VINEYARD MID-ATLANTIC

CONSTRUCTION AND OPERATIONS PLAN

VOLUME II

JANUARY 2025

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VINEYARD MID-ATLANTIC LLC

VINEYARD MID-ATLANTIC

VINEYARD OFFSHORE

PUBLIC VERSION

Vineyard Mid-Atlantic COP

Appendix II-D Essential Fish Habitat Assessment

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January 2025

Revision	Date	Description
0	January 2024	Initial submission.
1	September 2024	Updated to address Bureau of Ocean Energy Management Round 1 Comments and to incorporate revisions to the Project Design Envelope (PDE).
2	November 2024	Updated to address Bureau of Ocean Energy Management Round 2 Comments and to incorporate revisions to the PDE.
2	January 2025	Resubmitted without revisions.

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List of Acronyms

AC	Alternating Current
ADLS	Aircraft Detection Lighting System
ANSI	American National Standards Institute
BOEM	Bureau of Ocean Energy Management
CMECS	Coastal and Marine Ecological Classification Standard
CSIRO	Commonwealth Scientific and Industrial Research Organization
CWIS	Cooling Water Intake Structure
DC	Direct Current
DMM	Discarded Military Munitions
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EMF	Electromagnetic Field
EPRI	Electric Power Research Institute
ESP	Electrical Service Platform
FMP	Fishery Management Plan
ft	Feet
HAPC	Habitat Areas of Particular Concern
HDD	Horizontal Directional Drilling
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IPF	Impact Producing Factors
kHz	Kilohertz
km	Kilometer
km^2	Square Kilometer
KP	Kilometer Post
m	Meter
MAFMC	Mid-Atlantic Fisheries Management Council
MF	Magnetic Field
mi	Mile
MSIR	Marine Site Investigation Report
MW	Megawatt
NARW	North Atlantic right whale
NEFMC	New England Fisheries Management council
NEFSC	Northeast Fisheries Science Center
NM	Nautical Mile
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
OECC	Offshore Export Cable Corridor
RSD	Ripple Scour Depression

List of Acronyms (Continued)

SAV	Submerged Aquatic Vegetation
SEER	Synthesis of Environmental Effects Research
SEL	Sound Exposure Level
SPL	Sound Pressure Level
TSS	Total Suspended Solids
TTS	Temporary Threshold Shift
US	United States
UXO	Unexploded Ordnance
WTG	Wind Turbine Generator

1 Introduction

1.1 Vineyard Mid-Atlantic Overview

Vineyard Mid-Atlantic LLC (the "Proponent") proposes to develop, construct, and operate offshore renewable wind energy facilities in Bureau of Ocean Energy Management (BOEM) Lease Area OCS-A 0544 (the "Lease Area") along with associated offshore and onshore transmission systems. This proposed development is referred to as "Vineyard Mid-Atlantic." Vineyard Mid-Atlantic includes 118 wind turbine generator (WTG) and electrical service platform (ESP) positions within the Lease Area. One or two of those positions will be occupied by ESP(s) and the remaining positions will be occupied by WTGs. Offshore export cables installed within an Offshore Export Cable Corridor (OECC) will transmit power from the renewable wind energy facilities to onshore transmission systems on Long Island, New York. At its closest point, the 174 square kilometer (km^2) (43,056 acre) Lease Area is approximately 38 kilometers (km) (24 miles [mi]) south of Fire Island, New York (see Figure 1.1-1).

1.2 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act mandates that federal agencies conduct an Essential Fish Habitat (EFH) consultation for any activity that may adversely affect EFH for federally managed fish species. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Included in 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act, the primary goal of EFH designation is to identify and protect important fish habitat from certain fishing practices and coastal and marine development.

EFH is designated by National Oceanic and Atmospheric Administration's (NOAA) Fisheries (or National Marine Fisheries Service [NMFS]) and Regional Fishery Management Councils. EFH is typically assigned by egg, larvae, juvenile, and adult life stages and designated as waters or as substrates. In 50 CFR § 600.10, NOAA Fisheries defines waters and substrate as:

- Waters—Aquatic areas and their associated physical, chemical, and biological properties that are used by fish and, where appropriate, may include aquatic areas historically used by fish.
- Substrate—Sediments, hard bottoms, structures underlying the waters, and associated biological communities.

Additionally, the Regional Fishery Management Councils identify Habitat Areas of Particular Concern (HAPCs) within their Fishery Management Plans (FMPs). HAPCs are discrete subsets of EFH that serve important ecological functions or are especially vulnerable to degradation.

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Data Source: U.S. Bureau of Ocean Energy Management (BOEM), National Oceanic and Atmospheric Administration (NOAA)

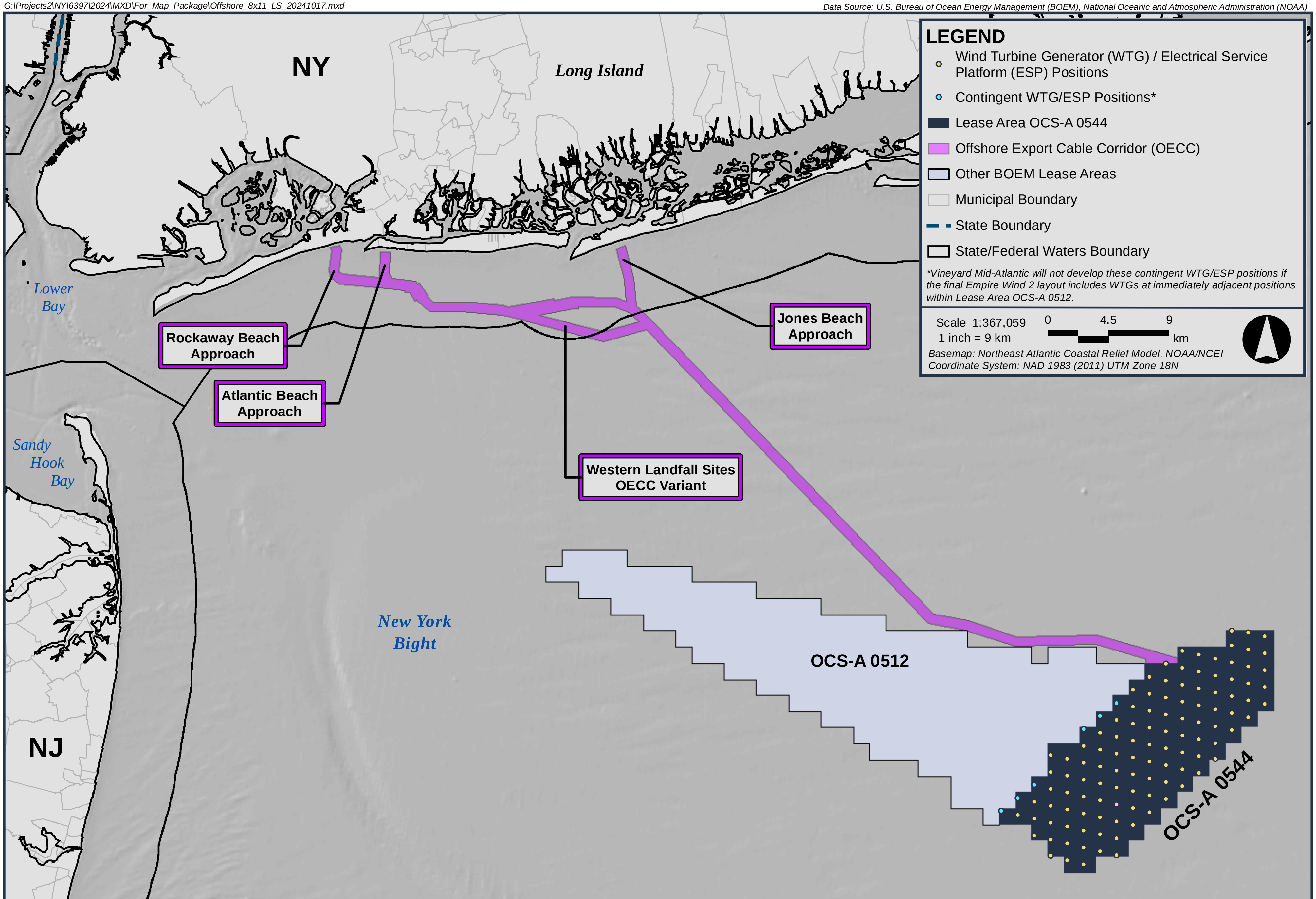

Figure 1.1-1
Overview of Vineyard Mid-Atlantic

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VINEYARD OFFSHORE

2 Affected Environment

2.1 Offshore Development Area

The Offshore Development Area is comprised of Lease Area OCS-A 0544 (the "Lease Area"), the Offshore Export Cable Corridor (OECC), and the broader region surrounding the offshore facilities that could be affected by Vineyard Mid-Atlantic activities.

Habitats within the Lease Area and OECC were evaluated utilizing geophysical data, vibracores, benthic grab samples, and underwater video transects. As will be further discussed in the Marine Site Investigation Report (MSIR) (see Appendix II-B), potential sensitive habitat boundaries were classified and mapped using NMFS' (2021) *Recommendations for Mapping Fish Habitat* for the entire Offshore Development Area. NMFS (2021) recommends the following habitat areas to be mapped:

- Soft Bottom habitats (i.e., mud and/or sand);
- Complex habitats (i.e., submerged aquatic vegetation [SAV], shell/shellfish, and/or hard bottom substrate);
- Heterogeneous Complex habitats (i.e., mix of soft and complex stations within a delineated area);
- Large Grained Complex habitats (e.g., large boulders); and
- Benthic Features (i.e., ripples, megaripples, and sand bedforms).

As described in Appendix II-B, multibeam, side scan, and backscatter data were used to define seafloor composition based on the acoustic reflectivity which is a function of the bottom texture, roughness, slope, relief, and sediment grain size. Initial habitat boundaries were made using sonar data to delineate zones with different sediment types. Then, ground truthing samples (grabs, video, and vibracores) were classified using the NMFS-modified Coastal and Marine Ecological Classification Standard (CMECS) classification system (NMFS 2021), which was then translated into a final classification of either a Soft, Complex, or Complex Mix (both soft and complex samples) for each station. Based on reflectivity of sonar and classifications of video transects and grab samples, each delineated area was assigned to one of the four NMFS (2021) habitat categories: Complex, Heterogeneous Complex, Large Grained Complex, or Soft Bottom. Sonar-delineated boundaries that bordered other boundaries of the same habitat category were kept as separate boundaries (i.e., not merged) to illustrate differences in sonar data that showed potentially different ground conditions (i.e., variation in quantity or type of Complex habitat). Benthic Features, including bedforms and Organic Mud were mapped using the sonar data. Organic Mud, though not a Benthic Feature specified in the NMFS (2021) mapping guidelines, may be mapped as a separate Benthic Feature.

Large scale maps of bottom habitats and benthic features located within the Offshore Development Area of Vineyard Mid-Atlantic following NMFS (2021) are presented in Annex A.

2.1.1 Lease Area

As discussed in the MSIR (see Appendix II-B), habitat within the Lease Area was evaluated during a benthic survey conducted from August to September 2022 using geophysical trackline data, vibracores, 65 grab samples, and 35 video transects. Analysis of the 2022 field program data indicate the Lease Area is comprised of primarily Soft Bottom habitat with some patches of Heterogeneous Complex habitat (see Figure 2.1-1). Video transects and grab samples collected in 2022 indicate the sediment within Soft Bottom habitats consists of primarily Medium Sand and Very Coarse/Coarse Sand. Patches of Silty Sand were also identified on sonar and video transect imagery within the northern parts of the Lease Area.

Heterogeneous Complex habitat present within the Lease Area contains Gravelly Sand to Sandy Gravel with a gravel component of Pebble/Granule. Video transects conducted within the Lease Area in 2022 indicate these patches of gravel are discontinuous, with areas of soft sediment surrounding patches of gravel typically found in ripple troughs. Heterogeneous Complex habitat is most abundant in the northern part of the Lease Area, except for some smaller patches present towards the center and southern portions of the Lease Area.

Ripples are located throughout nearly the entire Lease Area, except within the patches of Silty Sand in the northern section of the Lease Area (see Figure 2.1-1). These ripples are typically small, with wavelengths measuring less than 1.5 meters (m) (4.92 feet [ft]) and wave heights less than 20 cm (0.66 ft). The ripples are typically oriented in a north-northeast to south-southwest direction. No megaripples or sand waves were identified in the Lease Area. See Annex A for detailed benthic habitat charts showing the habitats identified within the Lease Area.

During the 2022 benthic surveys, a total of 65 grain size samples were attempted and successfully collected from 35 benthic grab stations. Of the 35 benthic grab stations, 15 stations included three replicate grain size samples while the other 20 sediment grab stations included just one grab sample. Thirty-five of the grain size samples were co-located with infaunal samples. Samples collected from 35 of these stations were assigned NMFS-modified CMECS classifications and analyzed for benthic infaunal community composition (see Appendix II-B). The remaining samples were assigned CMECS classifications for the separate MSIR (see Appendix II-B). Grain size analysis showed that the average grain size of sediment within the Lease Area was predominantly sand, with 97.96% sand, 0.89% gravel, 0.12% mud, and 1.03% gravel-sized shell across the 65 grab samples.

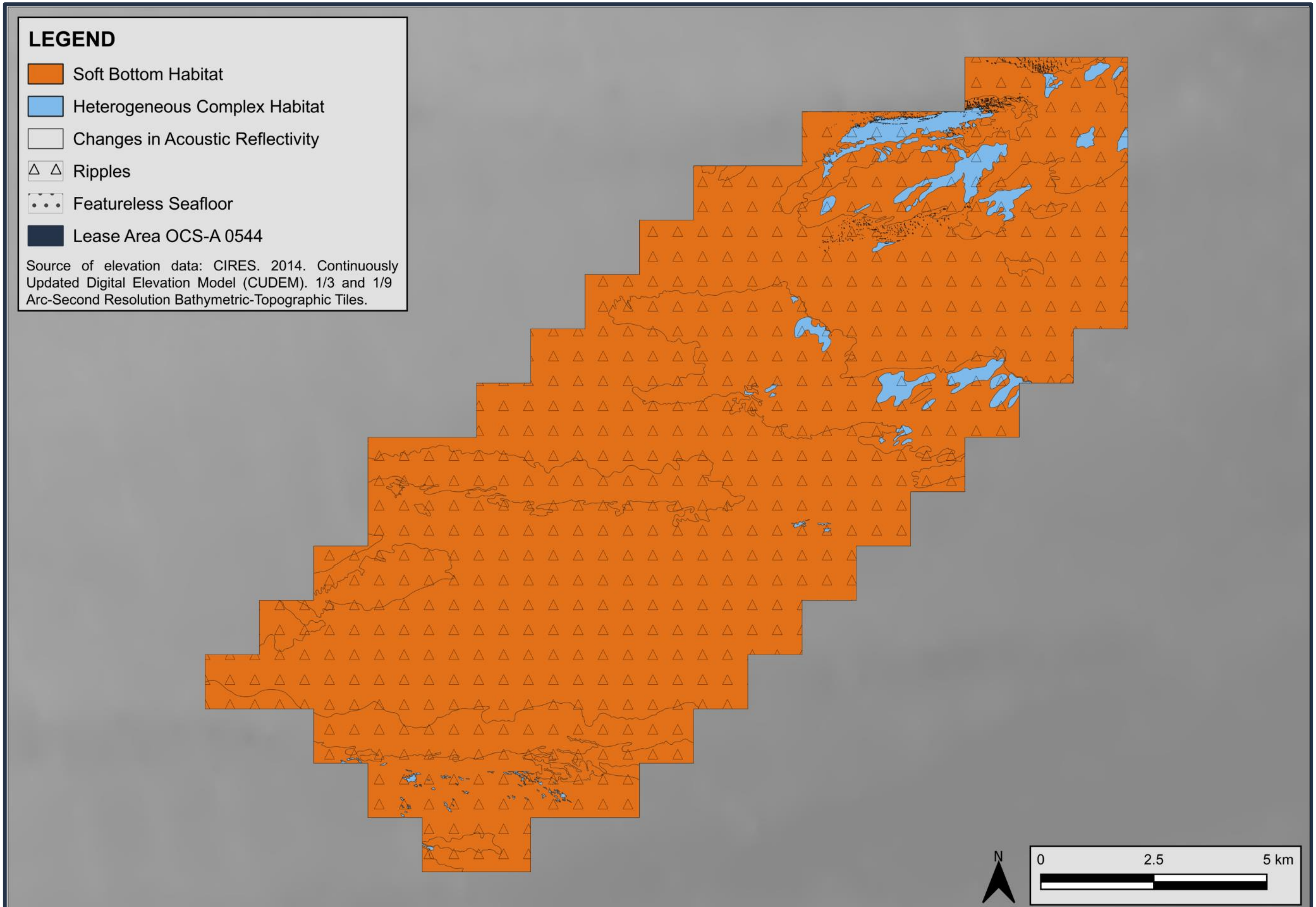

Figure 2.1-1
Habitat Mapping of Lease Area

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Table 2.1-1 Examples of CMECS Defined Substrates Captured During 2022 Underwater Video and Benthic Grab Sampling Throughout the Lease Area

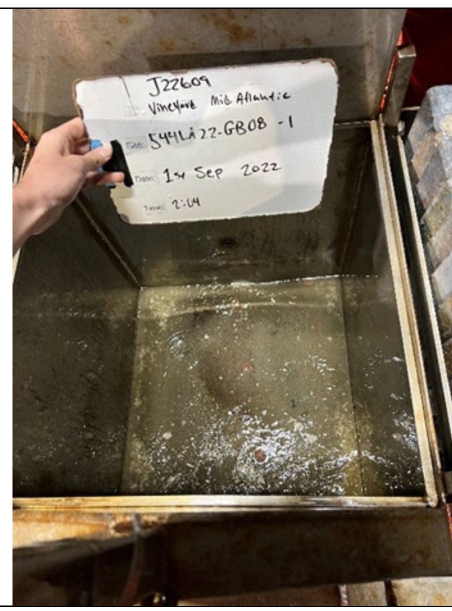
CMECS Substrate and NMFS (2021) Designations	Example Sample Information	Example Sample Image
Muddy Sand; Soft Bottom	Video Transect Still Image 544LA22-VT001-1	
Medium Sand; Soft Bottom	Grab Sample 544LA22-GB008-1 0.31% Gravel	

Table 2.1-1 Examples of CMECS Defined Substrates Captured During 2022 Underwater Video and Benthic Grab Sampling Throughout the Lease Area (Continued)

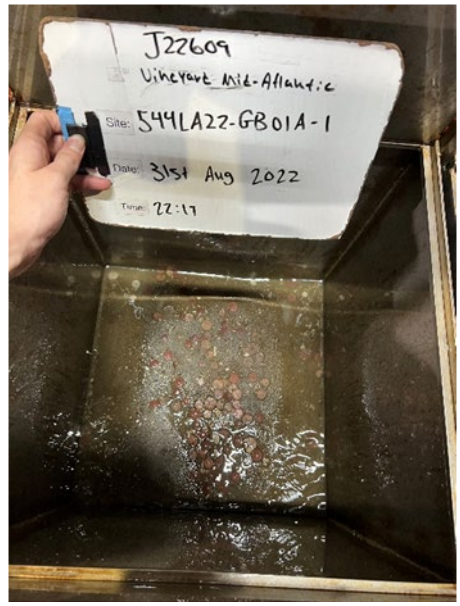
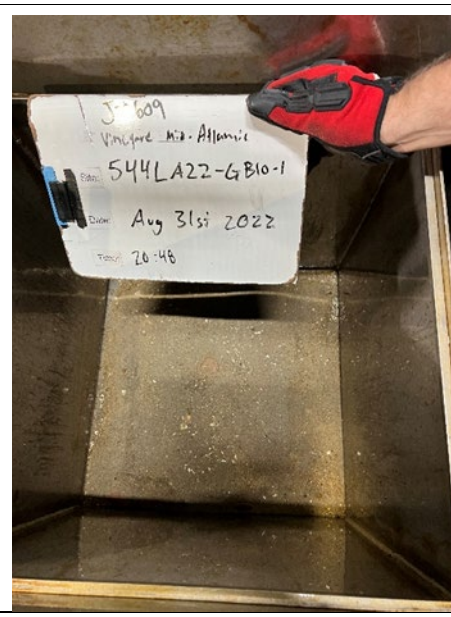
CMECS Substrate and NMFS (2021) Designations	Example Sample Information	Example Sample Image
Very Coarse/Coarse Sand; Soft Bottom	Grab Sample 544LA22-GB001A-1 0.46% Gravel	
Gravelly Sand; Complex	Grab Sample 544LA22-GB010-1 8.98% Gravel	

Table 2.1-1 Examples of CMECS Defined Substrates Captured During 2022 Underwater Video and Benthic Grab Sampling Throughout the Lease Area (Continued)

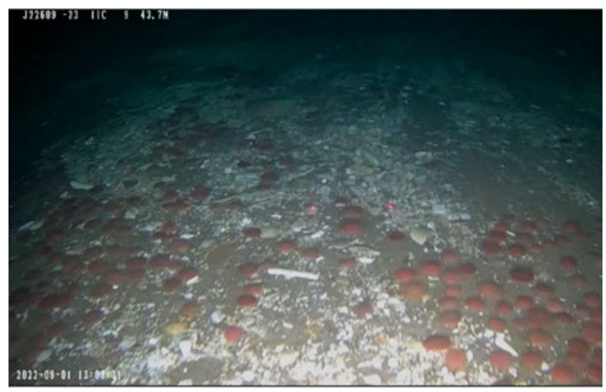
CMECS Substrate and NMFS (2021) Designations	Example Sample Information	Example Sample Image
Sandy Gravel; Complex	Video Transect Still Image 544LA22-VT021-1	
Shell Hash with Fine Substrate; Complex	Video Transect Still Image 544LA22-VT026-1	

Table 2.1-2 Benthic Habitat Classification in the Lease Area

Habitat Type	Area	% of Lease Area
Complex	0	N/A
Heterogenous Complex	5 km^2 (1,334 acres)	3%
Large Grained Complex	0	N/A
Soft Bottom	169 km^2 (41,721 acres)	97%

2.1.2 OECC

As the Vineyard Mid-Atlantic OECC approaches shore, it splits into three variations to connect to three potential landfall site(s) (of which, up to two will be used): the Rockaway Beach Approach, Atlantic Beach Approach, and Jones Beach Approach. The Proponent has also identified a "Western Landfall Sites OECC Variant" that may be used for routing offshore export cables to the Rockaway Beach and Atlantic Beach Landfall Sites (see Figure 1.1-1). Where needed, the term "primary OECC" is used to refer to the OECC without the Western Landfall Sites OECC Variant.

