onshore cable route alternatives from the Verrazzano-Narrows Bridge landfall were also determined not to be reasonable.

Verrazzano-Narrows Onshore Cable Route Alternatives

The Shore Road Park Onshore Cable Route Alternative from the Verrazzano-Narrows Cable Landfall Alternative results in extensive routing and impacts to municipal parkland. The Applicant evaluated three onshore HDDs along this route alternative to reduce impacts to parkland, as well as the 3rd Avenue Onshore Cable Route Alternative discussed below.

In the area of the Shore Road Park Onshore Cable Route Alternative, Shore Road Park varies in width from an approximately 75-ft (23-m)-wide north-south strip, to up to 525 ft (160 m) wide in areas with fields, tennis courts, and other recreational infrastructure. HDDs would both reduce surface disturbance to the parkland and avoid areas of steep side slopes that are present along the route. Trenchless construction would also be needed to cross the Belt Parkway/Shore Parkway on the north side of Owl's Head Park, ramps and railroad tracks associated with the 65th Street Railyard. These HDDs would be technically challenging and require additional study for feasibility based on soils data, calculations for the cables, and railroad crossing requirements. Overall, the number of HDDs required along this route adds logistical and construction complexity that would increase installation cost and duration.

The Shore Road Park Onshore Cable Route Alternative would also cross the Narrows Botanical Garden, a volunteer-run garden, along Shore Road Park on the east side of the Belt Parkway. Based on a nominal corridor width of 50 ft (15 m), along with the additional temporary workspace at HDDs, bores, and temporary access roads, tree clearing would be required during construction. While much of the cable corridor could be restored post-construction, some tree clearing directly over the cable corridor may be permanent. Infrastructure may also be present along this route; based on mapping from the NYCDEP (Open Sewer Atlas NYC 2019a, 2019b), it appears more than 30 outfalls are located along the shoreline in the vicinity of this route, although it is unknown how many would cross the onshore cable route.

The 3rd Avenue Onshore Cable Route Alternative would avoid much of the routing within Shore Road Park and the Narrows Botanical Garden but is expected to encounter significant utility congestion within the relatively narrow roadway corridors found throughout the densely developed Bay Ridge neighborhood of Brooklyn. Although 3rd Avenue is relatively large compared to other north-south corridors in this area, it is only approximately 45 ft (14 m) between sidewalks and flanked largely by multi-story and high-rise apartment buildings, with commercial development at ground level. Considerations and logistical constraints include vehicular traffic, pedestrian foot traffic, residential and commercial development density, noise impacts, business impacts, constructability, and workspace constraints due to existing infrastructure. Significant stakeholder opposition may be present due to construction disruptions along this route.

Many of the considerations for the 3rd Avenue Cable Route Alternative are similar to those described in Section 3.7.4.1 for the Coney Island Onshore Cable Route Alternative. Investigation of utilities indicated significant utility congestion along this route, and per NYCDEP, this route would also encounter a water main and sewer main on every block. The need to maintain traffic flow is also expected to drive the number and complexity of trenchless crossing installations along this route. Additionally, there is a mapped NYCDEP interceptor main that runs to the north and south along from the Owl's Head Wastewater Treatment Plant that would need to be crossed by either the Shore Park Road or 3rd Avenue Onshore Cable Route Alternatives. Assessment of the space available for the 3rd Avenue Onshore Cable Route Alternative indicated that joint bays may be especially difficult to locate in the city street for this route.

Both the 3rd Avenue and Shore Park Road Onshore Route Alternatives cross Owl's Head Park to the south of the 65th Street Railyard. During a meeting with the Applicant, the NYCPDR indicated that there is significant local concern about preserving Owl's Head Park, and that there has been opposition to previous plans for construction of improvements in the park. Owl's Head Park is the site of the former estate of Brooklyn politician Henry C. Murphy in the 19th Century (NYC 2021b). It was later sold to New York City with the stipulation that it remain parkland, and the estate buildings were eventually demolished. Owl's Head Park therefore has potential historic significance. The vicinity of Owl's Head Park is also mapped as an area of potential cultural significance and is notable compared to much of the surrounding area as being on a natural terminal moraine (NYC 2021b) instead of urban filled soils. The NYCDPR indicated that if a crossing of Owl's Head Park is needed, it would be preferable to route around the outer edge of the park, adjacent to Belt Parkway, however it may not be possible to entirely limit impacts to the park edge due to the need to cross the Belt Parkway and the 65th Street Railyard via HDD.

Both the 3rd Avenue and Shore Road Park Onshore Route Alternatives are expected to require parkland alienation legislation for the portions of the cable routes within Shore Road Park and Owl's Head Park. These areas are likely to require an easement, which would include certain development restrictions. As discussed in Sections 3.7.4.1 and 3.7.4.2, this represents a significant additional procedural requirement that would be needed for these onshore route alternatives, requiring support from both the local and State legislative bodies. The existence of reasonable alternatives for the Project that reduce impacts to parkland (e.g., the preferred alternative) likely would be challenging to overcome within the alienation process.

Because of the need for parkland alienation legislation, cultural sensitivity in the vicinity of Owl's Head Park., cost and complexity of several HDDs required along this route, the likelihood of significant utility congestion along 3rd Avenue and the potential for public stakeholder opposition along both routes, the Shore Road Park and 3rd Avenue Onshore Route Alternatives were not considered to be reasonable alternatives for the Project.

3.7.4.4 65th Street Railyard Alternatives

65th Street Railyard Cable Landfall Alternative

Although less space is required at 65th Street Railyard to construct a cable landfall, many of the same use conflicts described previously in Section 3.6.1.1 in the evaluation of the site for an onshore substation would also apply to the construction of the cable landfall. This includes the potential to conflict with potential development at the railyard associated with the Cross Harbor Freight Program rail tunnel alternative and other ongoing improvements. The Applicant's discussions with New York City stakeholders indicated the 65th Street Railyard would not be preferred for siting Project facilities due to the likelihood of conflict with other potential uses, which could make obtaining an easement agreement for the cable landfall difficult.