Habitat within the OECC was evaluated with data from environmental sampling conducted from May through July 2023 using 61 video transects and 107 total sediment grabs from 59 stations (see Appendix II-B). Thirty-five of the 59 stations were collected as single grab samples, while 24 of the stations were collected in triplicate. Grain size analysis showed that the average grain size of sediment within the OECC was predominantly sand, with 93.61% sand, 5.02% gravel, 0.48% mud, and 0.90% gravel-sized shell across the 59 grab stations. Habitat within the OECC is mostly Soft Bottom with some areas of Heterogenous Complex (see Figure 2.1-2 and Table 2.1-3). Complex and Large Grained Complex habitats are absent from the OECC.

The 2023 field program data (sonar and results from benthic grab samples, video transects, and vibracores) as well as publicly available datasets of benthic grab samples (usSEABED) were used to characterize the habitats present within the OECC (see Appendix II-B). The description of these habitats has been divided into offshore (federal) and nearshore (state) waters, with detailed charts of the benthic habitats identified within the OECC provided in Annex A.

Soft Bottom habitats are the dominant habitat type observed in the offshore portion of the OECC (see Figure 2.1-2). Ripples are common throughout the offshore portion of the OECC with wavelengths measuring less than 1.5 m (4.92 ft) and heights less than 20 cm (0.66 ft). No megaripples or sand waves were observed.

Soft Bottom and Heterogeneous Complex habitats are common within the nearshore portion of the OECC (see Figure 2.1-3). Ripples are also abundant and were frequently observed on sonar imagery and video transects close to shore. Ripple wavelengths measure less than 1.5 m (4.92 ft) and heights less than 20 cm (0.66 ft). Some ripples are located within Ripple Scour Depressions (RSDs). These RSDs are classified as Heterogeneous Complex habitats and primarily consist of Gravelly and Gravel Mix sediments, which were often observed in ripple troughs.

Specific to the habitats occurring within the three potential landfall approaches (see Figure 2.1-3):

- The Rockaway Beach Approach consists of Soft Bottom and Heterogeneous Complex habitats. RSDs cross the OECC along the approach, which contain gravel in the form of Pebble/Granule in ripple troughs classified as Heterogeneous Complex habitat. Additional ripples without gravel are also present in some Soft Bottom habitat areas.

- The Atlantic Beach Approach has one larger RSD categorized as Heterogeneous Complex habitat. Ripples are common, and smaller Heterogeneous Complex RSDs are also present.

- The Jones Beach Approach is dominated by Soft Bottom habitat, with the presence of some small RSDs containing Heterogeneous Complex habitat.

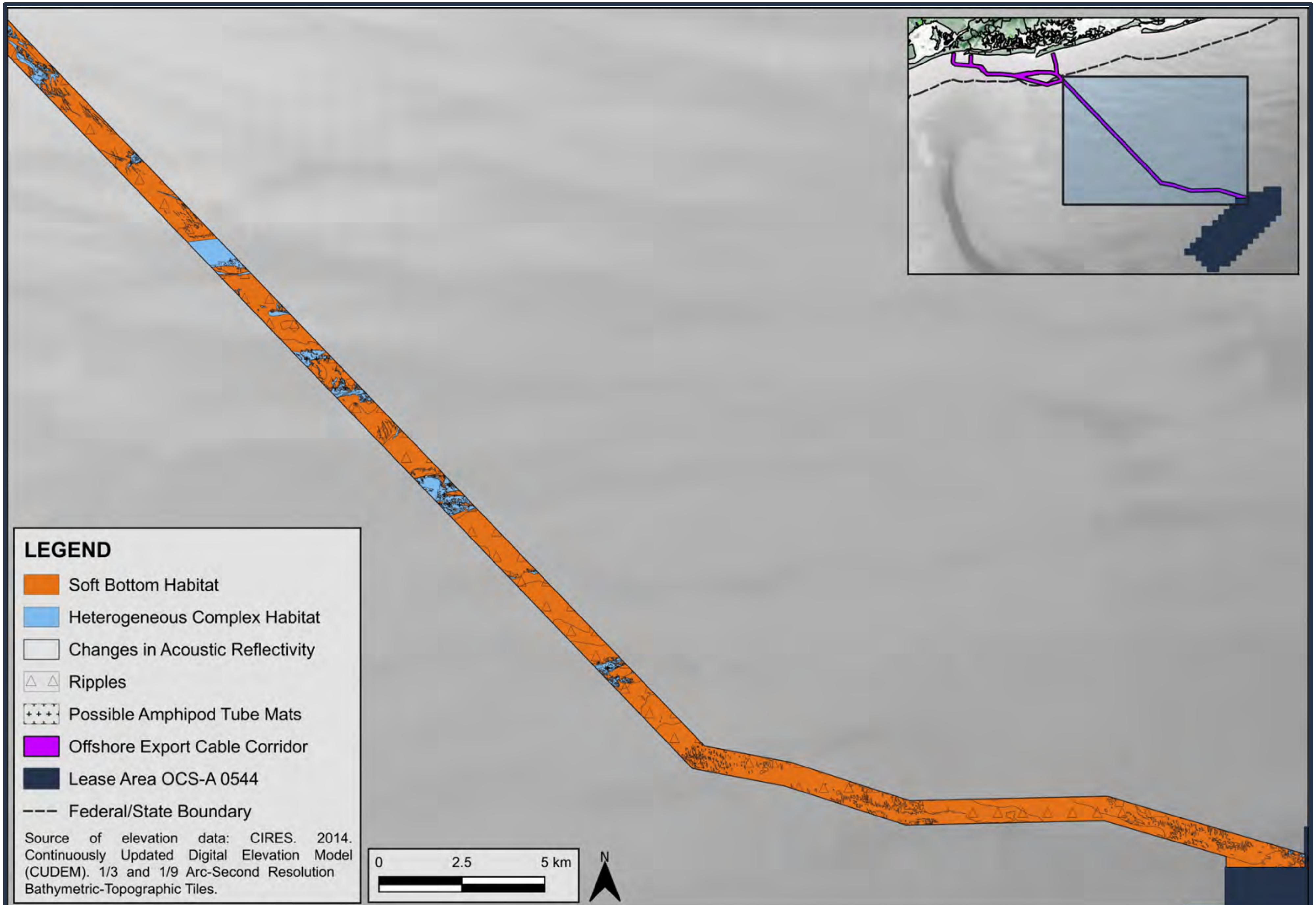


Figure 2.1-2
Habitat Mapping of Offshore Portion of OECC

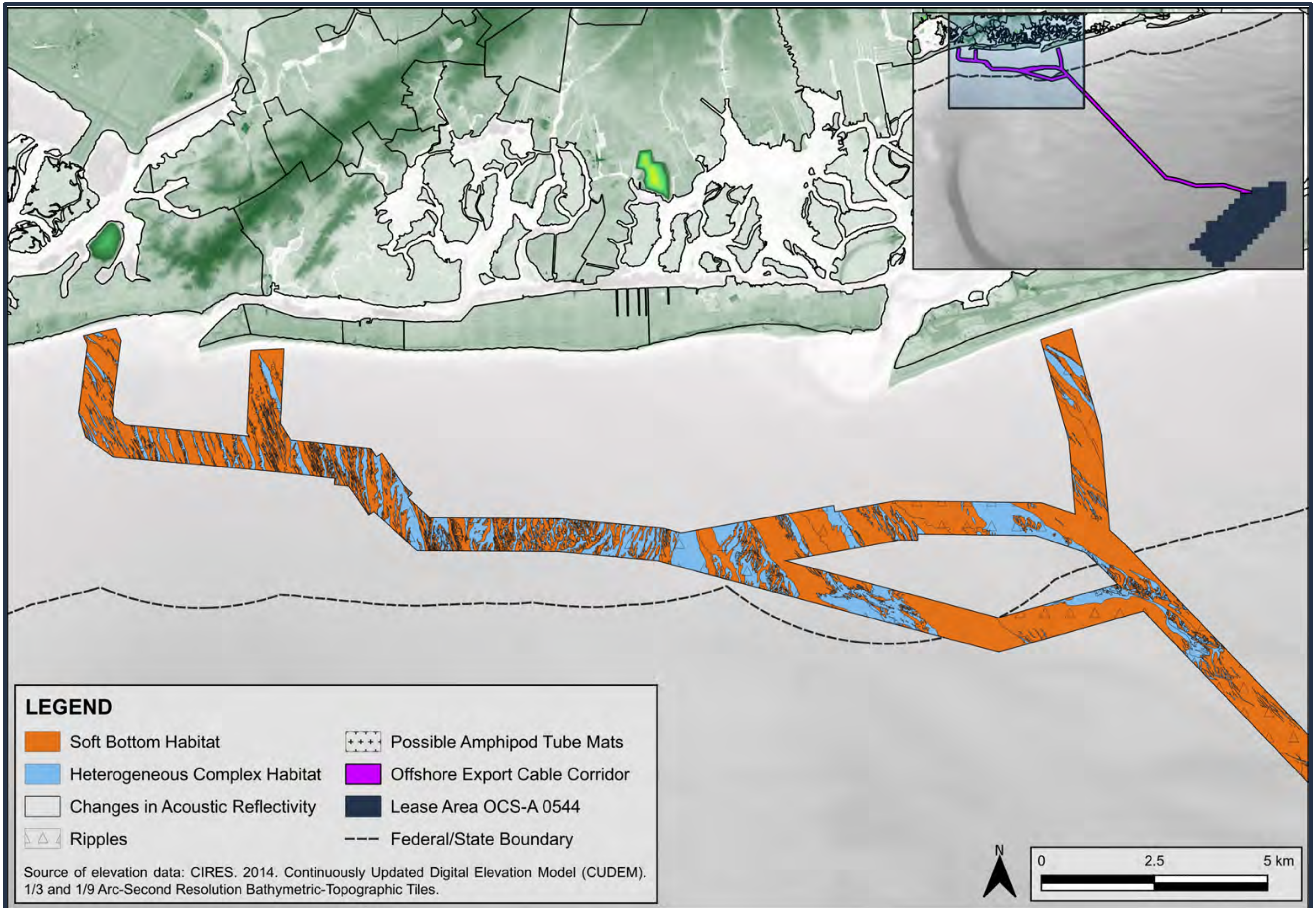


Figure 2.1-3
Habitat Mapping of Nearshore Portion of OECC

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Table 2.1-3 Benthic Habitat Classification in the OECC

Habitat Type	OECC (Rockaway Beach Approach)				OECC (Atlantic Beach Approach)				OECC (Jones Beach Approach)	
	Primary OECC		With Variant		Primary OECC		With Variant		Primary OECC	
	Area	% of Total Area	Area	% of Total Area	Area	% of Total Area	Area	% of Total Area	Area	% of Total Area
Complex	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A
Heterogenous Complex	10.3 km^2 (2,543 acres)	18%	10.1 km^2 (2,485 acres)	18%	9.7 km^2 (2,406 acres)	18%	9.5 km^2 (2,347 acres)	18%	4.3 km^2 (1,074 acres)	11%
Large Grained Complex	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A
Soft Bottom	45.7 km^2 (11,296 acres)	82%	44.6 km^2 (11,032 acres)	82%	43.5 km^2 (10,758 acres)	82%	42.5 km^2 (10,494 acres)	82%	35.5 km^2 (8,761 acres)	89%

The US Fish and Wildlife Service National Wetlands Inventory (NWI) indicates that the OECC and offshore export cable landfall site(s) do not intersect mapped wetlands (USFWS 2019) (see Table 2.1-4 and Figure 2.1-4). All three landfall sites, which are located in paved parking areas (see Section 3.7.1 of COP Volume I), are classified as "littoral zone," which includes "all lands under tidal waters which are not included in any other [wetland habitat] category, extending seaward from shore to a depth of six feet at mean low water" (NYSDEC 2023b; see Figure 8.2-10 of Appendix II-B). There are mapped wetlands in the waters between the OECC and the landfall sites; however, impacts to these areas will be avoided because, at each landfall site, the offshore export cables are expected to transition onshore using horizontal directional drilling (HDD) (see Section 3.7.1 of COP Volume I for further detail for landfall site construction).

Table 2.1-4 NWI Mapped Wetlands Within the OECC Approach(es) and Landfall Site(s)

Route Feature	NWI Classification	Area (acres)
Rockaway Beach Approach and Landfall Site	No NWI-mapped wetlands	0
Atlantic Beach Approach and Landfall Site	No NWI-mapped wetlands	0
Jones Beach Approach and Landfall Site	No NWI-mapped wetlands	0

Figure 2.1-4
NWI-Mapped Wetlands in Vicinity of the Offshore Development Area

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2.2 Long Island South Shore Estuary Reserve

The Long Island South Shore Estuary Reserve (an interior coastal area) extends from the western boundary of the Town of Hempstead about 113 km (70 mi) to the middle of the Town of Southampton and includes the area from the mean high tide line on the ocean side of the barrier islands to the inland limits of the mainland watersheds (see Figure 2.2-1). The estuary is a dynamic ecosystem that includes barrier islands with 448 km^2 (173 square miles [mi^2]) of shallow bays behind them. This area is constantly evolving in response to wave action, tides, coastal storms, and sea level rise. The estuarine environment contains tidal marshes, mud and sand flats, underwater plant beds and broad shallows that support prey items of finfish, shellfish, and other wildlife in the area. Specific to the Offshore Development Area, the Atlantic Beach and Jones Beach Landfall Sites and portions of the associated onshore cable routes are located within the Western Bays sub-region, which extends from the western boundary of the Town of Hempstead to the Nassau-Suffolk County line, including Hempstead Bay, South Oyster Bay, and all the lands that drain into them (see Figure 2.2-1). The Western Bays portion of the Long Island South Shore Estuary Reserve contains an extensive area of shallow water and salt marsh islands connected by channels and tidal creeks. Dredge material islands are also prevalent in this sub-region (South Shore Estuary Reserve Council and NYSDOS 2022).

As described in Section 4.1 and Appendix II-B, tidal wetlands are found in areas north of the Atlantic Beach and Jones Beach Landfall Sites within the Western Bays sub-region (see Section 4.1 of COP Volume II). Tidal wetlands provide important ecosystem services, such as shoreline stabilization and storm protection, water filtration, and detoxification. They also act as nursery habitat for ecologically and economically significant species of fish and crustacean (Purcell et al. 2020). Tidal salt marsh/estuarine marsh is a habitat that includes salt marsh, brackish marsh, and freshwater tidal marsh. Typically, a salt marsh has salt marsh cordgrass; brackish areas support salt marsh cordgrass as well as narrowleaf cattail. Additionally, this intertidal and subtidal area is home to several intertidal benthic species including, but not limited to, hard clam (*Mercenaria mercenaria*), soft shell clam (*Mya arenaria*), Atlantic bay scallop (*Argopecten irradians*), Atlantic sea scallop (*Placopecten magellanicus*), Eastern oyster (*Crassostrea virginica*), Atlantic surfclam (*Spisula solidissima*), blue mussel (*Mytilus edulis*), and bank (ribbed) mussel (*Geukensia demissa*) (NYSDEC 2023a).

The onshore cable routes are designed to avoid and/or minimize potential impacts to the sensitive habitats within the Western Bays. The onshore cable routes are sited primarily within public roadway layouts[1] (i.e., within previously disturbed areas) to minimize disturbance to sensitive habitat, such as tidal wetlands. Additionally, the Proponent intends to use multiple trenchless crossings (e.g., HDD, pipe jacking, or direct pipe trenchless drilling) where the onshore cables traverse tidal wetlands within the Western Bays.

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1 In limited areas, the onshore cable routes may follow utility rights-of-way (ROWs) or depart from public roadway layouts, particularly at complex crossings.

NYSDEC Statewide Seagrass Map identifies eelgrass, another sensitive benthic habitat important for fish and invertebrate resources, in the bays behind Long Island's barrier islands. However, all onshore routes will not intersect any of the NYSDEC mapped eelgrass areas (see Figure 4.1-4 in Section 4.1 of COP Volume II), which are at least 0.9 kilometers (km) (0.6 miles [mi]) east of the Jones Beach to Ruland Road Eastern Onshore Cable Route.

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Data Source: U.S. Bureau of Ocean Energy Management (BOEM), National Oceanic and Atmospheric Administration (NOAA)

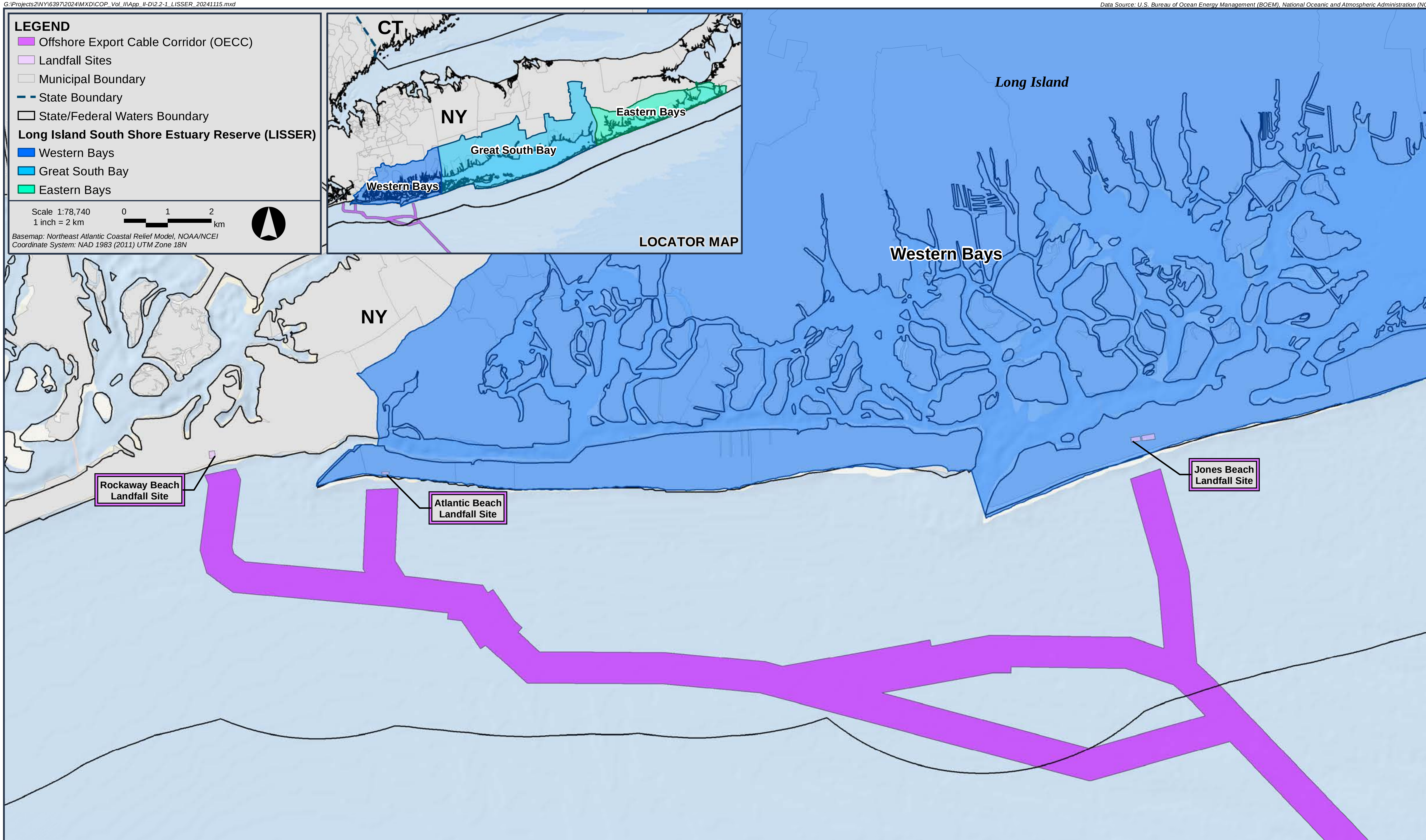

Figure 2.2-1

Long Island South Shore Estuary Reserve

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3 EFH Designations in the Offshore Development Area

The EFH designations described in this section correspond to those currently accepted and designated by the New England Fishery Management Council (NEFMC), Mid-Atlantic Fishery Management Council (MAFMC), and NOAA Fisheries Highly Migratory Species Division (NEFMC 2017). Many EFH designations are determined for each cell in a 10′ latitude by 10′ longitude square grid in state and federal waters. The Lease Area intersects 4 cells and the OECC intersects 7 cells (see Figure 3.0-1). Three of these cells that overlap the OECC also include EFH designations within the Long Island South Shore Estuary Reserve. The specific FMPs with protective designations of EFH include:

- New England Fishery Management Council
  - Northeast Multispecies FMP
  - Atlantic Sea Scallop FMP
  - Monkfish FMP
  - Atlantic Herring FMP
  - Skate FMP
- Mid-Atlantic Fishery Management Council
  - Atlantic Mackerel, Squid, and Butterfish FMP
  - Spiny Dogfish FMP
  - Summer Flounder, Scup, and Black Sea Bass FMP
  - Bluefish FMP
  - Atlantic Surf Clam and Ocean Quahog FMP
- NOAA Fisheries Highly Migratory Species Division
  - Consolidated Atlantic Highly Migratory Species FMP

Both substrate and water habitats are designated as EFH for 40 fish species within the Lease Area and the OECC (see Table 3.0-1). Though impacts to the Western Bays portion of the Long Island South Shore Estuary Reserve will be avoided by the use of multiple trenchless crossings (see Section 2.2), the species with designated EFH in that region are also described. For the purposes of this analysis, the Western Bays portion of the Long Island South Shore Estuary Reserve is referred to as the "inshore bays." It should also be noted that no HAPCs have been identified within the Offshore Development Area.