In addition, this site also presents challenges for either HDD or open cut landfall installation, due to shoreline infrastructure and cable burial depth limitations. Interferences and obstruction are present at the shoreline. Although as-builts of the seawall were not available, it is assumed to have deteriorated riprap that likely extends below the mudline. Other unidentified obstructions are also present on NOAA charts with only a narrow unobstructed corridor for a potential cable landfall alignment. Water depths immediately adjacent to the landfall are very shallow, however, coastal processes in this location do not appear to be a limiting constraint. Similar to other sites considered, the in-water HDD exit would be in deeper waters, which correspond to areas of higher marine traffic offshore. Also similar to other sites, there is a potential high risk for inadvertent returns of drilling fluid during HDD construction Based on the fact that Coney Island and Long Island were formed during the last period of glaciation, the soils throughout the area are likely to be underlain by glacial tills. The likely presence of loose sediments and soils at drill depths, and of fill materials present on the onshore entry side of the HDD contribute to inadvertent return risk. The required depth of an HDD cable landfall may exceed the maximum allowable depth of the cable installation due to thermoresistivity concerns (see Section 3.8.2). Initial feasibility analysis indicated that an open cut solution may also be possible at this location, but additional geotechnical assessment would be required to confirm this.

Based on the nature of the site, tree removal is not anticipated to be required nor are local road closures required, and residential impacts should be minimal. Similar to other locations to the north of the Verrazzano-Narrows Bridge, there is a potential to encounter contaminated soils and/or sediments, based on its nature and historic use as an industrial site.

The 65th Street Railyard Cable Landfall Alternative has the advantage of reducing the submarine export cable route length (and associated disturbance to the marine environment) by approximately 1.7 mi (2.7 km) relative to the preferred alternative. However, due to the potential land use conflicts associated with the 65th Street Railyard, the Applicant determined that the 65th Street Railyard Cable Landfall is not a reasonable alternative for the Project.

65th Street Railyard Onshore Cable Route Alternatives

Two onshore cable route alternatives were assessed from the 65th Street Railyard Cable Landfall Alternative; one route that predominantly follows 1st Avenue, and one route that predominantly follows 2nd Avenue. Of the two routes, the 2nd Avenue corridor was determined to be less risky than the 1st Avenue corridor, although neither route is considered reasonable, due to site constraints within the 65th Street Railyard (see above).

1st Avenue is a two-lane street with an approximate roadway width of 40 ft (12 m) that runs north to south to 39th Street, where it ends at the SBMT. An existing rail line, and large diameter sewer interceptor run along this corridor to the north of the Owl's Head Wastewater Treatment Plant. These features constrain the available space for the onshore cable ducts along this corridor. The 1st Avenue alternative also crosses the parcel and parking lot associated with the Brooklyn Army Terminal, an industrial manufacturing and commercial business complex managed by NYCEDC, immediately north of the 65th Street Railyard, before entering the southern end of 1st Avenue. The Brooklyn Military Ocean Terminal, located at what is now the Brooklyn Army Terminal, is a listed Formerly Used Defense Sites Property that staged chemicals for several decades, housing aboveground storage tanks, cask oil storage, and machine shops.

2nd Avenue is a two-lane city street that runs north-south between 63rd and 28th Street, which also has an approximate roadway width of 40 ft (12 m); however, some of the large infrastructure that is present along 1st Avenue is absent. The street is mostly commercial/industrial development, while the side streets to the east of 2nd Ave are mostly residential. The 2nd Avenue corridor generally runs closer to areas of commercial and residential development than the 1st Avenue corridor, which passes predominantly through areas of industrial land use. 2nd Avenue is a main route for transportation through Brooklyn and has several bus routes and stops. 2nd Avenue also has higher daily average traffic, with annual average daily traffic counts (8,500) that are nearly twice the volume along 1st Avenue (3,400). Utilities along this route are known to include a sanitary sewer transmission line, a water line, a high-pressure natural gas line, and storm drainage inlets. However, the risk caused by utility congestion along 2nd Avenue was estimated to be less than the risks associated with 1st Avenue.

Construction along either the 1st or the 2nd Avenue corridors would be associated with some additional construction noise and traffic impacts compared with an in-water route, due to the density of development along the route. Disruption adjacent to residential and commercial neighborhoods likely would be of concern to local stakeholders, and these routes may require extensive management of contaminated soils and/or groundwater.

Because the 65th Street Railyard Landfall Alternative and crossing the 65th Street Railyard are both not reasonable, these routes are also considered not reasonable.

3.7.4.5 Narrows Generating Station Alternatives

Narrows Generating Station Cable Landfall Alternative

The Narrows Generating Station parcel was considered for both an onshore substation alternative and a cable landfall alternative. The cable landfall at this site would be located on a pier with a bulkhead sheet pile wall. As described in Section 3.6.2 for the onshore substation alternative, space availability at the site is constrained by the presence of existing structures. Current land use and industrial development of the site is consistent with use of the site for a cable landfall.

The Applicant considered both HDD and open cut landfall alternatives for the Narrows Generating Station Cable Landfall Alternative. Obstructions and interferences are present near the shoreline and include submarine dolphin piles and ruins of a historical pier to the south. The main obstacle at the site is a deep bulkhead that extends to an elevation of -39 ft (-12 m) Mean Lower Low Water (MLLW), with tie rods connected to this bulkhead and sheet pile anchor walls installed on the land side of the bulkhead. Detailed assessment determined that an HDD landfall would not be feasible for the Narrows Generating Station Cable Landfall Alternative, for reasons similar to those that eliminated HDD at the preferred site, including the required HDD depth, thermoresistivity limits, the presence of loose sediments, and inadvertent return risk (see Section 3.8.2). Additionally, the available right-of-way width between the two existing buildings onsite is only 42 ft (13 m). Allowing for horizontal tolerances and the necessary setback distance from the edge of the right-of-way, the available horizontal separation distance is only approximately 7.8 ft (2.4 m), not considering existing utilities that may further constrain this corridor. This is significantly less than industry standard separation for an HDD installation and may not allow sufficient separation of the two cables. Additionally, vessel traffic around this site is expected to be heavy, with the potential for marine traffic impacts at the HDD exit location offshore.

The removal of existing structures at the Narrows Generating Station is dependent upon the decommissioning and remediation of the facility prior to the start of Project construction. As of the date of this filing, the plans for decommissioning the Narrows facilities have not yet been filed for the Gowanus Repowering Project (NYSDPS Case # 18-F-0758).

The Narrows Generating Station Cable Landfall Alternative is not expected to appreciably reduce disturbance to the marine environment relative to the preferred alternative, as it reduces the submarine export cable route by only approximately 1.3 mi (2.1 km) and would also require an open cut landfall installation method.

The Narrows Generating Station landfall is slightly further from the Gowanus POI, resulting in greater onshore impacts along the cable route as discussed below. Because of the industrial nature of the site, use of the site is not anticipated to require tree clearing or local road closures, and residential impacts should be minimal. However, upland sediment in this area may be contaminated, similar to the other industrial sites considered for cable landfall.

The Applicant has not been able to secure an agreement for use of the Narrows Generating Station site, while lease agreement discussions have advanced with SBMT for the preferred EW 1 Onshore Substation and Cable Landfall Alternatives. Moreover, siting of the onshore substation at SBMT directly adjacent to the cable landfall is expected to minimize impacts to the onshore and human environments during construction and operation of the Project (the preferred alternative; see Section 3.7.4.6).

Cable landfall at the Narrows Generating Station using either an HDD or open cut methodology was assessed to be an unreasonable alternative for the proposed Project, due to existing site constraints for cable landfall installation, lack of commercial availability, and the potential scheduling risks.

Narrows Generating Station Onshore Cable Route Alternatives

Of the two onshore cable route alternatives from the Narrows Generating Station, the Bush Pier Terminal Park Onshore Cable Route Alternative was determined to be not reasonable, due to the portion of the routing along Bush Pier Terminal Park. The Applicant determined that this portion of the route would result in additional potential impacts to recreational resources. The Applicant also received feedback during a meeting on August 23, 2019 with NYCEDC and NYCDPR, that the location of any facilities within the Bush Terminal Park fenceline would be discouraged due to the nature of the site as a former landfill. Landfill facilities, including leachate lines and groundwater monitoring wells, are located subsurface.

Considerations for routing along 1st Avenue from the Narrows Generating Station are similar to those described in Section 3.7.4.5 for the 65th Street Railyard Alternatives. Two trenchless (jack-and-bore) crossings would be required for active railroad lines. The 1st Avenue Onshore Cable Route Alternative from the Narrows Generating Station not a reasonable alternative for the Project because the associated Narrows Generating Station Cable Landfall Alternative is not reasonable and site constraints preclude crossing the Narrows Generating Station (see above for discussion of schedule risks to the Project due to uncertainty surrounding the facility decommissioning). This route would also result in additional onshore impacts in comparison to the preferred shorter onshore cable route alternative, as well as additional risks, cost, and construction duration associated with utility congestion along a longer route.

3.7.4.6 EW 1 Alternatives

EW 1 Cable Landfall Alternative

The concept for the EW 1 Cable Landfall Alternative is a cable landfall within or immediately adjacent to the preferred onshore substation site at SBMT. For this alternative, the Applicant assessed both open cut and HDD landfall installation and determined that HDD landfall would not be reasonable (see Section 3.8.2). The pier at the EW 1 landfall location consists of deep, concrete-filled caisson bulkhead at the pier tip. The north side of the pier appears to be constructed of a steel sheet pile and riprap shoreline. Both in water and under the riprap are buried timber piles, cut off at the mudline. The piles are assumed to extend to 26 ft to 33 ft (8 to 10 m) below the mudline (see Section 3.8.2 for additional discussion of existing conditions at the landfall).

Other unidentified obstructions noted on NOAA charts include an obstruction near the seaward entry of the waterway. Based on water and sewer data from the NYCDEP, there is a combined sewer easement in this area that discharges to the harbor and approximately in line with 32nd Street that would need to be avoided. The Applicant will coordinate with the property owner and NYCDEP on avoidance of the outlet. Depths adjacent to and between the piers at EW 1 vary and may be as shallow as 6.5 ft (2 m) below MLLW, increasing towards the bay.

Additionally, the assessment of a potential HDD installation at this location indicated that there would be a high risk for inadvertent returns of drilling fluid, due to the likely presence of loose sediments and soils at drill depths, and fill materials present on the onshore entry side of the HDD. It appears there are low levels of vessel traffic within approximately 330 ft (100 m) of the landfall at the shoreline, with higher density vessel traffic farther from the pier in Gowanus Bay. Vessel tracking AIS (Automatic Identification System) indicates that the landward boundary of heavy vessel traffic is approximately 160 ft (50 m) seaward of the SBMT pier edge. Therefore, in the case of an HDD landfall, marine traffic impacts were greater for HDD alignments that extend into the bay.

The Applicant also assessed installing the submarine export cables through the bulkhead at the shoreline at SBMT. This cable landfall installation would require dredging between the 35th Street and 29th Street Piers to allow for sufficient depth for access by the cable lay vessel, but this was determined to be a reasonable option for cable installation at this location. The existing bulkhead between the 35th Street and 29th Street Piers requires replacement due to its dilapidated condition.

Similar to other industrial sites, no tree removal or road closures are anticipated to be required to complete the shoreline installation of the cable at SBMT, and minimal residential impacts would be anticipated because of the nature of land use in the area. It is anticipated that there is some amount of existing contamination, similar to the other industrial sites considered.

Based on the assessment of construction feasibility of an open cut landfall methodology, consistency with existing land use and future development, progress in lease agreement negotiations with SBMT, minimization of impacts to local stakeholders and the environment from noise and traffic, the Applicant has identified EW 1 Cable Landfall Alternative as reasonable and as the preferred alternative. This alternative also reduces the length of the onshore cable route and associated impacts and risks as described in Section 3.7.5. Additionally, since the area around and between the 35th Street and 29th Street Piers will need modification associated with SSBMT's separate port upgrade activities (e.g., dredging, replacement of deteriorated bulkheads), siting disturbances associated with the cable landfall activities in the same area will help minimize overall environmental impacts relative to the use of another, undisturbed site.