Data Source: U.S. Bureau of Ocean Energy Management (BOEM), National Oceanic and Atmospheric Administration (NOAA)

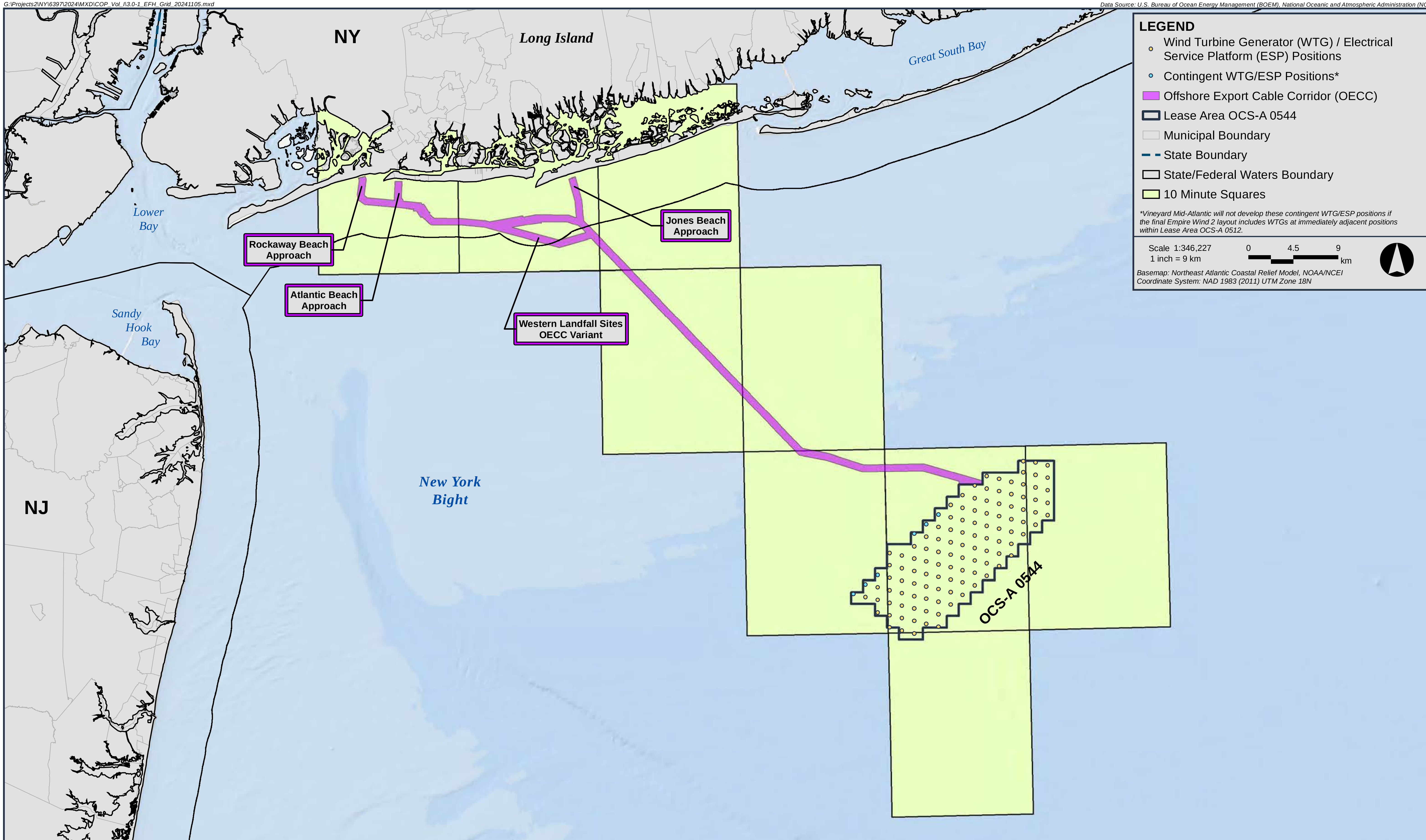

Figure 3.0-1

EFH Grid Units that Intersect with the Offshore Development Area

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Table 3.0-1 EFH Designated Species in the Offshore Development Area

Species	Eggs		Larvae/ Neonate[1]		Juveniles		Adults	
	OECC	Lease Area	OECC	Lease Area	OECC	Lease Area	OECC	Lease Area
Atlantic albacore tuna (*Thunnus alalunga)*	-	-	-	-	P	P	-	-
Atlantic bluefin tuna (*Thunnus thynnus*)[3]	-	-	-	-	P	P	P	-
Atlantic butterfish (*Peprilus triacanthus*)	P	-	P	P	S	S	S	S
Atlantic cod (*Gadus morhua*)	HC	HC	HC	HC	-	-	HC	HC
Atlantic herring (*Clupea harengus*)	-	-	P	P	P, HC	P, HC	P, HC	P, HC
Atlantic mackerel (*Scomber scombrus*)	P	P	P	P	P	P	P	P
Atlantic sea scallop (*Placopecten magellanicus*)	HC, S	HC, S	HC	HC	HC	HC	S, HC	S, HC
Atlantic skipjack tuna *(Katsuwonus pelami)*	-	-	-	-	P	P	P	P
Atlantic surf clam (*Spisula solidissima*)	-	-	-	-	S	S	S	S
Atlantic yellowfin tuna (*Thunnus albacares*)	-	-	-	-	P	P	-	-
Black sea bass (*Centropristis striata*)	-	-	P	-	HC	HC	HC	HC
Blue shark (*Prionace glauca*)	-	-	P	P	P	P	P	P

Table 3.0-1 EFH Designated Species in the Offshore Development Area (Continued)

Species	Eggs		Larvae/ Neonate[1]		Juveniles		Adults	
	OECC	Lease Area	OECC	Lease Area	OECC	Lease Area	OECC	Lease Area
Bluefish (*Pomatomus saltatrix*)	P	-	P	P	P	-	P	P
Common thresher shark (*Alopias vulpinus*)[2]	P	P	P	P	P	P	P	P
Dusky shark (*Carcharhinus obscurus*)[2, 3]	-	-	P	P	P	P	P	P
Haddock (*Melanogrammus aeglefinus*)	-	-	P	P	P,HC	P, HC	-	-
Little skate (*Leucoraja erinacea*)	-	-	-	-	S, HC	S, HC	-	-
Longfin inshore squid (*Loligo pealeii*)	S, HC	-	-	-	P	P	P	P
Monkfish (*Lophius americanus*)	P	P	P	P	S, HC	S, HC	S, HC	S, HC
Northern shortfin squid (*Illex illecebrosu*)	-	-	-	-	-	-	P	P
Ocean pout (*Macrozoarces americanus*)	HC	HC	-	-	S, HC	S, HC	S, HC	S, HC
Ocean quahog (*Artica islandica*)	-	-	-	-	S, HC	S, HC	S, HC	S, HC
Pollock (*Pollachius virens*)	P	-	P	P	P	-	-	-
Red hake (*Urophycis chuss*)	P	P	P, S, HC	P, S, HC	S, HC	S, HC	S	S

Table 3.0-1 EFH Designated Species in the Offshore Development Area (Continued)

Species	Eggs		Larvae/ Neonate[1]		Juveniles		Adults	
	OECC	Lease Area	OECC	Lease Area	OECC	Lease Area	OECC	Lease Area
Sand tiger shark (*Carcharias taurus*)	-	-	HC	HC	HC	HC	-	-
Sandbar shark (*Carcharhinus plumbeus*)	-	-	P	P	P	P	P	P
Scup (*Stenotomus chrysops*)	P	-	P	-	S, HC	S, HC	S, HC	S, HC
Shortfin mako shark (*Isurus oxyrinchus*)[2]	P	P	P	P	P	P	P	P
Silver hake (*Merluccius bilinearis*)	P	P	P	P	S	S	S	S
Smooth dogfish (*Mustelus canis*)[2]	S, HC	S, HC	S, HC	S, HC	S, HC	S, HC*	S, HC	S, HC
Spiny dogfish (*Squalus acanthias*)	-	-	-	-	-	P	P	P
Summer flounder (*Paralichthys dentatus*)	S, P	S.P	P	P	S, HC	-	S, HC	S, HC
Tiger shark (*Galeocerdo cuvier*)	-	-	-	-	P	P	P	P
White hake (*Urophycis tenuis*)	-	-	-	-	HC	HC	-	-
White shark (*Carcharodon carcharias*)[2]	-	-	P	P	P	P	P	P
Windowpane flounder (*Scophthalmus aquosus*)	P	P	P	P	S	S	S	S

Table 3.0-1 EFH Designated Species in the Offshore Development Area (Continued)

Species	Eggs		Larvae/ Neonate[1]		Juveniles		Adults	
	OECC	Lease Area	OECC	Lease Area	OECC	Lease Area	OECC	Lease Area
Winter flounder (*Pseudopleuronectes americanus*)	S, HC	-	S, HC	S, HC	S, HC	S, HC	S, HC	S, HC
Winter skate (*Leucoraja ocellata*)	-	-	-	-	S, HC	S, HC	S, HC	S, HC
Witch flounder (*Glyptocephalus cynoglossus*)	P	P	P	P	P,S	P, S	S, HC	S, HC
Yellowtail flounder (*Limanda ferruginea*)	P	P	P	P	S	S	S	S

Notes:

1. Shark species emerge from egg cases fully developed and are referred to as neonates.
2. Indicates EFH designations are the same for all life stages or designations are not specified by life stage.
3. "-" indicates EFH has not been designated for this life stage or the life stages
4. * indicates sub-adult life stage
5. HC = Heterogeneous Complex; P = Pelagic; S = Soft Bottom Habitat

Table 3.0-2 Monthly Presence of Each Life Stage of EFH Species in the Offshore Development Area

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Atlantic albacore tuna (*Thunnus alalunga*)[2]	-	-	-	-	-	J	J	J	J	J	-	-
Atlantic bluefin tuna (*Thunnus thynnus*)[2]	-	-	-	-	-	-	J A	J A	J A	J A	J A	-
Atlantic butterfish (*Peprilus triacanthus*)[2]	J A	J A	J A	E J A	All	All	All	All	All	L J A	L J A	J A
Atlantic cod (*Gadus morhua*)[2]	E J A	E J A	E J A	E J A	E J A	L A	L A	E J A	E J A	E J A	E J A	E J A
Atlantic mackerel (*Scomber scombrus*)[2]	A	A	A	E A	All	All	E J A	E J A	J	J	J	A
Atlantic herring (*Clupea harengus*)[2]	L J A	L J A	L J A	L J A	A	A	A	L J A	L J A	L J A	L J A	L J A
Atlantic sea scallop (*Placopecten magellanicus*)[2]	J A	J A	J A	J A	E J A	All	All	All	All	All	L J A	L J A
Atlantic skipjack tuna (*Katsuwonus pelami*)[2]	-	-	-	-	J A	J A	J A	J A	J A	J A	J A	-
Atlantic surf clam (*Spisula solidissima*)[2]	J A	J A	J A	J A	J A	J A	J A	J A	J A	J A	J A	J A
Atlantic yellowfin tuna (*Thunnus albacares*)[2]	-	-	-	-	-	J	J	J	J	-	-	-
Black sea bass (*Centropristis striata*)[2]	-	-	-	J A	J A	L J A	L J A	L J A	L J A	L J A	L J A	J A
Blue shark (*Prionace glauca*)	-	-	-	-	J A	J A	J A	J A	J A	J A	-	-
Bluefish (*Pomatomus saltatrix*)[2]	-	-	-	E L A	E L A	All	All	All	J A	J A	J A	-
Common thresher shark (*Alopias vulpinus*)[2]	All	All	All	All	All	All	All	All	All	All	All	All
Dusky shark (*Carcharhinus obscurus*)	-	-	-	-	-	J A	J A	J A	J A	-	-	-
Haddock (*Melanogrammus aeglefinus*)[2]	L J A	All	All	All	All	L J A	L J A	J A	J A	J A	J A	J A
Little skate (*Leucoraja erinacea*)[2]	L J A	L J A	L J A	L J A	L J A	L J A	L J A	L J A	L J A	L J A	L J A	L J A
Longfin inshore squid (*Loligo pealeii*)[2]	All	All	All	All	All	All	All	All	All	All	All	All
Monkfish (*Lophius americanus*)[2]	J A	J A	All	All	All	All	All	All	All	J A	J A	J A
Northern shortfin squid (*Illex illecebrosu*)[2]	A	A	A	A	A	A	A	A	A	A	A	A

Table 3.0-2 Monthly Presence of Each Life Stage of EFH Species in the Offshore Development Area (Continued)

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ocean pout (*Macrozoarces americanus*)	All	All	L J A	L J A	L J A	J A	J A	J A	E J A	E J A	All	All
Ocean quahog (*Artica islandica*)[2]	J A	J A	J A	J A	J A	J A	J A	J A	J A	J A	J A	J A
Pollock (*Pollachius virens*)[2]	E L	E L	L J	J	J	J	J	J	J	-	E	E L
Red hake (*Urophycis chuss*)[2]	J A	J A	J A	E J A	All	All	All	All	All	All	All	J A
Sand tiger shark (*Carcharias taurus*)	-	-	-	-	N J	N J	N J	N J	N J	-	-	-
Sandbar shark (*Carcharhinus plumbeus*)	-	-	-	-	-	J A	J A	J A	J A	-	-	-
Scup (*Stenotomus chrysops*)[2]	-	-	-	-	All	All	All	All	L J A	L J A	J A	-
Shortfin mako shark (*Isurus oxyrinchus*)[3]	-	-	-	-	-	J A	J A	J A	J A	J A	-	-
Silver hake (*Merluccius bilinearis*)[2]	All	All	All	All	All	All	All	All	All	All	All	All
Smooth dogfish (*Mustelus canis*)[2, 3]				All	All	All	All	All	All	All	All	
Spiny dogfish (*Squalus acanthias*)[2]	J A	J A	J A	J A	J A	J A	J A	J A	J A	J A	J A	J A
Summer flounder (*Paralichthys dentatus*)[2]	All	All	E J A	E J A	E J A	J A	J A	E J A	All	All	All	All
Tiger shark (*Galeocerdo cuvier*)	-	-	-	-	-	J A	J A	J A	J A	-	-	-
White hake (*Urophycis tenuis*)[2]	-	-	-	-	-	E J	E J	E J	E J	E J	J	-
White shark (*Carcharodon carcharias*)[3]	-	-	-	-	J A	J A	J A	J A	J A	J A	J A	-
Windowpane flounder (*Scophthalmus aquosus*)[2]	J A	J A	J A	J A	E J A	J A	All	All	E J A	J A	J A	J A
Winter flounder (*Pseudopleuronectes americanus*)[2]	J A	E J A	All	All	All	All	L J A	J A	J A	J A	J A	J A
Winter skate (*Leucoraja ocellata*)[2]	J	J	J A	J A	J A	-	-	-	J A	J A	J A	J
Witch flounder (*Glyptocephalus cynoglossus*)[2]	L J A	All	All	All	All	All	All	All	All	All	L J A	L J A
Yellowtail flounder (*Limanda ferruginea*)[2]	J A	J A	E J A	E J A	All	All	L J A	J A	J A	J A	J A	J A

Notes:
1. E=Eggs, L=Larvae, N=Neonate, J=Juvenile, A=Adult, All=All life stages potentially present throughout the year, and R=Rare.
2. Species of commercial or recreational importance.
3. Indicates EFH designations are the same for all life stages or designations are not specified by life stage.

3.1 Individual Species EFH

Atlantic Albacore Tuna

Albacore tuna (*Thunnus alalunga*) EFH is designated in the OECC and the Lease Area for juvenile life stage. EFH for juvenile albacore tuna is designated as occurring offshore the United States (US) Atlantic east coast from Cape Cod to Cape Hatteras. Juveniles migrate to northeastern Atlantic waters in the summer for feeding. Adult albacore tuna EFH is also designated along the US Atlantic east coast from Cape Cod to Cape Hatteras generally farther offshore than EFH for juveniles. Adults are commonly found in northern Atlantic waters in September and October for feeding. Albacore tuna are top pelagic predators and opportunistic foragers (NMFS 2009).

Atlantic Bluefin Tuna

Bluefin tuna (*Thunnus thynnus*) EFH is designated in the OECC for juvenile and adult life stages and the Lease Area for juvenile life stages. EFH for juvenile bluefin tuna is waters off Cape Cod to Cape Hatteras, including the inshore bays. EFH for adult bluefin tuna is pelagic waters from the mid-coast of Maine to southern New England. Bluefin tuna inhabit northeastern waters to feed and move south to spawning grounds in the spring. Both juveniles and adults exhibit opportunistic foraging behaviors and diets typically consist of fish, jellyfish, and crustaceans (Atlantic Bluefin Tuna Status Review Team 2011; NOAA Fisheries 2020a).

Atlantic Butterfish

Atlantic butterfish (*Peprilus triacanthus*) EFH is designated in the OECC for all life stages and the Lease Area for the larval, juvenile, and adults stages. Only the egg stage is found in the OECC. EFH is designated for butterfish eggs in pelagic habitats with depths under 1,500 m (4,921 ft) and average temperatures between 6.5 to 21.5° Celsius (°C [48–71 °F]) in inshore estuaries and embayments from Massachusetts Bay to the south shore of Long Island, New York; in Chesapeake Bay; and in patches on the continental shelf/slope from Maine southward to Cape Hatteras, North Carolina. EFH for butterfish larvae is designated as pelagic habitats in inshore estuaries and embayments from Boston Harbor to Chesapeake Bay and over the continental shelf, from the Gulf of Maine to Cape Hatteras.

Butterfish larvae are common in high salinity and mixing zones where bottom depths are between 41–350 m (134–1,148 ft). EFH for juvenile and adult butterfish is pelagic habitats in inshore estuaries and embayments from Massachusetts Bay to Pamlico Sound on the inner and outer continental shelf from the Gulf of Maine to Cape Hatteras. However, only the juveniles have designated EFH within the inshore bays. Juvenile and adult butterfish are generally found over sand, mud, and mixed substrates in bottom depths between 10–280 m (33–918 ft] (Cross et al. 1999). Juvenile and adult butterfish feed primarily on planktonic prey though adults may eat squids and fishes as well (Cross et al. 1999). Butterfish are found in the Offshore Development Area at all life stages throughout the year and are present in nearshore areas in the fall, and therefore may be impacted by cable installation (NEFSC n.d.).

Atlantic Cod

Atlantic cod EFH is designated in the OECC, and the Lease Area for egg, larvae, and adult life stages. EFH for Atlantic cod eggs is designated as surface waters from the Gulf of Maine to southern New England. Cod eggs are found in the fall, winter, and spring in water depths less than 110 m (361 ft). EFH for larval cod is pelagic waters (depths of 30–70 m [98–230 ft]) from the Gulf of Maine to southern New England and are primarily observed in the spring (Lough 2004). EFH for adult cod is designated as bottom habitats with substrates composed of rocks, pebbles, or gravel from the Gulf of Maine to southern New England, including the inshore bays, and the middle Atlantic south to Delaware Bay.

Atlantic Herring

Atlantic herring (*Clupea harengus*) EFH is designated in the OECC and the Lease Area for larval, juvenile, and adult life stages. Herring eggs adhere to the bottom; therefore, EFH is designated as inshore and offshore benthic habitats mainly in the Gulf of Maine, Georges Bank, and Nantucket Shoals in depths of 5–90 m (16–295 ft) on coarse sand, pebbles, cobbles, and boulders and/or macroalgae. EFH for larval Atlantic sea herring is pelagic waters within the Mid-Atlantic and New England regions such as: Great South Bay, Hudson Bay, Gulf of Maine, and southern New England (NEFMC 2017). Larvae are free-floating and generally observed between August and April in areas with water depths from 50–90 m (164–295 ft). EFH for juvenile and adult herring is pelagic and bottom habitats in the Gulf of Maine, Georges Bank, and southern New England, including the inshore bays. Juvenile and adult herring are found in areas with water depths from 20–130 m (66–427 ft). Herring opportunistically feed on zooplankton, with forage species changing as herring size increases (Reid et al. 1999).

Atlantic Mackerel

Atlantic mackerel EFH is designated in the OECC, Lease Area, and inshore bays for all life stages. EFH for mackerel (egg and larval stages) is pelagic habitats in inshore estuaries and embayments from Great Bay to Long Island, inshore and offshore waters of the Gulf of Maine, and on the continental shelf from Georges Bank to Cape Hatteras (Studholme et al. 1999). Eggs float in the upper 10–15m (33–49 ft) of the water column, while larvae can be found in depths ranging from 10–130m (33–427 ft) (Studholme et al. 1999). EFH for juvenile Atlantic mackerel is designated in pelagic waters in the OECC. The depth preference of juvenile mackerel shifts seasonally as they are generally found higher in the water column (20–50 m [66–164 ft]) in the fall and summer, deeper (50–70 m [66–230 ft]) in the winter, and widely dispersed (30–90 m [98–295 ft]) in the spring (NEFSC n.d.; Studholme et al. 1999). EFH for adult mackerel includes pelagic habitats the same region as for juveniles, but in waters with bottom depths less than 170 m (230 ft). Juvenile and adult mackerel feed on small crustaceans, larval fish, and other pelagic species.

Atlantic Sea Scallop

Atlantic sea scallop (*Placopecten magellanicus*) EFH is designated in the OECC and the Lease Area for all life stages (egg, larvae, juveniles, adults). All life stages have the same EFH spatial designation, which extends across much of the greater Atlantic region. Because sea scallop eggs are heavier than seawater and remain on the seafloor until the larval stage, EFH is designated in benthic habitats in inshore areas and the continental shelf. During the larval stage, scallops are free-swimming and occur within the water column and near the seafloor. EFH for the larval stage (referred to as "spat") includes benthic and pelagic habitats in inshore and offshore areas through the region. Hard substrate is particularly important as it provides essential habitat for settling larvae, which were found to have higher survival rates when attaching to hard surfaces rather than shifting sand or macroalgae. EFH for juvenile and adult sea scallops include sand and gravel substrates in the benthic habitats in depths of 18–110 m (59–361 ft) (NEFMC 2017).

Atlantic Skipjack Tuna

Skipjack tuna (*Katsuwonus pelami*) EFH is designated in both OECC and the Lease Area for juvenile and adult life stages. EFH for adult skipjack tuna includes coastal and offshore habitats between Massachusetts and South Carolina, including the inshore bays. EFH for juveniles is delineated within the same region, except in offshore waters only. Skipjack tuna are opportunistic foragers that feed primarily in surface waters but have also been caught in longline fisheries at greater depths (NMFS 2017).

Atlantic Surf Clam

Atlantic surf clam (*Spisula solidissima*) EFH is designated in the OECC for the juvenile and adult life stages. EFH for surf clams is throughout the substrate, to a depth of three feet below the water/sediment interface, from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic exclusive economic zone (EEZ). Surf clams are generally located from the tidal zone to a depth of about 38 m (125 ft) (Cargnelli et al. 1999b).

Atlantic Yellowfin Tuna

Yellowfin tuna (*Thunnus albacares*) EFH is designated in the OECC and the Lease Area for the juvenile life stage. EFH for juveniles and adults is in offshore pelagic and coastal waters from Cape Cod to the mid-eastern coast of Florida and North Carolina, respectively. The diet of yellowfin tuna primarily consists of *Sargassum* or *Sargassum*-associated fauna (NMFS 2009).

Black Sea Bass

Black sea bass (*Centropristis striata*) EFH is designated at the larval, juvenile, and adult life stages within the OECC and the Lease Area for juvenile and adult life stages. EFH for eggs is the estuaries where they are common and encounter mixing waters. Eggs are found in waters over the continental shelf from May through October. EFH for larvae is the pelagic waters over the continental shelf while juvenile and adult black sea bass is demersal waters over the continental shelf from the Gulf of Maine to Cape Hatteras (Steimle et al. 1999e). Juveniles prey on benthic and epibenthic crustaceans and small fish while adults tend to forage more generally for crustaceans, fish, and squids. Adults are generally associated with structurally complex habitats. Juveniles and adults are most commonly observed in water depths equal to those in the Lease Area and OECC in the spring, summer, and fall (Drohan et al. 2007). EFH has been designated for juvenile and adult life stages in the inshore bays.

Blue Shark

Blue shark (*Prionace glauca*) EFH is designated in the OECC and the Lease Area for neonate, juvenile, and adult life stages. EFH for neonate blue shark is in areas offshore Cape Cod through New Jersey (NMFS 2017). EFH for juvenile and adult blue sharks is waters from the southern part of the Gulf of Maine to Cape Hatteras (Lent 1999). Blue sharks are highly migratory and observed in New England from late May through October. Blue sharks feed primarily on small pelagic fishes and cephalopods (Nakano and Stevens 2008).

Bluefish

Bluefish (*Pomatomus saltatrix*) EFH is designated in the OECC for all life stages and in the Lease Area for the larval and adult life stage. In the northern Atlantic Ocean, eggs and larvae are found in pelagic waters over the continental shelf at mid-shelf depths from April through August. Juveniles and adults occur in estuaries, including the inshore bays, from June through October. As adults, they are highly migratory depending on the season and size of the individuals in the schools. Bluefish opportunistically forage on regionally and seasonally abundant fish species.

Common Thresher Shark

Common thresher (*Alopias vulpinus*) shark EFH is designated in the OECC and the Lease Area for neonate, juvenile, and adult life stages. EFH for all life stages is coastal and pelagic waters from Cape Cod to North Carolina and in other localized areas off the Atlantic coast. Common thresher sharks occur in coastal and oceanic waters but are more common within 64–80 km (35–43 nautical mile [NM]) of the shoreline. Small pelagic fishes and pelagic crustaceans make up much of common thresher shark diet (NMFS 2017).

Dusky Shark

Dusky shark (*Carcharhinus obscurus*) EFH is designated in the OECC and the Lease Area for neonate, juvenile, and adult life stages. EFH for neonate dusky sharks includes offshore areas of southern New England to Cape Lookout, North Carolina (NMFS 2017). EFH for juvenile and adult dusky sharks is waters over the continental shelf from southern Cape Cod to Florida (NMFS 2009). Dusky sharks migrate to northern areas of their range in the summer and return south in the fall as water temperatures decrease. Throughout their range, dusky sharks forage on bony fishes, cartilaginous fishes, and squid (Cortés et al. 2006). Although commercial and recreational fishing is prohibited, the main threat to the dusky shark population is from bycatch and illegal harvest.

Haddock

Haddock (*Melanogrammus aeglefinus*) EFH is designated in the Lease Area and the OECC for larval and juveniles life stages. Although adult haddock spawn near the sea floor, eggs are buoyant and are suspended in the water column. EFH for haddock eggs is surface waters over Georges Bank southwest to Nantucket Shoals and some coastal areas from Massachusetts Bay to Cape Cod Bay (Cargnelli et al. 1999a). Adult spawning generally occurs from February to May and eggs are observed from March through May (Brodziak 2005). EFH for haddock larvae is surface waters from Georges Bank to Delaware Bay and some coastal areas from Massachusetts Bay to Cape Cod Bay. Larvae can be observed from January through July with peaks in April and May and feed on phytoplankton, copepods, and invertebrate eggs. EFH for juvenile haddock is benthic habitats as shallow as 20 m (66 ft). EFH for adult haddock is bottom habitat with substrate consisting of broken ground, pebbles, smooth hard sand, and smooth areas between rocky patches on Georges Bank and around Nantucket Shoals. Adult haddock are demersal benthivores and primarily consume ophiuroids and amphipods (Brodziak 2005; Cargnelli et al. 1999a). Haddock was one of the dominant species captured in the Northeast Fisheries Science Center (NEFSC) Multispecies Bottom Trawl Surveys in spring, summer, and fall. Adult haddock move offshore into deeper waters in the winter, which may explain the lower capture rates during this season (Brodziak 2005; NEFSC n.d.).

Little Skate

Little skate (*Leucoraja erinacea*) EFH is designated in the OECC and the Lease Area for juvenile life stage. EFH for little skate includes intertidal and sub-tidal benthic habitats in coastal waters of the Gulf of Maine and in the mid-Atlantic region, and includes the inshore bays. EFH primarily occurs on sand and gravel substrates, but also is found on mud (NEFMC 2017). There is also EFH designated for adult little skate in the inshore bays.

Longfin Inshore Squid

Longfin inshore squid (*Loligo pealeii*) EFH is designated in the Lease Area for juvenile (pre-recruit), and adult (recruit) life stages, and in the OECC for eggs, juvenile, and adult life stages. EFH for longfin inshore squid eggs is inshore (including the inshore bays) and offshore bottom habitats from Georges Bank to Cape Hatteras. Longfin inshore squids lay eggs in masses referred to as "mops" that are demersal and anchored to various substrates and hard bottom types, including shells, lobster pots, fish traps, boulders, SAV, sand, and mud (Jacobson 2005). Female longfin squid lay these egg mops during three-week periods, which can occur throughout the year (Hendrickson 2017). Known longfin squid spawning grounds, which coincide with areas of concentrated squid fishing, intersect with the OECC. EFH for juveniles and adults, also referred to as pre-recruits and recruits, is pelagic habitats inshore and offshore continental shelf waters from Georges Bank to South Carolina. EFH has been designated for juveniles within the inshore bays. Pre-recruits and recruits inhabit inshore areas in the spring and summer and migrate to deeper, offshore areas in the fall to overwinter (Jacobson 2005). Forage base for longfin inshore squid varies with individual size, where small squids feed on planktonic organisms and large squids feed on crustaceans and small fishes (Jacobson 2005).

Monkfish

Monkfish (*Lophius americanus*) EFH is designated in the OECC and the Lease Area for all life stages. EFH for monkfish eggs and larvae is surface and pelagic waters of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic, including the inshore bays, south to Cape Hatteras. Monkfish eggs float near the surface in veils that dissolve and release zooplanktonic larvae after one to three weeks (MADMF 2022). Monkfish eggs and larvae are generally observed from March to September. EFH for demersal juvenile and adult monkfish is bottom habitats composed of a sand-shell mix, algae covered rocks, hard sand, pebbly gravel, or mud along the outer continental shelf in the middle Atlantic, mid-shelf off southern New England, and all areas of the Gulf of Maine. There is designated EFH for adult monkfish within the inshore bays, but not in the area behind the Jones Beach Landfall Site (NEFMC 2017). EFH for adult monkfish also includes the outer perimeter of Georges Bank (Steimle et al. 1999a). Larval monkfish feed on zooplankton; juveniles feed on small fish, shrimp, and squid; and adult monkfish eat other monkfish, crabs, lobsters, squid, and octopus (MADMF 2022).

Northern Shortfin Squid

Northern shortfin squid (*Illex illecebrosus*) EFH is designated in the OECC and the Lease Area for the adult life stage. EFH for adult northern shortfin squid is pelagic habitat on the continental shelf and slope from Georges Bank to South Carolina and in inshore waters of the Gulf of Maine and southern New England. Adult northern shortfin squid primarily forage for fish, euphausiids, and smaller squids (MAFMC and NOAA 2011).

Ocean Pout

Ocean pout (*Macrozoarces americanus*) EFH is designated in the Lease Area for egg, juvenile, and adult life stages. In the OECC, EFH is designated for the eggs, juvenile, and adult life stages. All ocean pout life stages are demersal and therefore have similar EFH designations. EFH for all life stages is bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay (Steimle et al. 1999d). Ocean pout eggs are laid in masses on hard bottom surfaces and develop from late fall and winter. Larvae are generally observed from late fall through spring. Juveniles and adults can be found throughout the year, though they move and shift habitats seasonally to remain in preferred temperature range (2–10 °C [36–50 °F]) (Steimle et al. 1999d). Primary prey species shift depending on location. Ocean pout near Nantucket Shoals target Jonah crabs (*Cancer borealis*), though sand dollars are also common in their diet (Steimle et al. 1999d).

Ocean Quahog

Ocean quahog (*Artica islandica*) EFH is designated in the OECC and the Lease Area for juvenile and adult life stages. EFH for all life stages is designated throughout the substrate, to a depth of 0.9 m (3 ft) below the water/sediment interface from Georges Bank and the Gulf of Maine throughout the Atlantic EEZ (Cargnelli et al. 1999c). Ocean quahogs feed on phytoplankton and support the diet of invertebrate and fish predators, including sea stars, ocean pout, haddock, and Atlantic cod (Cargnelli et al. 1999c).

Pollock

Pollock (*Pollachius virens*) EFH is designated in the Lease Area for the larval life stage, while the OECC has designations for the egg, larval, and juvenile life stages. Pollock eggs are buoyant upon fertilization and occur in the water column (Cargnelli et al. 1999d). EFH for pollock eggs is pelagic inshore and offshore habitat in the Gulf of Maine, Georges Bank, and southern New England (NEFMC 2017). The larval stage lasts between three and four months and is also pelagic. EFH designations for larvae are similar to those for eggs and includes pelagic inshore and offshore habitats in the Gulf of Maine, Georges Bank, and farther south in the Mid-Atlantic region, with bays and estuaries also included in these regions. As juveniles, pollock migrate between inshore and offshore waters with movements typically linked to water temperatures (Cargnelli et al. 1999d). Due to these migrations, EFH for juvenile pollock is designated as inshore (including the inshore bays) and offshore pelagic and benthic habitats intertidal zone to 180 m (591 ft) in the Gulf of Maine, Long Island Sound, and Narragansett Bay, between 40 and 180 m (131–591 ft) on western Georges Bank and the Great South Channel, and in mixed and full salinity waters in a number of bays and estuaries north of Cape Cod. Habitat types included in this designation consist of rocky bottom habitats with attached macroalgae and shallow eelgrass beds, which provide refuge from predators (NEFMC 2017). Adult pollock typically remain farther offshore than the EFH areas designated for larvae in the Offshore Development Area.

Red Hake

Red hake (*Urophycis chuss*) EFH is designated in the OECC and the Lease Area for all life stages. EFH for red hake eggs and larvae is surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Red hake eggs are generally observed from May through November while larvae are commonly observed from May through December. EFH for juvenile red hake is bottom habitats with a substrate of shell fragments in the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras (Steimle et al. 1999b). Juvenile red hake are pelagic and congregate around floating debris for a time before descending to the bottom (Steimle et al. 1999b). EFH for adult red hake is bottom habitats in depressions with sandy or muddy substrates in the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Adult red hake has designated EFH within the inshore bays (NEFMC 2017). Although adult red hake are generally demersal, they can be found in the water column (Steimle et al. 1999b). Red hake larvae primarily consume copepods; juveniles prey upon small benthic and pelagic crustaceans; and adults prey upon benthic and pelagic crustaceans, fish, and squid (Steimle et al. 1999b).

Sand Tiger Shark

Sand tiger shark (*Carcharias taurus*) EFH is designated in the OECC and the Lease Area for neonates and juveniles (NMFS 2017). EFH for sand tiger shark neonates is along the US Atlantic east coast from Cape Cod to northern Florida. Neonate sand tiger sharks inhabit shallow coastal waters within the 25 m (82 ft) isobath (NMFS 2017). EFH for juvenile sand tiger sharks is designated in habitats between Massachusetts and New York and between New Jersey and Florida, including the inshore bays (NMFS 2017). The sand tiger shark is a Species of Concern because population levels are estimated to be only 10% of pre-fishery conditions. Population declines were primarily caused by historic overfishing while continued decline is due to capture as bycatch. Although fishing is restricted for sand tiger sharks, low fecundity has limited their ability to recover (Carlson et al. 2009).

Sandbar Shark

Sandbar shark (*Carcharhinus plumbeus*) EFH is designated in the OECC and the Lease Area for the neonate, juvenile, and adult life stages. EFH for juvenile sandbar shark includes coastal areas of the US Atlantic between southern New England and Georgia (NMFS 2017). EFH for adult sandbar sharks is coastal areas from southern New England to Florida. EFH has been designated for both juvenile and adult sandbar sharks within the inshore bays (NMFS 2017). Sandbar sharks are a bottom-dwelling shark species that primarily forages for small bony fishes and crustaceans (NMFS 2009).

Scup

Scup EFH is designated in the Lease Area for juvenile and adult life stages and in the OECC for all life stages. EFH for eggs is estuaries from May through August, and May through September for larvae. EFH for juvenile and adult scup are the inshore and offshore demersal waters, including the inshore bays, over the continental shelf from the Gulf of Maine to Cape Hatteras (Steimle 1999c). Juvenile scup feed mainly on polychaetes, epibenthic amphipods, and small crustaceans, mollusks, and fish eggs while adults have a similar diet, they also feed on small squid, vegetable detritus, insect larvae, sand dollars, and small fish (Steimle et al. 1999c). Scup occupy inshore areas in the spring, summer, and fall and migrate offshore to overwinter in warmer waters on the outer continental shelf (Steimle et al. 1999c). Scup was a dominant finfish species captured in the NEFSC Multispecies Bottom Trawl survey during spring, summer, and fall surveys and in the Massachusetts Division of Marine Fisheries trawl surveys in the spring and fall.

Shortfin Mako Shark

Shortfin mako shark (*Isurus oxyrinchus*) EFH is designated in the Lease Area and the OECC for all life stages. EFH for all life stages is combined and considered the same due to insufficient data needed to differentiate EFH by life stage. EFH for shortfin mako shark is coastal and offshore habitats from Cape Cod to Cape Lookout, North Carolina and additional offshore areas in the Gulf of Maine, Florida, and Gulf of Mexico. Shortfin mako shark feed on swordfish, tuna, other sharks, clupeids, crustaceans, and cephalopods (NOAA Fisheries 2020a).

Silver Hake

Silver hake (*Merluccius bilinearis*), also known as whiting, has EFH designated in the Lease Area and the OECC for all life stages. EFH for the egg and larval stages is surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Whiting eggs and larvae are observed all year with peaks in egg observations from June through October and peaks in larvae observations from July through September. EFH for juvenile and adult life stages is bottom habitats of all substrate types in the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras (Morse et al. 1999). Silver hake are considered ravenous predators at all feeding life stages. Adults are semi-pelagic, nocturnal predators and primarily feed on fish, crustaceans, and squid (Lock and Packer 2004).

Smooth Dogfish

Due to insufficient information on the individual life stages (neonate, juvenile, and adult), EFH for smooth dogfish (*Mustelus canis*) is designated for all life stages combined and occurs in the OECC and the Lease Area. EFH for smooth dogfish includes coastal areas and inshore bays and estuaries from Cape Cod Bay to South Carolina (NMFS 2017). Smooth dogfish are primarily demersal and undergo temperature stimulated migrations between inshore and offshore waters. Throughout their region, diets are dominated by invertebrates, especially American lobster (*Homarus americanus*); however, they also feed on small bony fishes throughout New England (NMFS 2017).

Spiny Dogfish

Spiny dogfish (*Squalus acanthias*) EFH is designated in the OECC for sub-adult life stages and the Lease Area and inshore bays for sub-adult and adult life stages. EFH for juvenile and adult spiny dogfish is waters on the continental shelf from the Gulf of Maine through Cape Hatteras (McMillan and Morse 1999). Pups are born in the offshore wintering grounds from November to January. Spiny dogfish primarily feed on fish, squid, and ctenophores, which they detect through olfaction, vision, acoustics, and sensing electrical fields.

Summer Flounder

Summer flounder EFH is designated in the Lease Area for eggs, larval, and adult stages and the OECC for all life stages. EFH for eggs and larvae is pelagic waters found over the continental shelf from the Gulf of Maine to Cape Hatteras. Eggs are generally observed between October and May, while larvae are found from September through February. EFH for juvenile and adult summer flounder is demersal waters over the continental shelf from the Gulf of Maine to Cape Hatteras. Juvenile summer flounder inhabit inshore areas such as salt marsh creeks, seagrass beds, and mudflats, including the inshore bays, in the spring, summer, and fall and move to deeper waters offshore in the winter. Adults inhabit shallow coastal and estuarine areas, including the inshore bays, during the warmer seasons and migrate offshore during the winter (Packer et al. 1999). Summer flounder are opportunistic feeders and diets generally correspond to prey availability in relation to flounder size, with smaller individuals primarily consuming crustaceans and polychaetes and larger individuals focusing more on fish prey (Packer et al. 1999).

Tiger Shark

Tiger shark (*Galeocerdo cuvier*) EFH is designated in the OECC and the Lease Area for the juvenile and adult life stage. EFH for the juvenile life stage extends from Georges Bank to the Florida Keys in offshore pelagic habitats associated with the continental shelf break at the seaward extent of the US EEZ boundary (NMFS 2017). Tiger sharks are a warm water shark species and primarily remain south of the Mid-Atlantic Bight; however, they will occasionally travel farther north during the warmer summer months (NMFS 2017).

White Hake

White hake (*Urophycis tenuis*) EFH is designated in the Lease Area and the OECC for the juvenile life stages. Eggs are buoyant and occur in the water column; therefore, EFH is designated as pelagic habitats in the Gulf of Maine, including Massachusetts and Cape Cod Bays, and the outer continental shelf and slope (NEFMC 2017). Juveniles are pelagic until they reach a certain length and become demersal (Chang et al. 1999b). EFH for the juvenile stage is designated as intertidal and sub-tidal estuarine and marine habitats in the Gulf of Maine, Georges Bank, and southern New England, including mixed and high salinity zones in a number of bays and estuaries north of Cape Cod, to a maximum depth of 300 m (984 ft) (NEFMC 2017). For juveniles, EFH occurs on fine-grained, sandy substrates in eelgrass, macroalgae, and un-vegetated habitats. EFH for adults also occurs in fine-grained, muddy, substrates but also in mixed sand and rocky habitats.

White Shark

White shark (*Carcharodon carcharias*) EFH is designated in the OECC and the Lease Area for the neonate, juvenile, and adult life stages. EFH for neonates is inshore waters out to 105 km (57 NM) from Cape Cod to New Jersey, including the inshore bays. EFH for juvenile and adult white shark is combined and includes inshore waters out to 105 km (57 NM) from Cape Ann, Massachusetts to Cape Canaveral, Florida (NMFS 2017). White shark primarily consume fish as neonates and juveniles below 300 cm (120 inches) total length. Once they reach lengths greater than 300 cm (120 inches), white sharks begin consuming marine mammals primarily (Estrada et al. 2006).

Windowpane Flounder

Windowpane flounder (*Scophthalmus aquosus*) EFH is designated in the OECC and the Lease Area and inshore bays for all life stages. EFH for eggs is surface waters around the perimeter of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Windowpane flounder eggs are generally observed from July to August in northern Atlantic areas. EFH for larvae is pelagic waters around the perimeter of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. EFH for juvenile and adult life stages is bottom habitats that consist of mud or fine-grained sand substrate around the perimeter of the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras (Chang et al. 1999a). Juvenile and adult windowpane flounder feed on small crustaceans, especially mysid and decapod shrimp, and fish larvae (Chang et al. 1999a).

Winter Flounder

Winter flounder EFH is designated in the Lease Area for larval, juvenile, and adult life stages, and in the OECC and inshore bays for all life stages. EFH for eggs is bottom habitats with sandy, muddy, mixed sand/mud, and gravel substrates on Georges Bank, the inshore areas of Gulf of Maine, southern New England, and the middle Atlantic south to Delaware Bay. Eggs are primarily observed from February through June. EFH for larvae is pelagic and bottom waters in Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to Delaware Bay. Larvae are generally observed from March through July. EFH for juvenile and adult winter flounder is bottom habitats with muddy or sandy substrate in Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to Delaware Bay. Winter flounder spawning occurs in the winter with peaks in February and March (Pereira et al. 1999). Previous research has reported that winter flounder spawning is confined to shallow inshore waters; however, a study conducted by the Coonamessett Farm Foundation, Inc. identified gravid and, recently, spent winter flounder females in the offshore areas of southern New England, indicating that winter flounder spawning is not confined to shallow inshore waters (Siemann and Smolowitz 2017). Winter flounder are considered opportunistic feeders throughout each life stage and consume a wide range of prey. Adults feed on bivalves, eggs, and fish, but shift diets based on prey availability (Pereira et al. 1999).

Winter Skate

Winter skate (*Leucoraja ocellate*) EFH is designated in the OECC and the Lease Area and inshore bays for juvenile and adult life stages (NEFMC 2017). EFH for juvenile and adult winter skate includes sand and gravel substrates in sub-tidal benthic habitats in depths from the shore to 80–90 m (262–295 ft) from eastern Maine to Delaware Bay, on the continental shelf in southern New England and the mid-Atlantic region, and on Georges Bank. As a demersal species, winter skate consume a large variety of demersal prey including polychaetes, amphipods, and crustaceans (Packer et al. 2003).

Witch Flounder

Witch flounder EFH is designated in the Lease Area and the OECC for egg, larval, and adult stages. EFH for eggs is surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. EFH for larvae is surface waters to 250 m (820 ft) in the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Witch flounder eggs are generally observed from March through October, while larvae are observed from March through November (Cargnelli et al. 1999e). Witch flounder diet consists primarily of polychaetes and crustaceans (Cargnelli et al. 1999e).

Yellowtail Flounder

Yellowtail flounder (*Limanda ferruginea*) EFH is designated in the OECC and the Lease Area for all life stages. EFH for eggs and larvae is surface waters of Georges Bank, Massachusetts Bay, Cape Cod Bay, and the southern New England continental shelf south to Delaware Bay. Eggs are most often observed from April through June and larvae are observed from May through July. EFH for juvenile and adult yellowtail flounder is bottom habitats with sandy or mixed sand and mud substrates on Georges Bank, the Gulf of Maine, and the southern New England shelf south to Delaware Bay (Johnson et al. 1999). EFH has been designated for adult yellowtail flounder within the inshore bays (NEFMC 2017). Yellowtail flounder forage primarily for benthic macrofauna and diets largely consist of amphipods, polychaetes, and crustaceans (Johnson et al. 1999).

4 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential impact producing factors (IPFs) that may affect essential fish habitat during the construction, operations and maintenance (O&M), and/or decommissioning of Vineyard Mid-Atlantic are presented in Table 4.0-1.

Table 4.0-1 Impact Producing Factors for Essential Fish Habitat Assessment

Impact Producing Factors	Construction	Operations and Maintenance	Decommissioning
Seafloor Disturbance and Habitat Modification	•	•	•
Presence of Structures	•	•	•
Suspended Sediments and Deposition	•	•	•
Discharges/Intakes	•	•	•
Electromagnetic Fields and Cable Heat		•	
Noise	•	•	•
Artificial Light	•	•	•
Fisheries Survey Gear Utilization	•	•	
Port Utilization	•	•	•

Potential effects to EFH were assessed using the maximum design scenario for Vineyard Mid-Atlantic's offshore facilities as described in Section 1.5 of COP Volume II. In particular, the maximum design scenario is the full buildout of all 118 WTG/ESP positions within the Lease Area. One to two of those positions will be occupied by ESP(s) (on monopile or jacket foundations) and the remaining positions will be occupied by WTGs (on monopile foundations). Each IPF includes a discussion of whether the potential difference in foundation type (including scour protection and associated seafloor disturbance) for one or two ESP(s) would result in a meaningful change in potential impacts.