EW 1 Onshore Cable Route Alternative

Because the EW 1 Cable Landfall Alternative is directly adjacent to the preferred onshore substation alternative, the EW 1 Onshore Cable Route Alternative consists only of the interconnection cable route traversing SBMT and 2nd Avenue to the POI. This cable route would be required for any project alternative that incorporates the EW 1 Onshore Substation Alternative (i.e., any other cable landfall/onshore cable route combination under consideration). This onshore cable route alternative eliminates onshore impacts to public open space, and greatly minimizes impacts within developed areas of Brooklyn that are posed by the other onshore cable route alternatives, including impacts to vehicular traffic, pedestrian foot traffic, residential and commercial development, business disruption, noise impacts, and traversing potentially contaminated soils. This route also minimizes the onshore cable route constructability risks associated with existing utilities, infrastructure, and in-street work.

This EW 1 Onshore Cable Route Alternative results in the shortest onshore cable route, with a total onshore cable route of only 0.2 mi (0.3 km). The EW 1 Onshore Cable Route Alternative would cross one relatively infrequently used existing railroad track within SBMT that connects to the Sims Municipal Recycling Facility. This crossing would require trenchless construction; a jack-and-bore installation is anticipated. The site has plenty of available workspace for staging and construction of the crossing. In conjunction with the EW 1 Onshore Cable Landfall Alternative, the EW 1 Onshore Cable Route Alternative was determined to be the preferred alternative for the Project.

3.7.5 Summary of Preferred Cable Landfall and Onshore Cable Route Alternatives

Table 3.7-1 provides a summary comparison of the onshore cable route alternatives. Based on the assessment criteria, the EW 1 Cable Landfall and Onshore Cable Route Alternatives were selected as preferred.

Table 3.7-1 Comparison of Onshore Cable Route Alternatives

Assessment Criteria	Coney Island Route Alternative	Gravesend Bay Route Alternative	Verrazzano-Narrows		65th Street		Narrows Generating Station		EW 1 Alternative
			Shore Road Park Alternative	3rd Avenue Alternative	1st Avenue Alternative	2nd Avenue Alternative	Bush Pier Terminal Park Alternative	1st Avenue Alternative	
Route Characteristics									
Total EW 1 Project Route Length	41.5 mi (66.9 km)	45.0 mi (72.4 km)	43.8 mi (70.5 km)	44.0 mi (70.8 km)	44.3 mi (71.3 km)	44.3 mi (71.3 km)	44.4 mi (71.5 km)	44.3 mi (71.2 km)	43.9 mi (70.6 km)
Total EW 1 Project Submarine Export Cable Route Length	34.1mi (54.9 km)	37.7 mi (60.7 km)	39.4 mi (63.5 km)	39.4 mi (63.5 km)	42.1 mi (67.7 km)	42.1 mi (67.7 km)	42.4 mi (68.3 km)	42.4 mi (68.3 km)	43.7 mi (70.4 km)
Onshore Cable Route Length	7.4 mi (12.0 km)	7.3 mi (11.8 km)	4.4 mi (7.0 km)	4.5 mi (7.3 km)	2.2 mi (3.6 km)	2.3 mi (3.6 km)	2.0 mi (3.2 km)	1.8 mi (3.0 km)	0.2 mi (0.3 km) b/
Technical Considerations									
Sufficient space for landfall without demolition	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
Landfall construction complexity	High	High	High	High	High	High	High	High	Moderate
Expected onshore infrastructure congestion	High	High	High	High	High	High	High	High	Moderate
Expected number of onshore utility crossings	High	High	Moderate	High	Moderate	Moderate	Moderate	Moderate	Low
Sewer main crossing(s)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
New York Metropolitan Transit Authority subway line crossing	Yes	No	No	No	No	No	No	No	No

			Verrazzano-Narrows		65th Street		Narrows Generating Station		
Assessment Criteria	Coney Island Route Alternative	Gravesend Bay Route Alternative	Shore Road Park Alternative	3rd Avenue Alternative	1st Avenue Alternative	2nd Avenue Alternative	Bush Pier Terminal Park Alternative	1st Avenue Alternative	EW 1 Alternative
Number of submarine export cable utility crossings ~~c/~~	2	2	3	3	19	19	19	19	19
Commercial Considerations									
Landfall commercial availability	Unknown	Unknown	Not applicable c/	Not applicable c/	Unlikely	Unlikely	Unlikely	Unlikely	Yes
Cable route easement/permit risk	High	High	High	High	High	High	High	Moderate	Low
Onshore construction duration	High	High	Moderate	High	Moderate	Moderate	Low	Low	Low
Stakeholder Considerations									
Number of abutters	High	Moderate	Moderate	High	Moderate	Moderate	Moderate	Moderate	Low
Expected stakeholder considerations	High	High	High	High	Moderate	Moderate	Moderate	Low	Low
Environmental Considerations									
Coastal erosion concern	High	Low	Low	Low	Low	Low	Low	Low	Low
Potential onshore threatened & endangered species habitat	Yes	No	No	No	No	No	No	No	No
Potential offshore threatened & endangered species habitat	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Assessment Criteria	Coney Island Route Alternative	Gravesend Bay Route Alternative	Verrazzano-Narrows		65th Street		Narrows Generating Station		EW 1 Alternative
			Shore Road Park Alternative	3rd Avenue Alternative	1st Avenue Alternative	2nd Avenue Alternative	Bush Pier Terminal Park Alternative	1st Avenue Alternative	
New York City scenic landmarks crossed	1	0	0	0	0	0	0	0	0
Noise impacts	High	High	High	High	Moderate	Moderate	Low	Low	Low
Traffic impacts	High	Moderate	Moderate	High	Moderate	Moderate	Moderate	Moderate	Low
Areas of potential cultural significance crossed	Yes d/	Yes	Yes	Yes	No	No	No	No	No
Right-of-Way (Onshore)									
Approximate length in existing right-of-way e/	6.9 mi (11.1 km)	2.7 mi (4.3 km)	1.4 mi (2.3 km)	3.3 mi (5.3 km)	1.5 mi (2.4 km)	1.4 mi (2.3 km)	1.0 mi (1.6 km)	1.3 mi (2.1 km)	0.05 mi (0.1 km)
Length of existing right-of-way expansion	0	0	0	0	0	0	0	0	0
Approximate length across private parcels	0.5 mi (0.8 km)	0.1 mi (0.2 km)	0.1 mi (0.2 km)	0.1 mi (0.2 km)	0.2 mi (0.3 km)	0.2 mi (0.3 km)	0.4 mi (0.6 km)	0.4 mi (0.6 km)	0.02 mi (0.03 km)
Approximate length across municipal lands	0.02 mi (0.03 km)	3.9 mi (6.3 km)	2.9 mi (4.7 km)	1.9 mi (3.0 km)	0.5 mi (0.8 km)	0.6 mi (1.0 km)	0.6 mi (1.0 km)	0.1 mi (0.2 km)	0.07 mi (0.1 km)
Approximate length across federal land	0	0.6 mi (1.0 km)	0	0	0	0	0	0	0

			Verrazzano-Narrows		65th Street		Narrows Generating Station		
Assessment Criteria	Coney Island Route Alternative	Gravesend Bay Route Alternative	Shore Road Park Alternative	3rd Avenue Alternative	1st Avenue Alternative	2nd Avenue Alternative	Bush Pier Terminal Park Alternative	1st Avenue Alternative	EW 1 Alternative
Land Use Characteristics									
Land Use, Percent Developed Land	High intensity (59%), Medium Intensity (39%), Low Intensity (<1%)	High intensity (30%), Medium Intensity (26%), Low Intensity (22%)	High intensity (43%), Medium Intensity (20%), Low Intensity (13%)	High intensity (85%), Medium Intensity (9%), Low Intensity (3%)	High intensity (82%), Medium Intensity (13%)	High intensity (88%), Medium Intensity (6%)	High intensity (79%), Medium Intensity (15%), Low Intensity (1%)	High intensity (91%), Medium Intensity (4%)	High intensity (100%)
Land Use, Percent Herbaceous	5%	6%	9%	<1%	2%	2%	2%	2%	0
Land Use, Percent Barren Land	<1%	4%	2%	0	2%	2%	2%	2%	0
Land Use, Percent Open Space	0	7%	8%	1%	0	0	<1%	0	0
Land Use, Deciduous Forest	0	1%	1%	<1%	0	0	0	0	0
Land Use, Hay/Pasture or Shrub/Scrub	0	Hay/Pasture (2%), Shrub/Scrub (<1%)	Hay/Pasture (3%)	0	0	0	0	0	0
New York City Open Space crossing distance f~~e~~/, g~~d~~/	1.3 mi (2.0 km)	4.4 mi (7.0 km)	2.3 mi (3.7 km)	0.4 mi (0.6 km)	None	None	None	None	None

Notes:
a/ Based on aerial review and the New York State Department of Transportation road inventory; rights-of-way include roadway corridors, bike trails and railroads.
b/ Includes both the interconnection cable route and the EW 1 onshore export cables.
c/ Expected to require parkland alienation.
d/ Includes Ocean Parkway.
e/ Length within existing right-of-way is approximated based on New York City parcel mapping.
f~~e~~/ Based on the crossing distance of the cable route centerline.
g~~d~~/ Based on NYC 2020. This does not include the overlap of a portion of the submarine export cable siting corridor with an offshore portion of NYCDPR-owned property.

3.8 Alternative Technologies

In addition to the siting and routing alternatives evaluated above, the Applicant also assessed a variety of alternative facility designs, installation methods, and technologies to fulfill its energy requirements. A summary of the options evaluated is provided in this section.

3.8.1 Submarine Export Cable Transmission Technology Alternatives

The Applicant evaluated different transmission technologies for the submarine export cables against the following criteria:

- Transmission distances;
- Economic considerations; and
- Land required to support onshore electrical facilities.

The submarine export cables are designed to use HVAC rather than HVDC due to the considerably lower costs to interconnect HVAC into Con Edison's alternating current terrestrial grid at Gowanus 345-kV Substation. HVDC requires a considerably larger investment with greater complexity, significantly larger onshore space requirements, and higher maintenance needs than HVAC due to the need for converter stations onshore and offshore. HVDC becomes more cost-effective for wind farms with a larger nameplate capacity than is planned for the EW 1 Project, in part because HVDC may allow a reduction in the number of export cables for larger projects. This may also be preferable for long transmission lines carrying very large power capacities where HVDC reduces transmission losses relative to HVAC. The transmission distance and power rating of the EW 1 Project submarine export cables makes it suitable and more cost-effective to employ an HVAC system.

The Applicant also evaluated several alternative methods for cable installation offshore, including cable burial and direct placement on the seafloor. Placement of the submarine export cables directly on the seafloor as the primary installation method was determined to be impractical due to the heightened risk of third-party damage to the cables and increased maintenance requirements from anchor or fishing gear snagging. Although direct seafloor disturbance from jetting or trenching during construction would be avoided with this method, the additional cable protection measures required to minimize third-party damage would result in a much larger footprint alteration of the seabed surface and long-term impact to the benthos. Additional cable protection requirements would also likely offset the installation time savings from placing cables on the seafloor instead of burying them. As such, the Applicant has retained placement of the cables directly on the seafloor, with cable protection (such as rock berm or matting) only for limited areas where sufficient burial depths cannot be achieved due to seabed conditions.

For cable burial, the Applicant assessed a variety of methods including jet plow, mechanical plow, trenching/cutting, and dredging. Both jet plowing and mechanical plowing use a vessel that creates a trench and lays the cable in a single pass. Jet plowing consists of a device that travels along the seafloor surface and injects high pressure water into the sediments below through a blade that is inserted into the seafloor. The water sufficiently liquifies the sediments such that the cable can then settle down through the suspended sediments to the desired burial depth. Mechanical plowing uses a 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. Due to gravity, the displaced sediment returns to the furrow, covering the cable.

Jet plowing is considered the Applicant's primary and preferred method for cable installation. The jet plow method is the most efficient method of submarine cable installation that minimizes the extent and duration of bottom disturbance for the significant length and water depths along the submarine export cable route. The majority of suspended sediments from jet plowing settle back in the trench naturally, reducing sedimentation impacts.

The Applicant also considered trenching, or cutting, which may be used on seabed containing hard materials not suitable for mechanical plowing or jet plowing, as the trenching machine is able to mechanically cut through the material using a chain or wheel cutter fitted with picks or teeth. Once the cutter creates a trench, the submarine export cable is laid into it, and typically backfill is mechanically returned to the trench using a backfill plow. This method is less preferred due to lower efficiency, longer installation duration, and greater potential impacts from the additional step of backfilling the trench. However, both mechanical plowing and trenching (cutting) have been retained as potential installation methods to be used in the event that the Applicant encounters seabed or depth conditions where jet plowing is not practicable or efficient. Pre-sweeping or pre-trenching, as described in **Exhibit E-3: Underground Construction**, may be associated with any of the considered cable burial methodologies.