There are several potential buildout scenarios for the Lease Area. The Lease Area may be built out in one continuous construction campaign or developed in multiple construction campaigns separated by one or more years. Construction of Vineyard Mid-Atlantic will likely start with the onshore facilities (e.g., onshore cables and onshore substation) so that power from the electrical grid can be used to energize and commission the offshore facilities as soon as they are installed. Offshore construction, which may start while onshore construction is ongoing, will likely begin with offshore export cable installation and foundation installation (including scour protection installation). See Section 3.1 of COP Volume I for the anticipated order and approximate duration of construction activities for Vineyard Mid-Atlantic's offshore and onshore facilities. For a specific description of the foundation installation construction schedules, including monthly timing and hourly duration of piling activities, see Appendix II-E.

4.1 Seafloor Disturbance and Habitat Modification

Temporary to long-term seafloor disturbance and habitat modification may occur from the installation, maintenance, and decommissioning of Vineyard Mid-Atlantic components in the Lease Area and OECC. These components include foundations (for the WTGs and ESP[s]), scour protection, offshore export cables, inter-array and inter-link cables, and cable protection (if required). Long-term habitat modification may result from the installation of foundations, scour protection, and cable protection (if required). Additional temporary habitat modification may result from the installation, maintenance, and decommissioning of offshore export, inter-array and inter-link cables; pre-installation activities (such as a pre-lay grapnel run, boulder clearance, etc.); and usage of equipment that contacts the seafloor (such as jack-up vessels, vessel anchors or spud legs).

Table 4.1-1 provides the estimated long-term and temporary seafloor impacts by habitat type. Values are primarily based on the percentage of each habitat type in the Lease Area and OECC (as described in Section 2.1) and should be considered approximate since the specific locations of long-term and temporary impacts (such as placement of cable protection and the specific footprint of cable installation) are highly dependent upon the ongoing offshore export cable engineering process and the final selected cable routes. As noted, these calculations are based on the full buildout of 118 positions within the Lease Area and assume that there are 116 WTGs on monopile foundations and two ESPs on jacket foundations. The one or two ESP(s) could also be installed on monopile foundations; this would result in a trivial (<1%) decrease to the total seafloor disturbance in the Lease Area and is not discussed further.

Table 4.1-1 Summary of Maximum Potential Seafloor Disturbance by Habitat Type

Habitat Type	Lease Area		OECC (Rockaway Beach Approach)				OECC (Atlantic Beach Approach)				OECC (Jones Beach Approach)	
			Primary OECC		With Variant		Primary OECC		With Variant		Primary OECC	
	Long-Term	Temp.	Long-Term	Temp.	Long-Term	Temp.	Long-Term	Temp.	Long-Term	Temp.	Long-Term	Temp.
Complex	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)
Heterogenous Complex	0.05 km^2 (13 acres)	0.19 km^2 (47 acres)	0.12 km^2 (31 acres)	0.64 km^2 (157 acres)	0.13 km^2 (32 acres)	0.63 km^2 (157 acres)	0.10 km^2 (26 acres)	0.60 km^2 (149 acres)	0.11 km^2 (28 acres)	0.60 km^2 (148 acres)	0.06 km^2 (16 acres)	0.28 km^2 (68 acres)
Large Grained Complex	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)	0 km^2 (0 acres)
Soft Bottom	1.68 km^2 (414 acres)	5.98 km^2 (1,477 acres)	0.38 km^2 (95 acres)	2.83 km^2 (698 acres)	0.36 km^2 (89 acres)	2.81 km^2 (695 acres)	0.32 km^2 (80 acres)	2.69 km^2 (665 acres)	0.30 km^2 (74 acres)	2.68 km^2 (662 acres)	0.20 km^2 (49 acres)	2.26 km^2 (559 acres)
Total	1.73 km^2 (429 acres)	6.17 km^2 (1,524 acres)	0.51 km^2 (125 acres)	3.46 km^2 (855 acres)	0.49 km^2 (122 acres)	3.45 km^2 (852 acres)	0.43 km^2 (106 acres)	3.29 km^2 (813 acres)	0.41 km^2 (102 acres)	3.28 km^2 (810 acres)	0.26 km^2 (65 acres)	2.54 km^2 (627 acres)

Note:

1. Numbers may not sum perfectly due to rounding.

Direct impacts from seafloor disturbance during construction, maintenance activities, or decommissioning include the physical displacement, injury, and mortality of organisms and conversion of habitat types in both the Lease Area and OECC. Sessile and slow-moving benthic and demersal species including those that create habitat and early life stages of invertebrates and fishes such as eggs and larvae are most at risk of injury and death from physical trauma as foundations, scour protection, cables, anchors, anchor lines, jack-up legs, and spud legs contact the seafloor. Offshore export, inter-array, and inter-link cable installation and maintenance may affect organisms down to the target cable burial depth beneath stable seabed of 1.2 m (4 ft) in federal waters and 1.8 m (6 ft) in state waters,[2] and foundation installation may affect organisms down to the maximum foundation penetration depth as listed in Sections 3.3 and 3.4 of COP Volume I. Overall, these impacts are expected to be localized and limited to the relatively small impact areas from construction (see Table 4.1-1). In addition, the New York Bight Wind Energy Area was selected by BOEM because it contains very little sensitive finfish and invertebrate habitat (Guida et al. 2017). Mobile species and life stages including demersal and pelagic fishes and benthic and pelagic invertebrates are expected to be impacted temporarily as they move to avoid physical contact and motions perceived as threats. These temporary avoidance impacts occur over a relatively short period and are comparable to existing disturbances by vessel traffic and fishing gear with organisms expected to return after the action ceases. Impacts from sedimentation during construction are discussed in Section 4.2.

Temporary habitat modifications, including temporary alterations to bathymetry, may occur during construction. Within the Lease Area, temporary habitat modifications may particularly affect EFH of benthic and demersal species that associate with soft bottom habitats. Dynamic, sandy physical habitat begins to recover substantially within a few months of disturbance and can fully recover abundance within two years and recover biomass and diversity in two to four years (Van Dalfsen and Essink 2001; Dernie et al. 2003). There is potential for EFH of structure-associated benthic and demersal species to be affected if and where structured habitat is present. Additionally, if these structurally complex habitats do exist, they provide shelter and refuge habitat for small fishes and invertebrates and substrates for attachment epibenthic organisms (Auster 1998). Effects could range from increased seafloor relief to limited impacts from loss of key prey species due to mortality in affected areas. However, these effects are considered temporary because habitats are expected to begin recovery once construction, maintenance, or decommissioning activities are completed, the local severity of these impacts is comparable to ongoing fishing dredge impacts along the Northeast US shelf and potential impacts are relatively small in spatial scale (see Table 4.1-1). For vessels other than anchored cable laying vessels (which must maintain tension on anchor lines), the use of mid-line anchor

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[2] Based on a preliminary Cable Burial Risk Assessment (CBRA) (see Appendix II-T), in a limited portion of the OECC within the Nantucket to Ambrose Traffic Lane, the offshore export cables will have a greater target burial depth of 2.9 m (9.5 ft) beneath the stable seafloor. The target burial depths are subject to change if the final CBRA indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

buoys will be considered (where feasible and considered safe) as a potential measure to reduce impacts to sensitive seafloor habitat from anchor line sweep. There is no anchor line sweep from anchored cable laying vessels because the anchor lines are under tension. In addition, a benthic habitat monitoring plan framework has been developed (see Appendix II-R) to monitor recovery after construction in areas with sensitive habitats. A fisheries monitoring plan will be developed to monitor key indicators before and after construction; such monitoring may be part of regional monitoring efforts.

As discussed further in Section 4.2, long-term modification/conversion of habitat type may affect EFH of benthic/demersal and pelagic fishes. Foundations and scour protection will create structured habitat in the water column and along the seafloor that previously did not exist, and cable protection will cover existing habitat with anthropogenic hard bottom. The Proponent intends to avoid or minimize the use of cable protection to the greatest extent feasible through careful site assessment and thoughtful selection of the most appropriate cable installation tool to achieve sufficient burial. Foundations, scour protection, and cable protection are expected to have localized benefits for structure-associated species through the conversion of habitat, with potential localized adverse impacts to species that prefer fine substrates.

Any potential long-term changes due to the introduction of foundations, scour protection, and cable protection are only anticipated to affect a small percentage of the available habitat in the Lease Area and OECC. For example, long-term impacts are approximately less than 1% of the total size of the Lease Area. Additionally, the Proponent's goal is to minimize the use of cable protection to the greatest extent possible through a careful route assessment and the selection of the most appropriate cable burial tool for each segment of the cable route.

As further detailed in Section 3.7.1 of COP Volume I, at each landfall site, the offshore export cables are expected to transition onshore using HDD. HDD is a trenchless installation method that avoids or minimizes impacts to the beach, intertidal zone, and nearshore areas (including any tidal wetlands or other sensitive habitats near the landfall site[s]) and achieves a burial significantly deeper than any expected erosion. HDD at the landfall sites will require a staging area to be located in a parking lot or previously disturbed area. Further detail regarding dimensions and anticipated temporary disturbances associated with the approach pit, exit pit, and staging areas are provided in Section 3.7.2 of COP Volume I.

The Proponent intends to use multiple trenchless crossings (e.g., HDD, pipe jacking, or direct pipe trenchless drilling) where the onshore cables traverse tidal wetlands within the Western Bays.

During decommissioning, all offshore components will be removed to a depth of 4.5 m (15 ft) below the mudline, unless otherwise authorized by the Bureau of Safety and Environmental Enforcement. In particular, the offshore cables may be retired in place or removed. Temporary effects from decommissioning are expected to be similar to those experienced during construction. The long-term modifications of habitat are expected to be reversed upon decommissioning when offshore components are removed below the mudline (unless cable and scour protection are retired in place, in which case they will continue to function as structured bottom unless buried by sedimentation).

4.2 Presence of Structures

The presence of foundations (monopiles and piled jackets), scour protection, and cable protection will result in a conversion of the existing primarily sandy bottom habitat to a hard bottom habitat with areas of vertical structural relief (Wilhelmsson et al. 2006; Reubens et al. 2013; Bergström et al. 2014; Coates et al. 2014; Kaldellis et al. 2016; Degraer et al. 2020). The newly-created WTG and ESP foundation structures present throughout the water column can be compared to the addition of artificial reefs which have been shown to lead to ecological benefits (Langhamer 2012). These potential effects are anticipated to be similar whether the one or two ESP(s) are installed on monopile or jacket foundations. Some of the benefits observed around foundations include increased biodiversity and abundances of fishes (Wilhelmsson et al. 2006; Andersson and Öhman 2010; Riefolo et al. 2016; Raoux et al. 2017). Addition of foundations may also alter trophic dynamics from the bottom up through the introduction of new surfaces for filter feeders to colonize and consume plankton (Coates et al. 2014; Slavik et al. 2017). Cable protection is expected to have similar impacts in places where it is placed on fine substrate, but, where it is placed on Heterogeneous Complex habitat, it may have temporary negative impacts to structure-oriented species until it is colonized by the benthic community. Both cable protection and scour protection have potential for providing long-term benefits via increased cobble/boulder-like habitat which is a key habitat for lobsters (Linnane et al. 1999; Selgrath et al. 2007) and other species.

Additional research focused on changes in community assemblages related to habitat around offshore wind farms found that species that prefer complex habitat became newly established after installation while communities in nearby soft-bottom habitats remained unchanged (Stenberg et al. 2015). Wind farms have also been found to have localized increases in abundance (Løkkeborg et al. 2002) and improved condition and growth rates (Reubens et al. 2013) of commercially valuable species. However, the habitat created by the addition of offshore components also has potential to benefit non-indigenous species and provide a mechanism for wider dispersal of potentially harmful non-indigenous species through a steppingstone effect (Glasby et al. 2007) resulting in localized impacts to the finfish and invertebrates, such as blue mussels and fishes, that consume them. Further, while the invasive colonial sea squirt (*Didemnum vexillum*) was recorded at the Block Island Wind Farm (HDR 2020), this species is already an established species in New England, including in subtidal areas such as Georges Bank that hosted several sites with 50 to 90 percent coverage by colonial sea squirt (Bullard et al. 2007; BOEM 2024a). Although the impacts of invasive species on EFH have the potential to be widespread if the species were to become established and outcompete native fauna or modify habitat, the increased risk from Vineyard Mid-Atlantic is low in comparison to the risk from other ongoing activities, such as shipping and hull biofouling, aquaculture, and commercial and recreational fishing.

As discussed in Section 3.2, the presence of structures (WTGs, ESPs, and their associated foundations [monopiles for WTGs and monopiles or jackets for ESPs]) may alter physical oceanographic patterns at a fine scale. The presence of offshore wind structures can cause potential effects on the ocean due to 1) the physical presence of the turbines within the water column, and 2) the effects of wind energy extraction on wind-driven ocean circulation (NAS 2024). Studies have found that foundations induce vertical mixing in the water column as water flows around the structure (van Berkel et al. 2020); these potential alterations are broadly similar for monopile and jacket foundations. Though individual structures installed as part of Vineyard Mid-Atlantic are expected to have highly localized physical oceanographic effects, this vertical mixing may have some effects on carbon and nutrient cycling, phytoplankton, and overall production (Gill 2005; Dorrell et al. 2022; BOEM 2023). Local disturbances in the wake of the turbines may modify the stratification within the water column, thereby increasing vertical mixing and potentially turbidity, which in turn would either increase the phytoplankton primary production due to higher nutrient availability or lower it due to decreases in light availability due to increased turbidity (Floeter et al. 2017; Dannheim et al. 2019; Copping et al. 2020). Variation in mixing layer depth may also affect distributions of larval assemblages in the water column (Chen et al. 2021).

The presence of scour and cable protection (if used) could potentially alter bottom current patterns, leading to increased movement, suspension, and deposition of sediments (BOEM 2023; BOEM 2024a). Any hydrodynamic effects from scour and cable protection are expected to be extremely localized (i.e., only in the immediate vicinity of the structures themselves), and are not expected to have regional effects on EFH.

In addition to potential effects from the presence of underwater offshore wind structures, wind-driven ocean circulation may also be affected by above-water turbine-induced reductions in wind speed (BOEM 2023). Based on modeling simulations, turbines are expected to generate a leeward wind speed deficit, or wind wake, that could extend downstream of wind farms for up to 10 km (5.4 NM) for strongly convective conditions to 40 km (22 NM) during very stable conditions, with the extent dependent on the number of turbines and array configuration (Platis et al. 2020; Akhtar et al. 2021; Christiansen et al. 2022). Wind wakes can potentially reduce wind-driven mixing of surface waters, which transfers atmospheric changes to hydrodynamics (Paskyabi 2015), and wave energy is reduced at the sea surface (Bärfuss et al. 2021). Other physical oceanographic processes that could be affected include surface flow, surface layer mixing, bottom shear stress, and water column stratification (Christiansen et al. 2022; Daewel et al. 2022).

Changes in physical oceanographic patterns from the presence of offshore wind structures may affect the Mid-Atlantic Cold Pool, a seasonally present water mass of colder water trapped on the ocean floor that extends from Nantucket, Massachusetts to Cape Hatteras, North Carolina and is an important feature to the dispersal and survival of early life stages of many fish and invertebrates (BOEM 2021a; BOEM 2023). While the Mid-Atlantic Cold Pool has been described (Lentz 2017; Chen et al. 2018), its year-to-year dynamics are not fully understood and research is ongoing (BOEM 2021a; BOEM 2023). In areas where wind farms overlap with areas of stratification including the Mid-Atlantic Cold Pool, such stratification could be weakened by wind wakes (Paskyabi 2015; Djath et al. 2018) and underwater structures (Carpenter et al. 2016). In their modeling study investigating the impacts of offshore wind structures on large-scale stratification in the North Sea, Carpenter et al. (2016) did not find a significant reduction in stratification from small-scale installations (i.e., modeled wind farm length of 8 km [4.3 NM]) but did find localized reductions in stratification in large-scale installations (i.e., modeled wind farm length of 100 km [54 NM]). There are several fish and invertebrate species (e.g., yellowtail flounder, winter flounder, and Atlantic surfclam) identified as being dependent on the presence of the Mid-Atlantic Cold Pool (Able et al. 2014; Sha et al. 2015; Miller et al. 2016; Xu et al. 2018; Hofmann et al. 2018; Timbs et al. 2018; BOEM 2023). The populations of these species could be vulnerable to changes in the natural dynamics of the Mid-Atlantic Cold Pool. However, it should be noted that predicted warming of sea temperatures, a phenomenon that offshore wind farms aim to help alleviate, is expected to increase the long-term uncertainty associated with the dynamics and presence of the Mid-Atlantic Cold Pool (Miles et al. 2021). Therefore, any potential effects of the presence of offshore wind structures on the distribution of early life stages of fish and invertebrates are expected to be localized and are not expected to generate population-level effects.

New underwater structures can present a potential risk of entanglement; however, entanglement is not expected as a direct result of Vineyard Mid-Atlantic activities. The Proponent will use steel anchor cables on construction vessels, which will be taut during deployment, eliminating the potential for entanglement. Additionally, metocean buoys and anchor or tow lines used during cable installation will be kept taut at all times, thereby further reducing the risk of entanglement. No underwater offshore cables are expected to result in entanglement risk; these cables have large diameters and will be buried to target cable burial depth beneath the stable seafloor of 1.2 m (4 ft) in federal waters and 1.8 m (6 ft) in state waters.

The WTG and ESP structures may cause a secondary entanglement risk to marine organisms (such as fish and invertebrates) through ghost gear and/or marine debris caught on the structures themselves. However, the structures have large monopile or piled jacket diameters, without protrusions, which prevents much of the ghost gear and/or marine debris from being snagged on the structures. The Proponent will inspect the foundations and scour protection at regular intervals for the presence of marine debris (see Section 4.2.2 of COP Volume I) and will remove ghost gear and/or marine debris which may result in the entanglement of fish and invertebrates.

4.3 Suspended Sediments and Deposition

Temporary increases in suspended sediments and subsequent sediment deposition may occur in the Lease Area and OECC from the installation, maintenance, and decommissioning of offshore export cables, inter-array cables, inter-link cables, foundations (effects would be similar for monopile or jacket foundations), and scour protection. Specifically, sediment is expected to be suspended into the water column during cable pre-installation activities (e.g., a pre-lay grapnel run, boulder clearance, etc.), cable installation, seabed preparation prior to foundation installation (if needed), installation of cable protection (where required), the use of other equipment that contacts the seafloor (e.g., jack-up vessels, vessel anchors, or spud legs), and excavation and backfill of the temporary HDD exit pit. Most of these activities would occur during construction, with potential for limited activities during O&M if cables require repair or maintenance; however, any impacts would be expected to be far less than those from construction activities. Impacts from suspended sediments and deposition would be temporary and confined to a small area close to the location of the installation activity.

Direct effects on EFH from suspended sediments will temporarily impact water column EFH and can include visual impairment, asphyxiation, and reduced filter feeding abilities of species within the habitat. The severity of impacts from suspended sediments during construction, maintenance activities, or decommissioning would vary based on the concentration and duration of suspended material. Sediment is suspended regularly by storm events so many species are adapted to sediment impacts from suspended sediments. Reduced growth and oxygen consumption of bivalves can occur when sediment concentrations of 100 milligrams per liter (mg/L) persist for two days (Wilber and Clarke 2001). Sublethal effects (i.e., non-lethal asphyxiation) were observed for adult white perch (*Morone americana*) when 650 mg/L of suspended sediments persisted for five days (Sherk et al. 1974). Lethal effects for other adult fish species can occur at concentrations greater than 1,000 mg/L that persist for at least 24 hours (Sherk et al. 1974; Wilber and Clarke 2001). Fish eggs and larvae are typically more sensitive, with delayed hatching observed for white perch at a sediment concentration of 100 mg/L for one day (Sherk et al. 1974). Therefore, 100 mg/L for 24 hours is considered a conservative threshold for impacts from suspended sediments.

Minimum threshold effects for various benthic organisms have been determined in laboratory settings and are shown in Table 4.2–1. As shown, the suspended sediment threshold for the most sensitive species is 10 mg/L for 24 hours. The value for the most sensitive species is derived from studies of coral that are not present within the Offshore Development Area. The suspended sediment threshold for the next most sensitive benthic species that may be present within the Offshore Development Area, which likely provides a more reasonable conservative threshold, is either 100 mg/L for one day or 200 mg/L for 12 hours.

Table 4.2-1 Suspended Sediment Minimum Effects Threshold for Benthic Organisms

Organism Group (Life Stage)	Minimum Effects Threshold for Suspended Sediment
Mollusks (eggs)[1]	200 milligrams per liter (mg/L) for 12 hours
Mollusks (juveniles and adults)[2]	100 mg/L for 24 hours
Crustaceans (all life stages)[3]	100 mg/L for 24 hours
Corals (eggs)[4]	50 mg/L for 24 hours (preventing fertilization)
Corals (larvae)[4]	10 mg/L for 24 hours (altering larval settlement)
Corals (adults)[4]	25 mg/L for 24 hours (reducing calcification rate)

Notes:

1. Based on the concentration and duration at which sublethal effects were observed to the development of eastern oyster eggs (Cake 1983; Wilber and Clarke 2001).
2. Based on sublethal effects (i.e., reduced growth and reduced respiration) observed in northern quahog (Mercenaria mercenaria; Murphy 1985; Wilber and Clarke 2001).
3. Based on sublethal effects (i.e., reduced growth and reduced respiration) observed in copepods, and euphausiids (Anderson and Mackas 1986).
4. See Rogers 1990; Gilmour 1999; Fabricius 2005. Studies investigate tropical species that are not present within the Lease Area.

Direct effects on EFH from the resettlement of suspended sediments will temporarily impact water column EFH and can include mortality or injury, particularly for immobile species or life stages and habitat disturbance/conversion from burial and smothering. Severity of impacts from deposited sediments during construction, maintenance activities, or decommissioning would vary based on the thickness of material and habitat type. As discussed in Section 4.5 of COP Volume II, some infaunal bivalves can withstand deposition levels up to 300 mm (12 in) (Essink 1999). Sessile or seafloor surface-dwelling species, such as blue mussels and queen scallops (*Aequipecten opercularis*), are more sensitive to deposition levels and lethal effects have been observed with burial depths between 20–100 mm (0.8–4 in) (Essink 1999; Hendrick et al. 2016). For demersal eggs (fish [e.g., summer flounder (*Paralichthys dentatus*), Atlantic herring, and winter flounder], and whelk species), deposition greater than 1 mm (0.04 in) can result in the burial and mortality of that life stage (Berry et al. 2011). Therefore, sediment deposition thicknesses of 1 mm (0.04 in) and 20 mm (0.8 in) are considered the conservative thresholds for demersal eggs and shellfish, respectively.