Mechanical dredging was also assessed as a potential method for submarine cable installation. 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. Because of the greater duration and extent of sediment disturbance associated with dredging, this method is not preferred for the majority of the cable installation. Dredging, however, is proposed for certain locations such as the potential use of a suction dredge in limited locations for pre-sweeping activities and dredging required on the approach to the cable landfall at SBMT (see **Exhibit E-3** for additional information).

3.8.2 Cable Landfall Installation Alternatives

The Applicant considered several cable landfall installation alternatives, including installation of the submarine export cables through conduits in the bulkhead at the shoreline of SBMT, installation over the bulkhead, or HDD from offshore to onshore. Installation through the bulkhead was determined to be the preferred option as described below.

3.8.2.1 HDD Cable Landfall Alternative

The Applicant considered multiple potential HDD alignments in evaluating potential HDD landfall alternatives at SBMT. The preferred EW1 Cable Landfall Alternative is located between the 35th Street Pier and the 29th Street Pier. The 29th Street Pier houses the Sims Municipal Recycling Facility. The 35th Street Pier is the pier structure that is located immediately to the southwest of the preferred EW 1 Cable Landfall Alternative.

The shoreline around the 35th Street Pier is as follows:

1. The end of the 35th Street Pier is understood to have a deep concrete-filled caisson bulkhead with cofferdam to a depth of approximately 50 ft (15 m) below MLLW. This cofferdam has two layers of sheet pile.

2. The southern edge of the pier, which is crossed by one of the evaluated HDD alignments, consists of steel sheet pile bulkhead towards the tip of the pier, to a depth of approximately -14.9 ft (-4.5 m) MLLW, and rip rap armoring towards the base. The riprap was reported to extend approximately 28 ft (8.5 m) offshore to a depth of 10.5 ft (3.2 m). Wood fragments are also found in borings in this area.

3. Along the north side of the 35th Street Pier, the shoreline also consists of a combination of rip rap armoring and steel sheet pile. The rip-rap revetment extends from the southeast corner and out to the

offshore face of the pier. Prior to the installation of the rip rap revetment, a timber pier was demolished, leaving timber piles cut off approximately 2 ft (0.6 m) below the mudline.

At the base of the 35th Street Pier to the north, in the area of the preferred EW 1 Cable Landfall Alternative, the existing bulkhead predominantly consists of a concrete gravity wall in deteriorating condition, with a section of timber-supported low level relieving platform in the middle.

An HDD feasibility assessment, based on available geotechnical data in the vicinity of the cable landfall, determined that geotechnical conditions, HDD geometry, and bending radii would require installing the export cables to depths of greater than 70 ft (21 m). This depth requirement is driven by a combination of factors, including sediment characteristics that are unfavorable to a shallower HDD installation, the required HDD entry angle, avoidance of existing shoreline infrastructure, limitations on the length of the drill, and location of the offshore HDD exit due to maritime traffic.

Based on review of previous geotechnical investigations in the vicinity of the Project, it appears that deeper installation would be required due to the following conditions:

- In the vicinity of the HDD entry location, the geotechnical materials are anticipated to include fill materials overlying sands, silts, and clays, extending from the ground surface to a depth of 22 to 30 ft (6.7 to 9.1 m) below ground surface;
- Beyond the shoreline, the geotechnical materials are anticipated to include layers of very soft to soft silts with gravel and very loose to loose sand overlying medium dense sand and silts and medium stiff silt at depths of 50 to 59 ft (15.2 to 18.0 m) below ground surface; and
- In the vicinity of the exit locations, the site soils are anticipated to include various layers of very soft to soft silt and very loose sand to a depth of approximately 45 ft (13.7 m) below the mudline.

Due to the presence of loose fill materials in the soil column in at the HDD entry, and the elevation difference between the HDD entry and exit location, a conductor casing would be needed to bridge and support the drill path from the point of entry. The entry angle of the HDD would have to allow the installation of the temporary conductor casing through the upper 26 ft (7.9 m) of the fill materials. The HDD alignment would also cross beneath the existing pier known to consist of a steel sheet pile bulkhead with riprap armor stone. Avoidance of these features is factored into the required HDD angle, length, and depth.

As described in Section 3.7.2.1, the soil thermal resistivity is a critical factor for the cable design and limits the burial depth for the installation. The required depths of greater than 70 ft (21 m) for a cable landfall HDD would exceed the cable burial limitations and introduce thermal constraints on the submarine export cables resulting in cable derating. Derating reduces the current the cable is able to carry, to prevent degradation of the cable insulation due to heat.

Besides exceeding depths set by thermal resistivity limitations, the necessary HDD alignment would also place an HDD installation beyond the ends of the existing piers at the site and within the active vessel traffic area. Vessel tracking AIS data from December 2017 indicates that the landward boundary of heavy vessel traffic is approximately 164 ft (50 m) seawards of the end of 35th Street Pier. AIS data shows that the slips north (Sims Municipal Recycling Facility) and south of SBMT are both active with vessel traffic (including tug and barge traffic).

In addition to design limitations associated with the HDD installation depth in this location, geotechnical conditions indicate a high risk for inadvertent returns of drilling fluid. In the vicinity of a potential HDD landfall exit, the thickness of very soft silt and very loose sand is approximately 45 ft (13.7 m). The majority of the exit curves and exit tangents are within these low strength materials; therefore, inadvertent drilling fluid returns would be anticipated regularly and often during pilot bore, reaming, swabbing, and conduit installation. Within these soils at the exit location, a casing strategy to mitigate inadvertent returns cannot be developed without significantly deepening and lengthening the HDD installation.

In conclusion, the Applicant's assessment indicated that an HDD installation of the cable landfall at SBMT would not be reasonable for the Project, because the depth required for installation would exceed the depth limitations of the export cables. Additionally, the HDD alignment would have a high risk of inadvertent returns and potential associated environmental impacts, especially near the HDD exit location. Moreover, the constraints and impacts were similar for any HDD alignment in the vicinity of the cable landfall. The use of the HDD method would reduce seafloor disturbance between the HDD entry and exit points; however, in this area the seafloor is already highly disturbed and future dredging activities are planned. The potential benefits of the reduced seafloor disturbance with HDD installation are also offset by the additional impacts from a larger landfall workspace and cofferdam required offshore for HDD, HDD noise, navigational impacts, and potential impacts form inadvertent returns.

3.8.2.2 Through the Bulkhead Alternative

The preferred installation for the cable landfall (further described in Section 4.1 of **Exhibit 4** and **Exhibit E-3**) involves pulling the cables through conduits in the bulkhead at the shoreline at SBMT, aligned approximately with the end of 32nd Street, between the 35th Street and 29th Street Piers. 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. Around the cable landfall itself, a permanent sheet pile cofferdam will surround the J-tubes, supported by concrete wales, on the upland side of the bulkhead. The area of the cofferdam will be backfilled as needed to restore cover over the conduits up to the edge of the bulkhead. If the dredged material were determined to be unsuitable for backfill over the cable, it would be removed for disposal and suitable alternative clean material would be brought in.

Conduit openings will be installed at the bottom of the bulkhead below the mudline. Temporary sheet piling will also be installed in the water at the 24-inch diameter conduit openings. 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.

Prior to the cable installation, the temporary sheet pile previously installed at the conduit openings for the cofferdam would be removed. The end of the submarine export cables would be pulled up through the installed conduits. Once the appropriate burial depth is achieved, scour protection (e.g., concrete mattresses) would be installed at the toe of the bulkhead over the conduit exit.

Prior to installation of the cables approaching the cable landfall, dredging would be conducted between the 35th Street and 29th Street Piers. This dredging is necessary to facilitate cable vessel access between the two piers, prior to cable installation via jetting or an alternative cable installation method. Although this method of installing the submarine export cables would involve some additional seafloor disturbance associated with the dredging and burial of the cables to the shoreline, as compared to the HDD method alternative, this disturbance would be in an already highly-disturbed area. This area between the piers provides a straight alignment at cable landfall. Compared to the ends or sides of the 35th Street Pier, the area between the piers has a lower risk of jack-up vessel berthing. Jack-up vessel footings have the potential to pose a risk for third-party damage to the cables during operations; therefore, minimizing conflict with potential berthing areas is advantageous. The cable is also located within an area of SBMT that already has reduced bearing live load requirements, and therefore cables in this area would also have less potential impact in terms of future limitations on heavy loads at the SBMT site. Installing the submarine export cables into conduits through the bulkhead results in limited disturbance of the seabed at the exit point, minimal interference with marine traffic, and avoids the risk of inadvertent returns of drilling fluid that would be associated with the HDD installation method.

3.8.2.3 Over the Bulkhead Alternative

As an alternative method, the Applicant considered an installation that routes the export cables through a mildly sloped steel conduit that goes over the edge of the bulkhead down towards the mudline. Under this alternative, the conduit would remain on top of the bulkhead instead of routing through the bulkhead. Similar to the method of installing conduits through the bulkhead, the conduits may need to be supported by a steel structure between bulkhead and mudline, and a cofferdam may be installed to facilitate installation of the conduit underwater. Impacts for this method would be similar to installing a conduit through the bulkhead.

The Applicant assessed several alignments for an over the bulkhead cable landfall, including onto the 35th Street Pier. Nearshore conditions such as bathymetry, in-water obstructions, seabed conditions, and vessel traffic were investigated. Landfall directly onto the pier was determined to be challenging due to existing remnant pile structures, unknowns associated with future planned structural improvements and dredging activities, the potential for jack-up vessels or barges berthing at the pier, cable alignment complexity and greater potential conflicts with high vessel-traffic areas. Routing the cables along the 35th Street Pier was also determined to have greater potential to conflict with future site uses, based on discussions with SSBMT. Based on these factors, a cable landfall over the bulkhead to the 35th Street Pier was determined not to be a reasonable alternative for the Project.

For the alignment between the 35th Street and 29th Street Piers, directly adjacent to the onshore substation the submarine export cable landfall through the bulkhead is also preferred. Installation over the bulkhead in this alignment would result in projection of the conduits out beyond the edge of the bulkhead. In designing the landfall, minimizing new structures seaward of the bulkhead was preferred. Keeping the cables underground/within the bulkhead provides greater safety and protection to the cables from external damage and running the cable over the bulkhead also may introduce stress from a steeper approach angle.

3.8.3 Cable and Pipeline Crossing Method Alternatives

The submarine export cable route will cross existing in-service and out-of-service assets including existing transmission cables, natural gas and petroleum pipelines, and water siphons, especially as the route traverses the Narrows (see **Exhibit E-6**). The reasonable methods for installing the submarine export cables across third-party assets are using concrete or rock-filled mattresses or rock berm protection, as described further in **Exhibit E-3**.

In a meeting in June 2020, the USACE also requested that the Applicant evaluate the possibility of using trenchless methods to install the submarine export cables under assets in New York Harbor, to avoid the need for shallower burial and surface protection at these crossings. As such, the Applicant assessed the potential to use HDD or microtunnel installation methods for several cable and pipeline crossings.

A water-to-water HDD installation would be similar to the method described for the land-to-water HDD in Section 3.7.6.2, except that it would be completed using barge support on both ends of the installations. In other words, these crossings would require a barge-to-barge installation for each crossing. Each barge would need to be a jack-up type to eliminate the impacts of waves and tides. It is expected that the soil conditions below the mudline of the harbor would require installation of a 24-inch (610-millimeter) outer diameter stainless steel conduit. Starter casings would be required on both ends of the HDD alignment to help manage and control drilling fluid loss. Potential HDD alignments assessed were 1,990 to 2,365 ft (606 to 720 m) in length.

The resulting depth of the HDD installation greatly exceeds the depth limitation for the electrical cables. Even if temporary casing pipes were not needed and the vertical curve could be started very close to the mudline, the resulting installation elevation would still exceed the depth limitation. Additionally, based on the available geotechnical information, soils consisting of extremely low to low strength clay and silt are anticipated from the mudline and extending down to depths of at least 22 ft (6.7 m) below mud line. These soils present significant risk of drilling fluid inadvertent return. Even with the casing pipe installation, the risk of a drilling fluid inadvertent return is considered extremely high and containing any drilling fluid inadvertent return would be difficult.