To assess the impacts of suspended sediments and deposition, sediment transport modeling was completed for offshore export and inter-array cable installation and HDD exit pit construction[3] (see Appendix II-P). Activities were modeled separately within the Lease Area and the OECC. Model results provided the following estimates of the durations and concentrations of suspended sediment during construction:

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3 As described in Appendix II-P, the modeling for HDD exit pit construction focused on backfilling since it may result in greater water quality effects than excavation under the conservative assumption that excavated material is released at the water surface.

- **Offshore export and inter-array cable installation:** Above-ambient total suspended solids (TSS) concentrations substantially dissipate within three hours and fully dissipate between six and 12 hours. The modeling analyses predict that suspended sediment concentrations induced by installation of the cables will largely be of short duration, confined to the near-bottom portion of the water column, and will return to ambient conditions within several hours after the installation device has passed. Additionally, if a pre-pass jetting run (using a jet plow or jet trencher) were to be conducted along the route (see Section 3.5.4 of COP Volume I), it is anticipated this would occur with sufficient time for any suspended sediment concentrations to return to ambient conditions prior to cable installation.
- **HDD exit pit construction:** Above-ambient TSS concentrations may be present throughout the entire water column because sediments were released at the water surface but are predicted to return to ambient conditions within six to 12 hours.

Since suspended sediments are expected to dissipate within 12 hours for all modeled scenarios and do not exceed the conservative effects threshold of concentrations of 100 mg/L for 24 hours (for fish eggs and larvae, all life stages of crustaceans, and juvenile and adult mollusks; see Table 4.2-1), suspended sediments from construction and operation activities are not expected to have lethal or sublethal effects to finfish and invertebrates in the Offshore Development Area. In addition, suspended sediments are expected to be localized, with high concentrations not expected to travel greater than a few kilometers (a couple of miles) from the centerline.

Model results also provided estimates of the extent, area, and range of thicknesses of deposited sediment during construction (see Appendix II-P). Model results of sediment deposition for offshore export cable and inter-array cable installation and HDD exit pit construction provided the following estimates:

- **Offshore export and inter-array cable installation:** In most areas, the model predicted a depositional thickness between 1 mm (0.04 in) and 5 mm (0.2 in); small areas were predicted to have a depositional thickness between 5 mm (0.2 in) and 20 mm (0.8 in). For the maximum jetting scenario in the Lease Area, a small area of deposition was predicted to exceed 20 mm (0.8 in).
- **HDD exit pit construction:** The model predicted a depositional thickness greater than 100 mm (4 in), however, the areas associated with these thicknesses were relatively small (0.01 km^2 [2.5 acres]) and were local to the source.

For offshore export cable installation and HDD exit pit construction, the model predicted that deposition in most areas would be below the 20 mm (0.8 in) sensitivity threshold for shellfish, with only a small area (up to 0.03 km^2 [7.4 acres]) predicted to have deposition above 20 mm (0.8 in) for each HDD exit pit. If a pre-pass jetting run (using a jet plow or jet trencher) were to be conducted along the route (see Section 3.5.4 of COP Volume I), the predicted deposition is expected be similar to that of the offshore export cable installation scenario and remain below the 20 mm (0.8 in) threshold. Sufficient time is also anticipated between the pre-pass jetting run and cable installation to allow for some of this sediment deposition to be redistributed due to the forcing of surrounding currents.

Although there are expected to be primarily short-term impacts on the finfish and invertebrate resources along the OECC and Lease Area, these are not anticipated to result in population-level effects due to suspended sediments and deposition. In addition, a benthic habitat monitoring plan framework has been developed (see Appendix II-R) to monitor recovery after construction in areas with sensitive habitats where similar post-construction monitoring has not already been conducted for other projects (such as along the OECC).

4.4 Discharges/Intakes

Discharges and intakes that may affect EFH include entrainment and impingement, use of anti-biofouling compounds, discharges from cooling water intake systems, and inadvertent releases or spills. These potential effects are independent of the foundation type selected for the ESP(s).

Localized entrainment and potentially impingement of planktonic life stages of finfish and invertebrates within water column EFH may occur in the Lease Area and OECC from the installation, maintenance, and decommissioning of offshore export cables, inter-array cables, inter-link cables, foundations, and cable and scour protection. Short-term impacts may result from vessel cooling systems used during all phases and from other pump intakes including the potential use of jetting equipment to install offshore export, inter-array, and inter-link cables. If the selected ESP includes high voltage direct current (HVDC) equipment, impacts may result from the cooling water intake structure (CWIS) which may be required.

Direct impacts from entrainment could be mortality of entrained organisms in the Lease Area and OECC. Impacts from impingement can range from injury to mortality. The rate of entrainment and impingement are dependent on the physical characteristics of the intake and composition of the local finfish and invertebrate community. The size of the intake screen controls the maximum size of organisms that can be entrained while intake flow velocities determine the capability of organisms to avoid entrainment and impingement. The intake flow volume influences the total number of organisms that may be impacted. Planktonic organisms, such as some egg and larval fish and invertebrates, are most at risk of mortality from entrainment due to their small size and zero to limited swimming ability. Although survival rates of entrained organisms may vary (Mayhew et al. 2000), it is conservatively assumed that entrained eggs and larvae would experience 100% mortality rates.

An HVDC CWIS is expected to intake up to a maximum design intake of 47,200 cubic meters per day (m^3/day) (12,500,000 gallons per day [gal/day]) throughout the operational period, which is roughly 0.0006% of the volume of water within the Lease Area assuming an average depth of 42.5 m (138 ft). It is important to note this is a very conservative estimate as the amount of cooling water used will vary with the amount of electricity being produced by the wind farm, and with seasonal variations in water temperature (see Appendix II-N). In addition, based on this volume and because more than 25% of the intake volume will be used for cooling, this new facility will be subject to the National Pollutant Discharge Elimination System (NPDES) permit requirements for new facilities defined in 40 CFR §125.81 as it pertains to Section 316(b) of the Clean Water Act. Therefore, an additional permitting process will be performed in coordination with the Environmental Protection Agency prior to construction of a CWIS that will further evaluate the potential impacts from entrainment and impingement. Through this process, best available technology for minimizing impacts will be further considered. For example, intake screen designs can be modified to reduce intake velocities, so it is expected that impingement will not be a significant impact for most species.

To estimate the impacts of entrainment from an HVDC CWIS, an assessment using anticipated flow rates and local zooplankton data was completed as described in Appendix II-N. Model results provided estimates of the composition and magnitude of intake mortality for ichthyoplankton and other zooplankton. Based on seasonal plankton densities and entrained water volumes, annual estimated ichthyoplankton losses from HVDC CWIS entrainment are expected to range from a maximum of 1,583 to 4.1 million fish larvae per season, or 8.7 million fish larvae annually. Annual estimated losses of other zooplankton are expected to be a maximum of 65 billion individuals. It is important to highlight the conservative nature of these results and note that this analysis may be updated at a later date with a more realistic range of expected flow rates as that technical information becomes available. As described further in Appendix II-N, the water usage rate and total intake volume used for the initial entrainment analysis are still considerably lower than most similarly-sized traditional fossil fuel power plants.

According to the Electric Power Research Institute (EPRI), 99.9% of young spawned by a typical female fish can be expected to die prior to adulthood (EPRI 2004). Similarly for the fish entrained at a CWIS, only a fraction would have survived to reproduce or be harvested by fishermen. Therefore, if the annual number of equivalent adults (age 1) lost to entrainment were calculated using the forward projection approach as described in EPRI (2004), it is expected that tens to thousands of times fewer age-one equivalent fish would be lost to entrainment when compared to larvae lost due to high early-life stage mortality. Based on the magnitudes of the results, ecological and socioeconomic effects from entrainment of EFH resources by the HVDC CWIS will likely be undetectable.

As described further in Section 3.2 of COP Volume II, anti-biofouling additives (e.g., sodium hypochlorite) may be injected near the intake of the HVDC ESP seawater cooling system to prevent marine growth within the system. The anti-biofouling additives (if used) may not be completely removed prior to discharge. However, any discharged additives are expected to rapidly dissipate given the large mass of surrounding ocean. Water quality monitoring and controls would be implemented, if deemed necessary, in accordance with the NPDES permit. Similarly, anti-fouling paints and agents may be used on offshore structures; however, anti-fouling paints are widely used on boat hulls and submerged structures, such as piers, aquaculture nets, buoys, and offshore platforms (Voulvoulis et al. 2002; Konstantinou and Albanis 2004; Chambers et al. 2006; Almeida et al. 2007). Any potential impacts to water quality from Vineyard Mid-Atlantic's use of anti-fouling paints or agents will likely be limited in comparison to these ongoing activities.

Additionally, the use of an HVDC CWIS involves the discharge of warmed seawater after it leaves the heat exchangers; this warmed seawater will be discharged below the water's surface through pipes that are attached to the foundation. The Proponent will be conducting an assessment of any potential thermal impacts as part of the NPDES permitting process for the cooling water intake structure. Any thermal impacts are anticipated to be limited to the immediate area surrounding the discharge, leaving large areas of the surrounding water mass unaffected. Drifting plankton in the vicinity may experience stress or mortality primarily due to water temperature changes; however, any impacts to EFH are expected to be spatially limited (BOEM 2024a).

Section 7.5 and 7.6 of COP Volume II provide a discussion of potential impacts from accidental releases and discharges, as well as measures that will be adopted to avoid, minimize, or mitigate potential impacts to EFH. Specifically, invasive species may be accidentally released during ballast and bilge water discharges from marine vessels (Pederson et al. 2021); however, utilizing best management practices for ballast and bilge water discharges (particularly for vessels transiting from foreign ports) would reduce the likelihood of accidental release of invasive species (BOEM 2024a). Further, any potential introduction of invasive species from the offshore wind industry would be far less than existing activities like trans-oceanic shipping. Additionally, these infrequent releases would be spatially and temporally dispersed. Accordingly, ballast and bilge water releases are only anticipated to result in localized and short-term impacts to EFH.

4.5 Electromagnetic Fields and Cable Heat

Electromagnetic fields (EMFs) and cable heat will be produced by energized offshore export, inter-array, and inter-link cables during operation. EMFs consist of two components: electric fields and magnetic fields. The characteristics of the EMF can vary greatly depending on the energy flow of electricity and the type of current: high-voltage alternate current (HVAC) vs. HVDC (Tricas 2012). Due to cable configuration and shielding, electric fields are not expected in the marine environment from Vineyard Mid-Atlantic's cables. Therefore, the following discussion describes EMF generally and then focuses on magnetic fields (MFs) when discussing the potential effects from Vineyard Mid-Atlantic. These potential MF effects are independent of the foundation type selected for the ESP(s). As described further in Section 3.5 of COP Volume I, two to six offshore export cables installed within the OECC will transmit electricity from the ESP(s) to landfall site(s) on the southern shore of Long Island, New York.

The effects on finfish and invertebrates from EMF are not fully understood but can include disorientation and other behavioral responses (e.g., avoidance, changes in prey detection or feeding activity) (Riefolo et al. 2016). The severity of impacts from EMF during operation would vary based on the strength of the EMF and the electromagnetic sensitivity of organisms. Of species potentially present in the Offshore Development Area, electromagnetic sensitivity has been primarily documented in elasmobranchs (sharks, skates, and rays) as well as some teleost fish species (ray-finned fishes), and invertebrates such as cancer crabs. The effects of EMF would be localized because EMFs produced by cables decrease with distance. In addition, at the target cable burial depth beneath stable seabed of 1.2 m (4 ft) in federal waters and 1.8 m (6 ft) in state waters, EMFs at the seabed would be expected to be weak and likely only detectable by demersal species (Normandeau et al. 2011). In areas where seafloor type potentially prohibits cable burial, cable protection would serve as a similar although thinner barrier to exposure.

A white paper review study funded by BOEM determined that HVAC EMFs produced by power transmission cables would result in negligible, if any, effects on bottom-dwelling commercial and recreational fish species and no negative effects on pelagic commercial and recreational fish species in southern New England (Snyder et al. 2019). Other reviews have concluded that effects of HVDC and HVAC EMFs on invertebrates can be measurable but generally not at the EMF strengths of offshore wind projects (Albert et al. 2020; Gill and Desender 2020). For example, there is some evidence of attraction to HVDC EMF for a species of *Cancer* crab at an EMF strength hundreds of times greater than expected based on modeling for Vineyard Mid-Atlantic (Scott et al. 2021; see Appendix II-O). Similarly, although there were changes in the behavior of little skate, an elasmobranch, and American lobster in the presence of energized HVDC cables, EMFs from cables did not act as a barrier to movement in any way (Hutchison et al. 2018; 2020). Other research investigating habitat use around energized cables found no evidence that fishes or invertebrates were attracted to or repelled by EMFs emitted by HVAC cables (Love et al. 2017).

For HVDC cables, other manmade sources of perturbations to Earth's steady direct current (DC) geomagnetic field in coastal environments include shore-based structures such as docks, jetties, and bridges; sunken ships; pipelines; and ferromagnetic mineral deposits (Normandeau et al. 2011; CSA Ocean Sciences Inc. and Exponent 2019). Additionally, Normandeau et al. (2011) reported that MF impacts nearby to these sources can be on the order of tens of milliGauss (mG), while CSA Ocean Sciences Inc. and Exponent (2019) observed that undersea sources of DC MFs including steel ships and bridges can create DC MFs up to 100 times greater than MFs from DC submarine cables.

For HVAC cables, a seven-year study reported the first findings in the US of the response of demersal fish and invertebrates to construction and operation of an offshore wind project (Wilber et al. 2022). This study reported findings for analyses of catch data from monthly demersal trawl surveys conducted by local fisherman and scientists during construction and operation of the Block Island Wind Farm. This study did not report findings supporting harmful impacts of EMF from the project’s 60-Hz alternating current (AC) submarine export cables or other offshore electrical infrastructure on local demersal fish and invertebrates, and instead reported evidence of increased populations of several fish species near the wind farm during the operation time period relative to the reference areas. Similarly, as part of the U.S. Offshore Wind Synthesis of Environmental Effects Research (SEER) effort, researchers at the U.S. Department of Energy's Wind Energy Technologies Office, National Renewable Energy Laboratory, and Pacific Northwest Laboratory found "no conclusive evidence that EMFs from a subsea cable creates any negative environmental effect in individuals or populations" (SEER 2022). While behavioral responses have been observed in some species, they concluded that a reaction to EMFs does not necessarily relate to negative impacts. The researchers also discuss how factors such as cable burial depth, cable shielding, and the limited range of EMFs result in "a highly localized environmental condition that does not affect the entire habitat range for an animal" (SEER 2022).

To assess the potential effects of Vineyard Mid-Atlantic, modeling of MFs from HVDC and HVAC cables was completed as described in Appendix II-O.[4] Model results provided estimates of the magnitude and extent of MFs from a range of loads during operation and for cables that are either buried at a depth of 1.2 m (4 ft) or surface-laid. Surface laid cables are assumed to have 0.5 m (1.6 ft) thick cable protection covering. These conservative modeling results demonstrate that MFs at the seafloor from the buried cables decline with distance, with a maximum MF directly above the centerline that decreases rapidly with distance (see Table 4.4-1 and Table 4.4-2; see Appendix II-O). Tables 4.4-1 and 4.4-2 show the rapid drop-off in MF levels with increased lateral distance from the HVAC cables or HVDC cable bundles for each of the modeling scenarios. More specifically, the analysis shows > 95 to > 99% reductions in MF levels at lateral distances of ±25 ft (±7.6 m) from the centerlines of HVAC cables or HVDC cable bundles. At lateral distances of ±25 ft (±7.6 m), there is a negligible difference in MF levels for the buried versus the surface-laid cables. Based on the results, MFs are likely only able to be sensed, if at all, directly over the buried cable centerline. Therefore, any effects from EMF on the suitability of EFH are expected to be localized with only behavioral impacts, if any at all, for most finfish and invertebrate species.

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4 Modeling was focused on offshore export cables because inter-array cables are expected to have lower currents and MFs. Inter-link cables are expected to have similar or lower MFs.

Table 4.4-1 Summary of Modeled Magnetic Fields for HVDC Offshore Export Cables, as Deviations from Earth's Steady DC Magnetic Field

Cable Voltage	Installation Scenario[2]	DC Magnetic Field Deviation[1,3] (mG)			
		Maximum (above cables)	± 10 ft	± 25 ft	± 50 ft
±320 kV	Buried	-395 to 407	-58.8 to 60.0	-11.6 to 11.7	-2.9 to 2.9
	Surface-laid	-267 to 2,039	-72.5 to 72.6	-11.5 to 11.5	-2.8 to 2.8
±525 kV	Buried	-431 to 450	-65.5 to 67.0	-13.0 to 13.0	-3.2 to 3.2
	Surface-laid	-270 to 2,207	-81.1 to 81.2	-12.9 to 12.9	-3.2 to 3.2

Notes:

1. Magnetic fields are presented as the deviation from the Earth's steady DC magnetic field of 508 mG and are maximum deviations across modeling cases that include two representative cable orientations (north-south and east-west) and both possible current flow direction scenarios for each representative cable orientation. Negative values are the maximum reductions below the Earth's steady DC magnetic field of 508 m mG.
2. Magnetic fields at the seabed are reported for buried cables at 1.2 m (4 ft) depth. Surface-laid cables are assumed to have 0.5-m (1.6-ft) thick cable protection covering. For these scenarios, magnetic fields are reported at the top of the cable protection, specifically at 0.65 m (2.14 ft) for the ±320-kV cables, and 0.67 m (2.20 ft) for the ±525-kV cables.
3. Horizontal distance is measured from the center of the cable bundle.

Table 4.4-2 Summary of Modeled Magnetic Fields for HVAC Offshore Export Cables

Cable Voltage	Installation Scenario[1]	AC Magnetic Field (mG)[2]			
		Maximum	± 10 ft	± 25 ft	± 50 ft
220 kV	Buried	285	47.1	9.1	2.8
	Surface-laid	1,243	54.0	9.3	2.8
345 kV	Buried	319	53.7	10.4	3.2
	Surface-laid	1,354	61.6	10.7	3.2

Notes:

1. Magnetic fields at the seabed are reported for buried cables at 1.2 m (4 ft) depth. Surface-laid cables are assumed to have 0.5-m (1.6-ft) thick cable protection covering. For these scenarios, magnetic fields are reported on top of the cable protection, specifically at 0.79 m (2.58 ft) for 220-kV cables, and 0.82 m (2.68 ft) for 345-kV cables.
2. Horizontal distance is measured from the center of the cable bundle.
3. The offshore export cable MF modeling assumes straight-laid phase-conductor cable cores, as opposed to the actual helical or "twisted" phase-conductor cores. A helical design achieves a considerable degree of magnetic field cancellation; hence the modeled MF levels are expected to be overestimates of actual MF levels.

Inter-array and offshore export cables emit thermal radiation to the surrounding environment that may minimally increase water and sediment temperatures in the immediate vicinity of the cables (Boehlert and Gill 2010; Hogan et al. 2023). Buried cables have been found to increase the temperature of sediments, but such effects are limited to the surrounding sediments touching the cable (up to tens of centimeters) (Taormina et al. 2018). Similarly, any minimal increase in water temperature from cable heat is predicted to dissipate within a few centimeters of the cable (Boehlert and Gill 2010). As noted above, the target cable burial depth beneath stable seabed is 1.2 m (4 ft) in federal waters and 1.8 m (6 ft) in state waters; cable protection will be installed in areas where a sufficient burial depth cannot be achieved.

Accordingly, if cable heat were a stressor to EFH resources, any potential impacts are expected to be limited to small areas immediately surrounding the cables (BOEM 2024a). Potential impacts from EMF and cable heat will be minimized via cable shielding and cable burial depth (Normandeau et al. 2011).

4.6 Noise

Temporary to long-term increases in noise may occur in the Lease Area and OECC from the installation, O&M, and decommissioning of foundations, WTGs, and offshore cables. The intensity and duration of noises is expected to vary based on activity. Temporary construction noise is expected to include both repetitive, high-intensity (impulsive) sounds produced by pile driving, and continuous (non-impulsive), lower-frequency sounds produced by vessel propulsion, drilling, vibratory installation of foundations, and cable pre-installation/installation activities. Noise will also be produced during unexploded ordnance (UXO) detonation, if needed. Long-term operational noise is expected to be continuous (non-impulsive) noise from WTGs and vessel traffic. Additional continuous noise may also be produced temporarily during cable maintenance or aircraft activities.

Effects of Sound on Finfish and Invertebrates

Direct effects on EFH from noise can include decreased suitability in the form of behavioral changes, stress responses, injury, and mortality of finfish and invertebrates. Severity of impacts from noise during construction, maintenance activities, or decommissioning would vary based on the duration and intensity of sound and biology (e.g., auditory system and swim bladder presence) of the fish. Impulsive sounds can lead to mortality, ruptured gas bladders and damage to surrounding organs, damage to auditory processes, and altered behavior in some fish species (Popper and Hastings 2009; Casper et al. 2012; Riefolo et al. 2016). Continuous noise typically has lower sound pressure levels but can result in avoidance behavior that interferes with feeding and breeding, alter schooling behaviors and migration patterns, and can mask important environmental auditory cues (CBD 2012). In general, the presence of a swim bladder makes a fish more susceptible to injury from sounds because loud, usually impulsive, noises (i.e., impact pile driving, explosions) can cause swim bladders to vibrate with enough force to inflict damage to tissues and organs around the bladder (Halvorsen et al. 2011; Casper et al. 2012).

Risk of injury occurs at the lowest noise levels in fishes with swim bladders connected to the inner ear, such as Atlantic herring and Atlantic cod. Least sound sensitive fish species, which do not have a swim bladder, include both flatfishes and elasmobranchs (Thomsen et al. 2006; Popper et al. 2014). Noise could also affect the functionality and sensitivity of the sensory systems of marine invertebrates, but most studies on these effects have been performed *ex situ*, making it difficult to control and assess the acoustic conditions and typically only measure and report on the pressure component of sound. Additionally, most crustacean species lack swim bladders and are considered less sensitive to sound, however, understanding of the impact of sound and vibration on invertebrates is limited by a dearth of data (Edmonds et al. 2016).