The extremely low to low strength clay and silt present additional challenges associated with steering to maintain the design alignment. To induce a steering deflection, the downhole tooling must be able to push off of the existing soil. Difficulty steering can result in a deeper and/or longer than anticipated installation. Designing the HDD alignment within more favorable soils with sufficient strength where the HDD bore curves are located can decrease this risk.

In addition, barge-to-barge crossings carry a unique set of risks in addition to typical HDD risks. Water levels and storms are significant variables that have effects on scheduling and site productivity. Underwater currents during violent storms can alter the casing pipe, in turn affecting the drill string. This is less likely once the casing has been fully placed into the soil but remains a strong possibility until the casing is set. Site logistics, including incoming and outgoing materials and products, including fluid and spoil removal from the site, can also be more difficult than land crossings due to the more isolated nature of the entry and exit points. Barges and/or ships used for the removal of the fluid returns must be adequately sized so as to not reduce the productivity of downhole operations, meaning larger vessels may be needed in areas of marine traffic. Given the risks and challenges associated with the site soils and the exceedance of the maximum depth of the electrical cables, an HDD construction alternative is not a reasonable crossing method.

Microtunneling is a method of constructing a tunnel that involves underground installation of a casing pipe by jacking it into place from a jacking shaft, using hydraulic jacks. Excavation is carried out with a remotely controlled, closed face, fully shielded, steerable, laser-guided or similar articulated Microtunneling Boring Machine (MTBM). The MTBM can exert a continuous, controllable pressure at the tunnel heading, utilizing pressurized slurry to prevent groundwater inflows and soil movement into the heading. The MTBM is propelled by thrust from a continuous string of pipe that is advanced from a jacking shaft to a receiving shaft by hydraulic jacks. As the MTBM advances, the cutter head excavates the encountered material in front of the machine. The excavated material passes through a crushing/mixing chamber, where the spoils mix with the recycled slurry water that is pumped down from a slurry separation plant, which is located at the surface. The jacking pipe used for microtunnel installations can be either reinforced concrete jacking pipe or steel.

For a microtunnel, the Applicant assessed a 42- to 60-inch (1,067- to 1,524-millimeter) outer diameter reinforced concrete jacking pipe that would need to be installed. Similar to HDD, sands, silts and clays in a very soft to soft or very loose state may not provide sufficient bearing capacity to support the heavy MTBM, which would make maintaining the design alignment difficult. Based on the Applicant's geotechnical investigations in support of the cable routing, the anticipated sediments in the vicinity of potential crossings in New York Harbor are expected to include extremely low to low strength clay and silt. These materials are unlikely to provide sufficient bearing capacity to resist the weight of the MTBM, which would impact steering, and increase the risk of a lost MTBM and the potential for significant ground disturbance. Advancement of the MTBM through the anticipated very soft soils may cause a stress redistribution within the soils leading to increased risk of settlement. Settlement, in turn, also has the potential to introduce risk to the existing assets above the microtunnel.

Microtunnel operations also require dry or watertight shafts. Constructing and sealing each of these shafts presents significant challenges. Given the extent of the very soft/extremely low strength soils, these shafts may require significant depth to provide a stable and watertight seal at the base of the shaft. Given the risks and challenges associated with the site soils, the low anticipated bearing capacity of the site soils, and difficulties laying the export cables through the casing pipe, a microtunnel construction alternative is not a reasonable crossing method.

In addition to these trenchless crossing methods, the Applicant also evaluated artificial reef and pipe-supported bridge crossing methods.

An artificial reef concept would use an artificial reef structure as cable protection in lieu of the mattress or rock protection that would be employed for a traditional trenched asset crossing. However, the Applicant did not find examples of artificial reefs having been previously used for cable protection at asset crossings; therefore, the effectiveness of these structures is unknown. Because of the soft soils present at the locations of the existing cable and pipeline crossings, it was determined that a mattress foundation would likely need to be employed in combination with the artificial reef structures for sufficient support. The reef units also carry the risk of creating anchor snag points. Therefore, the Applicant determined that the use of an artificial reef in conjunction with asset crossings was not a reasonable option for the Project.

A pile-supported bridging crossing would require driving piles to either side of the asset crossing, and significant trench dredging. Seabed impacts, as well as potential underwater noise impacts, would be greater than with the preferred solutions. This method is also more labor-intensive and costly than traditional crossing methods. It was therefore determined that a pile-supported bridge crossing is not a reasonable solution for the Project.

As described in **Exhibit E-3**, rock filled mattresses, concrete articulated mats and rock berm protection were determined to be reasonable options for asset crossings, considering concerns such as river hydraulics, scour, and anchor drag/impact. These methods therefore have been retained for case-by-case use at the cable and pipeline crossings along the submarine export cable route.

3.8.4 Onshore Substation Alternatives

The Applicant evaluated gas-insulated and air-insulated options for the design of the onshore substation. A gas-insulated substation design was selected due to the limited space available onsite. The main reason for using gas-insulated switchgear is that it enables the Applicant to design a compact substation with as small a footprint as possible, and to minimize visual impacts in this urban area. Gas-insulated switchgear can be designed as either indoor or outdoor. The difference in noise output between indoor and outdoor switchgear is not significant compared to noise generated by other substation components. Indoor switchgear would be visually shielded by buildings, while outdoor switchgear and other main components would employ visual screening to minimize visual impacts. The Applicant is evaluating indoor switchgear for the main voltage level; however, outdoor air-insulated equipment may be used for lower voltage levels.

3.8.5 Onshore Cable Alternatives

The Applicant compared underground installation of the onshore cables for the Project with aboveground installation of overhead transmission lines. Based on the proposed location of the onshore cable route within a highly developed urban area, underground installation of the onshore cables is preferred due to the reduction in visual impacts and the ability to use the existing roadway corridors for installation. The use of overhead cables would likely require additional negotiation for property rights and would be space-limited for the corridors under consideration. Additionally, although the initial installation cost and duration for overhead transmission lines is typically lower than installing underground cables, overhead transmission lines and associated transmission structures are more vulnerable to impacts during storms and flood events, reducing system reliability and requiring more frequent maintenance than underground cables. For these reasons, an underground transmission system is preferred for the Project.

3.9 References

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