In a cooperative effort between federal and state transportation and resource agencies, interim criteria were developed to assess the potential for injury to fish exposed to pile driving sounds (Stadler and Woodbury 2009) and described by the Fisheries Hydroacoustic Working Group (FHWG 2008). The injury and behavioral response levels for fish were compiled and listed in NMFS (2023) for assessing the potential effects to ESA-listed fish exposed to elevated levels of underwater sound from pile driving. Impulsive criteria were used for both impulsive and non-impulsive sources since there is limited research available for non-impulsive fish injury thresholds.

A technical report by an American National Standards Institute (ANSI)-registered committee (Popper et al. 2014) reviewed available data and suggested metrics and methods for estimating acoustic impacts for fish. Their report includes thresholds for potential injury but does not define sound levels that may result in behavioral response, though it does indicate a high likelihood of response near impact pile driving (tens of meters), a moderate response at intermediate distances (hundreds of meters), and a low response far (thousands of meters) from the pile (Popper et al. 2014).

Table 4.5-1 provides the acoustic thresholds that were used to evaluate impacts to fish exposed to construction noise.

Table 4.5-1 Acoustic Thresholds Used to Evaluate Impacts to Fish

Hearing group	Injury, impulsive signals (L_{pk})[1,2]	Injury, impulsive signals ($L_{E,24h}$)[1,2]	Behavior (L_p)[1]
Fish greater than or equal 2 grams (g) [0.07 ounces (oz)][3]	206	187	150
Fish less than 2 g (0.07 oz)[3]	206	183	150
Fish without swim bladder[4]	213	216	-
Fish with swim bladder[4]	207	203	-

Notes:

1. L_{pk} – peak sound pressure level (dB re 1 μPa), $L_{E,24h}$ – sound exposure level (dB re 1 μPa^2·s), L_p – root mean square sound pressure level (dB re 1 μPa^2). A dash indicates that there are no thresholds for the category.
2. Fish injury thresholds from impulsive sources were used for both source types since non-impulsive injury criteria do not exist for fish.
3. NMFS recommended criteria adopted from the Fisheries Hydroacoustic Working Group (FHWG 2008).
4. Popper et al. (2014).

Foundation Installation

Foundation installation is expected to require impact pile driving and may also require the use of a vibratory hammer and/or drilling. Potential effects from each of these activities are described below. Results of the acoustic modeling for foundation installation activities (i.e., impact pile driving, vibratory pile setting, and drilling), provided in Appendix II-E, were used to calculate modeled distances to potential fish injury and behavioral thresholds for each foundation type for WTGs and ESP(s) (see Table 4.5-1).

Impact Pile Driving

Impact pile driving would result in temporary, transient, repetitive, and discontinuous high intensity impulsive noise during construction. Field measurements of pile driving show that source, or near-source, levels are typically in the range of 210 to 250 dB re 1 μPa (McHugh 2005; Tougaard et al. 2009a; Bailey et al. 2010) and frequencies are predominantly <1 kilohertz (kHz) (Robinson et al. 2007; Tougaard et al. 2009b), although they can extend to much higher frequencies (MacGillivray 2018), including at least 100 kHz (Tougaard et al. 2009b).

Sound thresholds derived from Popper et al. (2014) indicate that pile driving sound above 207 dB peak can lead to mortality of the most sensitive fish species, such as Atlantic herring, while noise above 186 dB can lead to impairment. In their experiments, Jones et al. (2020) found that longfin squid, an invertebrate, had no physical harm but exhibited a startle response to recorded pile driving sound played at 190–194 dB; the squid habituated quickly and startle responses typically diminished within the first eight strikes, but the response returned when the squid were tested again 24 hours later (Jones et al. 2020). In their more recent study, when playing pile driving noise to mating squid, Jones et al. (2023) found no significant effects on the occurrence rates of agnostic behaviors, mate guarding, mating and egg laying, when compared to silent control trials. From this study, Jones et al. (2023) conclude that while there can be some disturbance to some non-reproductive behaviors, the results of their study show that species with limited opportunity to reproduce can tolerate intense stressors to secure reproductive success. The effects of impulsive sound on fish eggs and larvae have also been studied in the context of offshore pile driving. Common sole (*Solea solea*) larvae exposed to impulsive stimuli up to a sound exposure level (SEL) of 206 dB re 1 $\mu Pa^2 \cdot s$ (corresponding to 100 strikes at a distance of 100 m [328 ft]) had no statistically significant differences in mortality (Bolle et al. 2012). Published exposure guidelines for fish eggs and larvae based on pile driving data proposed a precautionary threshold for mortality of fish eggs and larvae of greater than 207 dB re 1 μPa PK, which was noted by the publisher to likely be conservative (Popper et al. 2014).

There are no studies available on the potential effects of pile driving sounds on plankton and no established acoustic thresholds for plankton. Although use of air guns is not a proposed action, they provide insight on potential effects from impulsive sound. The results from air gun studies on plankton are mixed, varying from no significant effects on mortality (Parry et al. 2002) to a maximum horizontal effect-range of 1.2 km (0.65 NM) in which decreases in zooplankton abundance with mortality in adult and larval zooplankton increased two- to three-fold when compared to controls (McCauley et al. 2017). The Commonwealth Scientific and Industrial Research Organization (CSIRO) (Richardson et al. 2017) simulated the large-scale impact of a seismic survey on zooplankton on the Northwest Shelf of Western Australia using the mortality rate found by McCauley et al. (2017). The major findings of the CSIRO study were that seismic activity had substantial impacts on zooplankton populations on a local scale within or close to the survey area; however, on a regional scale, the impacts were minimal and not discernible over the entire Northwest Shelf Bioregion. The study found that the zooplankton biomass recovered to pre-seismic levels inside the survey area, and within 15 km (8 NM) of the area, within three days following the completion of the survey. This relatively quick recovery was due to the fast growth rates of zooplankton as well as the dispersal and mixing of zooplankton from both inside and outside of the impacted region (Richardson et al. 2017). Another study found that the potential effects of seismic pulses of 221 dB re 1 $\mu Pa^2 \cdot s$ to zooplankton are limited to within approximately 10 m (33 ft) from the seismic source with immediate mortality rates of up to 30% of copepods when compared to controls (Fields et al. 2019).

There has also been a suite of studies examining potential impacts from air guns on a variety of invertebrate life stages. New Zealand scallop (*Pecten novaezelandiae*) larvae exposed to extended periods of air gun signals during their ontogeny had increases in abnormality and mortality rates (Aguilar de Soto et al. 2013). Blue mussel clearance (i.e., filtration rate) increased with pile driving noise, likely in response to increased metabolic demands triggered by stress (Spiga et al. 2016). High-intensity, low-frequency sound exposure to crustaceans and mollusks do not appear to result in immediate mass mortality events (Edmonds et al. 2016; Day et al. 2016; Carroll et al. 2017) but may have longer-term effects (Day et al. 2016). Specifically, tail tonicity (i.e., extension) and righting behavior, reflexes used in lobster fishery industries in grading animals for their likelihood of survival, were assessed in southern rock lobster (*Jasus edwardsii*) and significant responses to righting responses were observed after exposure to air gun sounds. André et al. (2011) and Solé et al. (2013) provide evidence of acoustic trauma in four cephalopod species—common cuttlefish (*Sepia officinalis*), common octopus (*Octopus vulgaris*), European squid (*Loligo vulgaris*), and southern shortfin squid (*Illex condietii*)—which they exposed (underwater) for two hours to low-frequency sweeps between 50–400 hertz (Hz) (1 second duration) generated by an in-air speaker. The measured level at the animals' position was 157 dB re 1 μPa with peak levels (unspecified) up to 175 dB re 1 μPa. Both studies reported permanent and substantial morphological and structural alterations of the sensory hair cells of the statocysts following noise exposure, with no indication of recovery. In a more recent experiment, Solé et al. (2017) exposed common cuttlefish to tonal sweeps between 100–400 Hz in a controlled exposure experiment in open water. Their results showed a clear statistical relationship between the cellular damage detected in the sensory cells of the individuals exposed to the sound sweeps and their distance from the sound source. The maximal particle motion level was 0.7 ms^{-2} (2.3 ft^{-2}) observed at 1 m (3.3 ft) depth, the pressure reached levels of 139–142 dB re 1 μPa^2. The reported sound pressure levels were only slightly higher than the hearing threshold determined for longfin squid measured by Mooney et al. (2010). The maximum particle motion (reported in terms of particle acceleration) reported by Solé et al. (2017) is in the same order of magnitude as the behavioral thresholds measured at 100 Hz by Packard et al. (1990) using a standing wave acoustic tube.

In general, the impacts from pile driving will depend on an individual's proximity to the source, intensity of noise, and sensitivity to sound. However, Vineyard Mid-Atlantic plans to implement mitigation measures including a soft-start procedure to the pile driving process, which delivers initial pile drives at a lower intensity, allowing mobile species to move out of the activity area before the full-power pile driving begins. In addition, the Proponent expects to implement noise abatement systems to reduce sound levels by a target of approximately 10 dB, and adhere to an anticipated time of year restriction on pile driving between January 1 and April 30 to protect North Atlantic right whales (NARW) (see Section 4.7 of COP Volume I), which may also confer protection to fish that occur within the Offshore Development Area during that timeframe.

Vibratory Pile Setting

A vibratory hammer could be used to install the monopile through surficial sediments in a controlled fashion to avoid the potential for a "pile run," where the pile could drop quickly through the looser surficial sediments and destabilize the installation vessel, risking the integrity of the vessel and safety of the crew. Once the pile has penetrated the surficial sediments with the vibratory hammer, an impact hammer would be used for the remainder of the installation. During vibratory pile driving, piles are driven into the substrate due to longitudinal vibration motion at the hammer's operational frequency and corresponding amplitude. This causes the soil to liquefy, allowing the pile to penetrate into the seabed. Sounds generated by vibratory pile setting are non-impulsive, which are known to be less damaging than impulsive sounds to marine fauna (Tsouvalas et al. 2016; Zykov et al. 2016; Molnar et al. 2020).

There are few data on the effects of vibratory pile driving on fish. Further, generalizations can be difficult because sound affects species differently, particularly with regards to the presence or absence of a swim bladder and its proximity to the ear. Nedwell et al. (2003) detected no changes in activity level or startle response in brown trout, a species without specialized hearing structures, when exposed to vibratory piling at close ranges (<50 m). There are no direct data available on the behavioral response to continuous noise in fish species with more specialized hearing. The masking of communicative signals, as well as signals produced by predators and prey, may be the most likely behavioral impact to fish (Popper and Hawkins 2019). However, the effect is expected to be short term (Popper et al. 2014). Additionally, high risk of any behavioral impacts from continuous sound sources (e.g., vibratory pile driving) are likely to only occur at close range to the source (Popper et al. 2014).

There are no data linking continuous noise to mortality or permanent injury in fish (Popper et al. 2014). Continuous noise has been linked to temporary threshold shift (TTS) in some fish species; however, exposure times to these sounds were at least 12 hours (Amoser and Ladich 2003; Smith et al. 2006).

There is a lack of data involving the effects of vibratory pile installations on invertebrates. Among marine invertebrates, some can detect particle motion and are sensitive to noise (Popper et al. 2014; André et al. 2016; Jézéquel et al. 2023). Invertebrates generally do not possess air-filled spaces like lungs, middle ears, or swim bladders; thus, they have been considered less susceptible than fish to noise and vibration. Invertebrates display measurable behavioral responses to noise, such as interruptions to feeding and resource gathering, startle responses, and escape behaviors (Mooney et al. 2010; Roberts et al. 2015).

Drilling

During the construction phase of Vineyard Mid-Atlantic, there may be instances when hard sediments or large sub-surface boulders are encountered during pile driving, requiring drilling operations to pass through these barriers.

During drilling activities, a drill head produces vibrations that propagate as sound through the sediment and water column (Hall and Francine 1991; Nguyen 1996; Willis et al. 2010). Most measurements of offshore drilling sounds have been made for oil exploration and production drilling. The sound levels associated with those drilling operations have been documented to be within the hearing range of fish injury and behavioral thresholds (Popper et al. 2014). To assess the impacts of underwater sound produced by drilling activities, modeled distances to potential fish injury and behavior thresholds were calculated. The results are provided in Supplement I of Appendix II-E.

It is unclear whether the sound emitted by marine drilling activities is likely to impact the behavior of fish. McCauley (1998) determined that any effects to fish from sounds produced by marine drilling activity would likely be temporary behavioral changes within a few hundred meters of the source. For instance, measured source levels during drilling operations reached 120 dB at 3–5 km, which may have caused fish avoidance (McCauley 1998). The available literature suggests that continuous sound produced by drilling operations may mask acoustic signals of fish that convey important environmental information (McCauley 1994; Popper et al. 2014). Recordings of planktivorous fish choruses showed that the fish were still active during drilling operations off the coast of the Timor Sea; however, it is likely that partial masking of their calls would have occurred (McCauley 1998).

There are no data to support a clear link between anthropogenic sound and permanent injury or mortality in fish, particularly with non-impulsive sound sources (Popper and Hawkins 2019). Continuous sound has been linked to TTS in some species of fish; however, exposure times to these sounds were at least 12 hours (Amoser and Ladich 2003; Smith et al. 2006). The sounds emitted by marine drilling operations for wind farm construction are expected to be short-term and intermittent. Acoustic masking to fish from drilling could occur during the short-term drilling events.

There are very few data on the effect of sound from drilling on marine invertebrates. Solé et al. (2022) reported a decreased survival rate in cephalopod (cuttlefish) larvae exposed to drilling sound levels (167 dB re 1 μPa^2). Importantly, levels below 163 dB re 1 μPa^2 did not elicit severe damage. Evidence from research on the levels of particle motion associated with behavioral responses in blue mussels indicates that the threshold of sensitivity in this species falls within vibration levels measured near blasting, pile driving, and impact drilling (Roberts et al. 2015). Studies have indicated reception of vibration in bivalves and an associated behavioral response, which included closing syphons and, in more active mollusks, moving away from the substrate (Mosher 1972; Ellers 1995; Kastelein 2008). As described above, invertebrates are considered less susceptible than fish to noise and vibration.

Cofferdam Installation

At the HDD offshore exit pit, a temporary cofferdam (or similar method) may be used depending on subsurface conditions and the depth of burial. If used, the cofferdams will be constructed of sheet piles likely using a vessel-mounted crane and vibratory hammer. Up to six cofferdams could be installed in total, with up to four cofferdams at a single landfall site. The cofferdams would also be removed likely using a vessel-mounted crane and vibratory hammer. The vibratory hammer would produce continuous (non-impulsive) sound.

As with vibratory pile driving during foundation installation (described above), non-impulsive sound from vibratory piling during cofferdam installation/removal may result in hearing damage or behavioral responses in fish. To assess the impacts of underwater sound produced by vibratory hammering during cofferdam installation/removal, modeled distances to potential fish injury and behavioral thresholds were calculated. The results are provided in Supplement K of Appendix II-E. As described above, invertebrates are considered less susceptible than fish to noise and vibration.

Unexploded Ordnances

As described in Section 3.10.2 of COP Volume I, if potential UXO and/or DMM (Discarded Military Munitions) are discovered in the Lease Area or OECC, the Proponent will prioritize avoidance of UXO/DMM wherever possible by micro-siting structures and cables around the object. Where avoidance is not possible (e.g., due to layout restrictions, presence of archaeological resources, etc.), UXO/DMM will be relocated or otherwise disposed of (e.g., via deflagration [burning without detonating], detonation, or dismantling the UXO/DMM to extract explosive components). The exact number and type of UXO/DMM that may be present, and which subset of those UXO/DMM cannot be avoided by micro-siting, are unknown at this time (further evaluation is ongoing).

Underwater explosive detonations generate impulsive sound waves with high pressure levels that could cause disturbance and/or injury to marine fauna. An explosion produces hot gases that create a large oscillating sphere and a shock wave (Chapman 1985). The extreme increase in pressure followed by a decrease to below ambient pressure caused by an explosive shock wave can cause injury to soft tissues, membranes, and cavities filled with air (Keevin and Hempen 1997). However, these sound producing events produce a short signal duration, and the extent of impact will depend on the proximity of the receiver to the detonation.

Injury to fish from exposures to explosion are called barotrauma injuries. Rapid changes in gas volume and rapid changes in the solubility of gas in the blood and tissues cause barotrauma injuries. When pressure increases, solubility increases and vice versa. Injury mechanisms include bubble formation in fluids/tissues (i.e., decompression sickness), and rapidly expanding gas-filled bodies (i.e., swim bladder) that push against surrounding tissues, thereby damaging surrounding tissues (Carlson 2012; Halvorsen 2012).

The potential acoustic impacts of UXO/DMM detonation on fish are further assessed in Supplement J of Appendix II-E. The effects of detonation pressure exposures to fish are assessed according to the peak sound pressure level (L_{pk}) limits for onset of mortality or injury leading to mortality due to explosives, as recommended by Popper et al. (2014), as well as thresholds to fish injury for L_{pk} and sound exposure level ($L_{E,24h}$) defined by NMFS (FHWG 2008).

Currently, there is no available information describing the effect of sound on invertebrates related to UXO detonation. Particle motion changes may cause behavioral response, injury, mortality, sensory damage, and physiological changes (Fitzgibbon et al. 2017; McCauley et al. 2017). Vibration caused by anthropogenic sound, such as UXO detonation, can propagate to the seabed (Roberts and Elliott 2017). Researchers have reported substrate-borne vibrations from anthropogenic sound can alter invertebrate behavior (Roberts et al. 2015, 2016).

Vessel Noise

Vessel traffic associated with construction, operation, and decommissioning would result in temporary, transient, and continuous non-impulsive noise primarily originating from the vessel's propulsion system. Sound emission from vessels, especially vessels using dynamic positioning, depends on vessel operational state and is strongly weather-dependent. Zykov et al. (2013) and McPherson et al. (2019) report a maximum broadband source level of 192 dB re 1 μPa for numerous vessels with varying propulsion power using dynamic positioning. Vessel noise can present a chronic impact for fish species (Popper 2003), whose communication is mainly based on low-frequency sound signals (Ladich and Myrberg 2006; Myrberg and Lugli 2006). Continuous noise greater than or equal to 158 dB root-mean-square (rms) for 12 hours can lead to behavioral disturbance, while noise above 170 dB rms for 48 hours can lead to injury (Popper et al. 2014; Hawkins and Popper 2017). Vessel noise can also cause avoidance behavior that interferes with feeding and breeding, alter schooling behaviors and migration patterns, and mask important environmental auditory cues (CBD 2012;). Recent studies have shown that vessel noise can induce endocrine stress response (Wysocki et al. 2007); diminish hearing ability; and mask intra-specific relevant signals in exposed fish species (Scholik and Yan 2002; Amoser et al. 2004; Vasconcelos et al. 2007; Codarin et al. 2009). Masking communication is of concern because although fishes are generally not loud (120 dB re 1 μPa [at 1 m (3.3 ft)], with the loudest on the order of 160 dB re 1 μPa), species make unique noises that allow for individual identification (Normandeau Associates 2012). In addition, vessel noise has the capacity to provoke short-term changes in the spatial position and group structure of pelagic fish in the water column (Buerkle 1973; Olsen et al. 1983; Schwarz and Greer 1984; Soria et al. 1996; Vabø et al. 2002; Handegard et al. 2003; Mitson and Knudsen 2003; Ona et al. 2007; Sarà et al. 2007). Fish can respond to approaching vessels by diving towards the seafloor or by moving horizontally out of a vessel's path (Ona et al. 2007; Berthe and Lecchini 2016). Nedelec et al. (2014) investigated the response of reef-associated fish by exposing them in their natural environment to playback of motorboat sounds. They found that juvenile fish increased hiding and ventilation rate after a short-term boat sound playback, but responses diminished after long-term playback, indicating habituation to sound exposure over longer durations. These results were corroborated by Holmes et al. (2017) who also observed short-term behavioral changes in juvenile reef fish after exposure to boat noise as well as desensitization over longer exposure periods. Therefore, areas of high vessel traffic may result in habituation by localized fishes. As stated in the BOEM Environmental Assessment and the Alternative Energy Programmatic Environmental Impact Statement that were prepared for the assessment and designation of wind energy areas by BOEM, regular vessel traffic occurs throughout this area thus implying that biological resources in the area are presumably habituated to this noise (BOEM 2007; BOEM 2014).

Pre-Installation and Cable Installation Activities

Prior to offshore cable installation, pre-installation activities may include debris and boulder clearance and minimal to no sand bedform leveling. Boulder clearance (if required) is expected to be accompanied by a grab tool suspended from a vessel's crane, which lifts individual boulders clear of the alignment and relocates them elsewhere within the OECC. Alternatively, a route clearance plow may be towed by a vessel along the cable alignment to push boulders aside. Sand bedform leveling (if required) may be accomplished by one or a combination of the following techniques: controlled flow excavation, offshore excavator, or a route clearance plow. Following boulder clearance and sand bedform leveling (if necessary), pre-lay surveys and pre-lay grapnel runs will be performed to verify seafloor conditions and confirm that the cable alignments are suitable for installation (free of obstructions). The pre-lay surveys are expected to be performed using multibeam echosounders and potentially magnetometers. The offshore cable will then be buried beneath the stable seafloor, likely using jetting techniques or a mechanical plow. Further detail pertaining to the pre-installation activities is included in Section 3.5.3 of COP Volume I.

Sounds from pre-installation activities and cable installation activities are considered non-impulsive and are not expected to produce sounds above those of routine vessel activities. Specific to sand bedform leveling, the sounds produced during excavation vary depending on the sediment type—the denser and more consolidated the sediment is, the more force the equipment needs to impart, and the higher sound levels that are produced (Robinson et al. 2011). Sounds from mechanical dredges (such as an excavator) occur in intervals as the excavator lowers a bucket, digs, and raises the bucket.

Table 4.5-2 provides available sounds of various activities that are similar to some of the pre-installation and cable installation activities proposed for Vineyard Mid-Atlantic. Table 4.5-2 includes representative sounds from different types of dredging activities; however, minimal to no sand bedform leveling is anticipated and therefore this activity (if required) will be of a short duration.

Table 4.5-2 Examples of Broadband Sound Pressure Levels (SPL) of Some Anthropogenic Sounds

Activity	SPL (dB re 1μPa), 1 m from the source[1]	Frequency range (kHz)[2]	Reference
Plough trenching in sandy gravel	178.0	0.7-50	Taormina et al. (2018)
Trenching and cable installation	188.5	N/A	
Dredging	168–186	0.03–20	Thomsen et al. (2009)
Drilling	145–190	0.01–10	
Hydraulic cutterhead dredge	168–178	0.02–1000	Reine et al. (2014)
Trailer Suction Hopper dredge during active dredging (1 knot speed)	172.6–179.9	N/A	
Backhoe dredge, bottom grabs during removal of gravel and rock	179.4	N/A	

Notes:

1. SPL is representative of a distance of 1 m (3.2 ft) from the source.
2. Not available (N/A) in the cited references.

Table 4.5-2 shows that sounds from cable installation, drilling, and sand bedform leveling are broadly similar. Further, these sounds are quieter than sound from impact pile driving (as shown in Appendix II-E). Sounds from pre-installation and cable installation activities are also quieter than sound measured from transiting vessels (supertankers and frigates), based on measurements taken in Stellwagen Bank (Haver et al. 2019), which is a region with a similar acoustic soundscape as the Lease Area (both sites are in the shallow water portion of the continental shelf and both sites are in areas that have ports with high density traffic). All noise sources for pre-installation and cable installation activities predominantly emit noise at frequencies less than approximately 1 kHz and there is no substantial overlap with the frequency range for fish chorusing.

Sound levels decrease as a receptor moves away from the source and would be reduced by about 40 dB at a distance of around 500 m (1,640 ft) (based on a common acoustic decay rate of 15log*10*(R)), which is similar to ambient noise. Accordingly, underwater sounds from pre-installation and cable installation activities are spatially localized and temporary and would only have limited effects, if any, to fish and invertebrates.

Operational Sounds

Operation of WTGs would result in variable, mostly continuous (i.e., during power generation) non-impulsive noise. Underwater noise level is related to WTG power and wind speed, with increased wind speeds creating increased underwater sound (Wahlberg and Westerberg 2005). Operational noise from WTGs is low frequency (60–300 Hz) and at relatively low sound pressure levels near the foundation (100–151 dB re 1 µPa) and decreases to ambient within 1 km (0.6 mi) (Tougaard et al. 2009a, 2009b; Lindeboom et al. 2011; Dow Piniak et al. 2012; HDR 2019).

At high wind speeds, Wahlberg and Westerberg (2005) estimated permanent avoidance by fish would only occur within a range of 4 m (13 ft) of a WTG. In a study on fish near the Svante wind farm in Sweden, Atlantic cod and roach (*Rutilus rutilus*) catch rates were significantly higher near WTGs when rotors were stopped, which could indicate fish attraction to WTG structures and avoidance to generated noise (Westerberg 2000 as cited in Thomsen et al. 2006). Alternatively, no avoidance behavior was detected, and fish densities increased around WTG foundations of the Lillgrund offshore wind farm in Sweden (Bergström et al. 2013). In addition, ambient noise can influence how fish detect other sounds and a change in background noise could alter how fish perceive and react to biological noise stimuli (Popper and Fay 1993). Baseline data on ambient noise within the New York Bight will be measured by the "Blue York" buoy deployed as a joint venture between Wood Hole Oceanographic Institution and Wildlife Conservation Society, located near the southwestern boundary of the Vineyard Mid-Atlantic Lease Area (WHOI 2018). Vineyard Mid-Atlantic will further assess this data as it pertains to operational sounds once it becomes publicly available.

Underwater sound radiated from operating WTGs is low-frequency and low level (Nedwell and Edwards 2004). At distances of 14 to 20 m (46 to 66 ft) from operational WTGs in Europe, underwater sound pressure levels ranged from 109 dB to 127 dB re 1µPa (Tougaard et al. 2009a, b). Pangerc et al. (2016) recorded sound levels at ~50 m (~164 ft) from two individual 3.6 megawatt (MW) WTGs monopile foundations over a 21-day operating period. Miller and Potty (2017) measured a sound pressure level (SPL) of 100 dB re 1 µPa within 50 m (164 ft) of five General Electric Haliade 150–6 MW wind turbines with a peak signal frequency of 72 Hz. At the Block Island Wind Farm off Rhode Island, sound levels were found to be 112–120 dB re 1 µPa near the WTG when wind speeds were 2–12 m/s (4-23 knots) and the WTG sound levels declined to ambient within 1 km (0.5 NM) from the WTG (Elliott et al. 2019). Tougaard et al. (2009a, b) found that sound level from three different WTG types in European waters was only measurable above ambient sound levels at frequencies below 500 Hz, and Thomsen et al. (2016) suggest that at approximately 500 m (1,640 ft) from operating WTGs, sound levels are expected to approach ambient levels.

Two recent meta-papers (Tougaard et al. 2020; Stöber and Thomsen 2021) assessed WTG operational sounds by extracting sound levels measured at various distances from operating WTGs from currently available reports. Both studies found sounds to generally be higher for higher powered WTGs; thus, distances to a given sound threshold are likely to be greater for higher powered WTGs. However, as Stöber and Thomsen (2021) point out, direct drive technology could reduce these distances substantially. Importantly, no measurements exist for these larger turbine sizes and few measurements have been made for direct drive turbines so the uncertainty in these estimates is large.

Overall, current literature indicates noise generated from the operation of offshore wind projects is minor and does not cause injury or lead to permanent avoidance by fish at distances greater than 1 km (0.6 mi) (Wahlberg and Westerberg 2005; Stenberg et al. 2015), with the potential to have minimal effects at much closer distances up to within a few meters of the WTG (Bergström et al. 2013) such as masking auditory sensitivity and communication of fishes within a few tens of meters of WTGs (Zhang et al. 2021).

Subsea Cables

Previous impact assessment studies for various cable projects have concluded that sound related to subsea cable installation or cable operation is not a significant issue (Nedwell et al. 2003; Austin et al. 2005). This was based on the prediction that anticipated sound levels would not exceed existing ambient sound levels in the area, although background sound level measurements were often not presented (Meißner et al. 2006). Subsea cables are expected to produce low-frequency tonal vibration sound in the water, since Coulomb forces between the conductors cause the HVAC lines to vibrate at twice the frequency of the current (direct current cables do not produce a similar tonal sound because the current is not alternating). Anticipated SPLs arising from the vibration of alternating current cables during operation are significantly lower than SPLs that may occur during cable installation (Meißner et al. 2006) and may be undetectable in the ambient soundscape of the Offshore Development Area, especially after consideration of the target cable burial depth beneath stable seabed of 1.2 m (4 ft) in federal waters and 1.8 m (6 ft) in state waters.

4.7 Artificial Light

Artificial lighting will be required during the construction, O&M, and decommissioning of the Offshore Development Area. During construction and decommissioning, there will be a temporary increase in lighting from construction equipment and vessels with navigational, deck, and interior lights. During O&M, WTGs and ESP(s) will require lighting that complies with applicable Federal Aviation Administration, US Coast Guard, BOEM, and Bureau of Safety and Environmental Enforcement guidelines. Vessel use and associated lighting will also occur, though at a significantly lower frequency than during construction and decommissioning. Other temporary lighting (e.g., helicopter hoist status lights on WTGs, helipad lights on the ESP[s], temporary outdoor lighting on the ESP[s] if any maintenance occurs at night or during low-light conditions) may be used for safety when necessary. These potential effects are independent of the foundation type selected for the ESP(s).

As required for navigational safety, artificial lights will be installed on the WTGs and ESP(s). The approximate maximum height of the marine navigation lights above water is 35 m (115 ft), which is equal to the maximum height of the foundation (including the transition piece) above water (see Section 3.3 of COP Volume I). These navigation safety lights are designed to penetrate only the top few centimeters of the water column; thus, the majority of the water column will not be illuminated (TetraTech 2022). Similarly, marine vessels have small amounts of downward-focused lighting with only a small fraction of emitted light entering the water (BOEM 2024b). Light impacts from vessels and offshore foundations can be mitigated through the application of BOEM's Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development (BOEM 2021b). Light could deter, attract, or initiate other behavioral responses for some finfish and invertebrates with designated EFH; however, effects would likely be short-term for vessel activity, limited to highly localized attraction for vessel activity and operation of offshore foundations, and may include some potential disruptions of biological cycles dependent on daylight (e.g., spawning) (BOEM 2024b). However, the amount of artificial light that penetrates the sea surface from vessels and offshore structures is expected to be minimal and localized; thus, artificial light is unlikely to cause adverse impacts to finfish, invertebrate, and EFH resources.

Lighting at the top of WTG structures for aviation safety will likely be too high above sea level to penetrate the water surface, meaning it is unlikely to cause adverse impacts to finfish and invertebrates. Further, Vineyard Mid-Atlantic will minimize lighting by using an Aircraft Detection Lighting System (ADLS) or similar system that automatically activates all aviation obstruction lights when aircraft approach the structures. The use of an ADLS will substantially reduce the amount of time that the aviation obstruction lights are illuminated.

4.8 Fisheries Survey Gear Utilization

A draft preliminary fisheries monitoring plan for pre-, during, and post-construction fisheries surveys has been developed for Vineyard Mid-Atlantic and is included as Appendix II-U. A preliminary list of potential surveys includes:

- Seasonal trawl survey following the NorthEast Area Monitoring and Assessment Program (NEAMAP) survey protocol;
- Baited remote underwater video;
- Highly migratory species acoustic telemetry;

- Drop camera survey;
- Hydraulic surfclam dredge survey; and/or
- Ecosystem monitoring plankton survey.

The number of surveys to be conducted is expected to be a subset of those listed above and in Appendix II-U. Further refinement will be based on future research and agency and stakeholder feedback. Fisheries monitoring surveys are anticipated to be carried out by qualified scientists.

Several of these potential monitoring survey types include remote or minimally disruptive techniques that are unlikely to meaningfully affect finfish and invertebrates, and EFH; therefore, the rest of this discussion is focused on those surveys that will harvest finfish and macroinvertebrates via trawl surveys (impacting finfish and squid) and clam dredge surveys (ocean quahog and surfclam). Trawl surveys will likely result in direct impacts to fish, invertebrates, and EFH and have the potential to result in injury and mortality, reduced fecundity, and delayed or aborted spawning migrations for some species (Moser and Ross 1995; Collins et al. 2000; Moser et al. 2000). However, trawl surveys conducted as part of fisheries monitoring would be limited to small sampling nets, short tow times, and slow tow speeds, which would reduce the risk of capture of non-target species.

The planned trawl and surf clam dredge surveys could cause habitat disturbance due to direct interaction between the survey equipment and the seafloor. During trawl surveys a net is towed behind a vessel along the seafloor and expanded horizontally by a pair of otter boards or trawl doors. During hydraulic surf clam surveys, high-pressure jets direct water into the seafloor to push sediments aside and allow a metal blade to pass through the upper portion of the seafloor and scoop up clams into a metal cage. The use of bottom trawl and surfclam dredge surveys may also result in limited resuspension of sediments (including any pollutants, although they are not expected to be present given the predominantly sandy surficial sediments in the Lease Area).

Dredging and trawling are methods used to land clams, scallops, and other benthic species, and these dredge and trawl surveys would be expected to have similar effects as existing commercial fishing activities. In particular, commercial dredge gear is used regularly in the Lease Area. Disturbance of benthic invertebrate communities and associated EFH by commercial fishing activities can adversely affect community structure and diversity and limit recovery from offshore wind farms (Avanti Corporation and Industrial Economics 2019), although this impact is less prevalent in sandy areas that are strongly influenced by tidal currents and waves, such as the Lease Area (Nilsson and Rosenberg 2003; Sciberras et al. 2016;

BOEM 2024b). Any potential impacts to finfish, invertebrates, and EFH from biological monitoring surveys would be similar to disturbance from existing activities and will be minimized by short tow times for trawl surveys. These intermittent impacts would be temporary and localized, and these areas would be expected to undergo relatively fast recovery (Dernie et al. 2003; Brooks et al. 2006), with no population-level effects expected.

4.9 Port Utilization

The Proponent has identified several ports in the US or Canada (for potential construction ports only) that may be used during construction or operations. See Sections 3.10.1 and 4.4.1 of COP Volume I for more information about potential construction or operations ports. Only a subset of the ports described in Sections 3.10.1 and 4.4.1 of COP Volume I would ultimately be used. Each port under consideration for Vineyard Mid-Atlantic is either located in an industrial waterfront area with sufficient existing infrastructure or where another entity may develop such infrastructure by the time construction proceeds. The Proponent does not expect to implement any port improvements. Although port utilization and vessel activity would increase at the potential ports utilized by Vineyard Mid-Atlantic (with the greatest activity occurring during construction), such increases in port utilization would be consistent with the intended use of each port. As described further under the various IPF sections above, vessel activity will generally have minimal impacts on EFH. Given the reasons detailed above, impacts from port utilization on EFH resources are expected to be minimal.

4.10 Summary of Avoidance, Minimization, and Mitigation Measures

The Proponent's proposed measures to avoid, minimize, and mitigate potential effects to EFH during Vineyard Mid-Atlantic are summarized below:

- Offshore export cable installation will avoid sensitive habitats[5] where feasible.
- The Proponent will require the cable installation contractor to prioritize the least environmentally impactful cable installation alternative(s) that are practicable for each segment of cable.
- For vessels other than anchored cable laying vessels (which must maintain tension on anchor lines), the use of mid-line anchor buoys will be considered (where feasible and considered safe) as a potential measure to reduce impacts to sensitive seafloor habitat from anchor line sweep. There is no anchor line sweep from anchored cable laying vessels because the anchor lines are under tension.

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[5] Eelgrass, Complex habitat, and Large Grained Complex habitat are absent from the Lease Area and OECC.

- Near the potential landfall site(s), HDD will be used to avoid or minimize disturbance to coastal habitats by drilling underneath them.

- The target cable burial depth beneath stable seabed of 1.2 m (4 ft) in federal waters and 1.8 m (6 ft) in state waters, which will reduce effects of EMFs and cable heat. In areas where seafloor type or cable crossings potentially prohibit cable burial, cable protection would serve as a barrier to exposure.

- The Proponent's goal is to minimize the use of cable protection to the greatest extent possible through a careful route assessment and the selection of the most appropriate cable burial tool for each segment of the cable route.

- The Proponent will apply a soft-start procedure to the pile driving process, which delivers initial pile drives at a lower intensity, allowing mobile species to move out of the activity area before the full-power pile driving begins.

- Noise abatement system(s) will be used to reduce sound levels by a target of approximately 10 dB during pile driving.

- The Proponent does not intend to conduct pile driving between January 1 and April 30 when higher numbers of NARW are expected to be present in the Offshore Development Area.

- A benthic habitat monitoring plan framework has been developed (see Appendix II-R) to monitor recovery after construction in areas with sensitive habitats.

- A fisheries monitoring plan has been developed to monitor key indicators before and after construction (see Appendix II-U); such monitoring may be part of regional monitoring efforts. Trawl surveys conducted as part of fisheries monitoring would be limited to small sampling nets, short tow times, and slow tow speeds, which would reduce the risk of capture of non-target species.

- WTGs and ESP(s) will be widely spaced, leaving a large portion of the Lease Area undisturbed by WTG and ESP installation.

5 Conclusions

The EFH impact producing factors during the construction, O&M, and decommissioning of Vineyard Mid-Atlantic include seafloor disturbance and habitat modification, suspended sediments and deposition, entrainment and impingement, EMFs, and noise. If potential impacts to EFH cannot be avoided, most potential impacts to EFH are expected to be temporary and/or localized. Direct habitat alterations from the installation of WTG/ESP foundations, scour protection, and potential cable protection have the potential to result in long term (lasting for the duration of Vineyard Mid-Atlantic operations) impacts to EFH, specifically by converting soft-bottom habitat or open pelagic habitat to complex habitat; this could have certain beneficial effects by creating artificial reef effects. However, the long-term seafloor disturbance impacts would be expected to impact less than 1% of the total Lease Area and up to 0.9% of the OECC depending on the landfall site approach (see Table 4.1-1). The Proponent plans to avoid, minimize, and mitigate all potential impacts to EFH, wherever possible.

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Annex A: Large-Scale Maps of Bottom Habitats and Benthic Features Located Within the Offshore Development Area of Vineyard Mid-Atlantic

Habitat maps included in Annex A display the characterized delineations of benthic habitat type and benthic features along with all ground truthing samples collected in the Offshore Development Area in 2022 and 2023. Sixteen maps depict the Lease Area at a scale of 1:100,000 based on the extensive homogeneous nature of the habitat. Habitat along the OECC is presented in a series of 123 maps at a scale of 1:5,000 based on the presence of Heterogenous Complex observed throughout. For each series of maps, the kilometer posts (KP), grab and vibracore sample locations, video transects, representative HDD exit pit locations, and CMECS classification are provided.

Essential Fish Habitat Map Cover Page

OCS-A 0544 Lease Area and Offshore Export Cable Corridor Habitat Mapping Definitions and Additional Map Notes

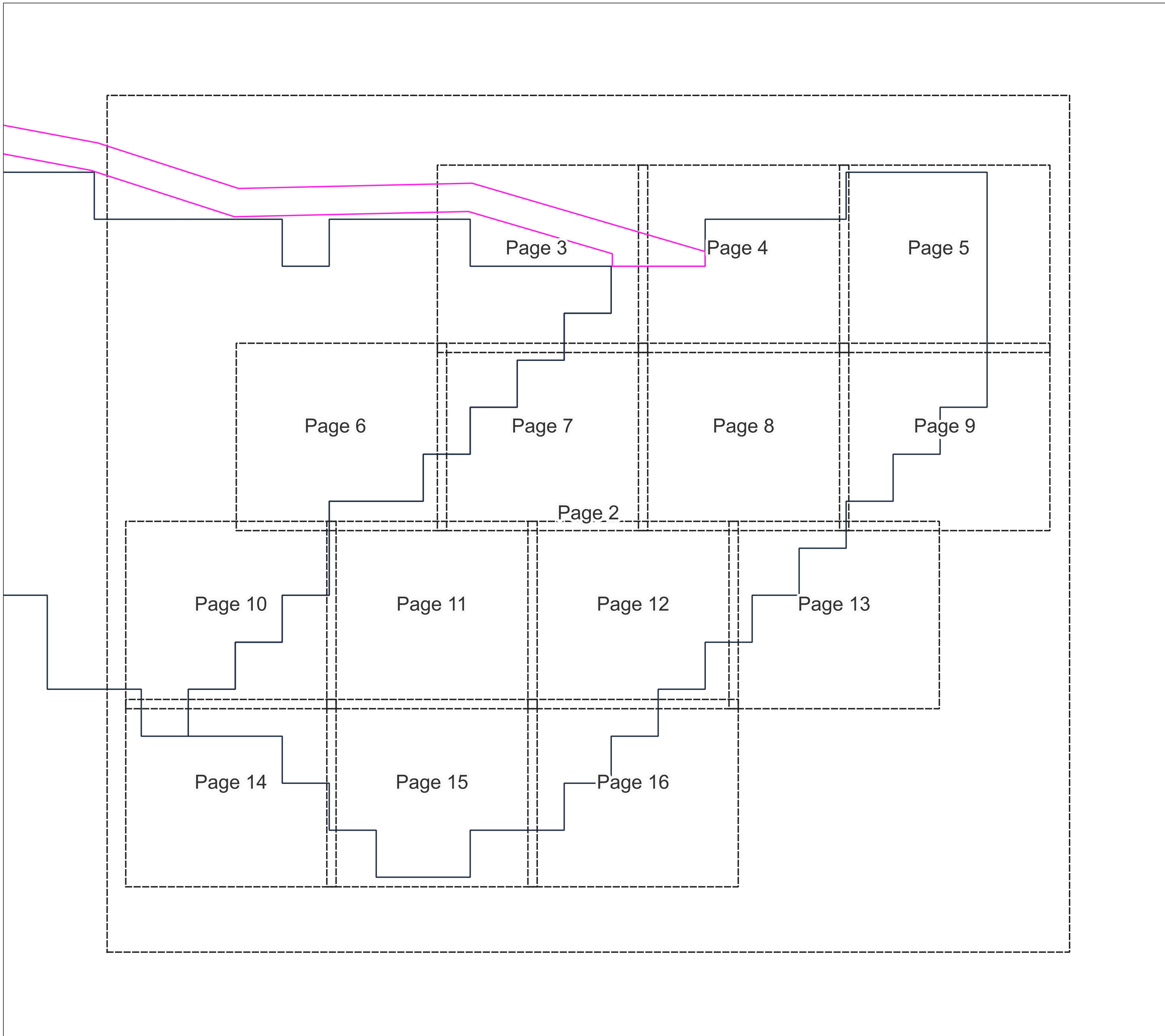
Habitat Mapping

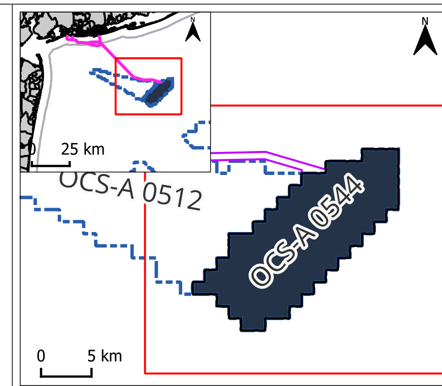
1. Soft Bottom- Fine Unconsolidated Substrate groups (i.e. Sand, Muddy Sand, Sandy Mud, and Mud) including subgroups (i.e. Very Coarse/Coarse Sand, Medium Sand, and Fine/Very Fine Sand)
2. Heterogeneous Complex- Mix of Soft and Complex Stations Within a Delineated Area
3. Complex- Coarse Unconsolidated Substrate groups (i.e. Gravels, Gravel Mixes, Gravelly, and Shell) including subgroups (i.e. Boulder, Cobble, Pebble/Granule, Gravel Pavement, Sandy Gravel, Muddy Sandy Gravel, Muddy Gravel, Gravelly Sand, Gravelly Muddy Sand, and Gravelly Mud). (Complex areas were not present in the OCS-A 0544 Lease Area or Offshore Export Cable Corridor mappings.)
4. Large Grained Complex- Rock Substrate subclasses (i.e. Bedrock/Megaclast) and Large Boulders. (Large Grained Complex areas were not present in the OCS-A 0544 Lease Area or Offshore Export Cable Corridor mappings.)

Definitions obtained from National Marine Fisheries Service (NMFS) Greater Atlantic Fisheries Office, Habitat Conservation and Ecosystem Services Division. Recommendations for Mapping Fish Habitat. March 2021. Page 8 of 20.

Notes

1. The data depicted on these maps represent the results of geophysical, geotechnical, and environmental surveys performed in 2022 and 2023, and can only be considered to indicate the general conditions existing at the time of survey.
2. Geophysical survey data was acquired in the Lease Area by Fugro USA Marine and in the OECC by TDI-Brooks International, Inc. Geotechnical and environmental samples collected by TDI-Brooks International, Inc. Map sheets compiled by Geo SubSea.
3. Habitat mapping files are created by interpreting the different sediment types using sidescan sonar, bathymetry, and backscatter data. Video transects, grab samples, and vibracores are then used to ground truth this interpretation. The habitat mapping delineations are created using a best estimate of the sediment type boundaries, and transitions between Soft Bottom and Heterogeneous Complex habitat may be gradational in nature. Additional boundaries are created within a single classification type to show differences in acoustic reflectivity. Occasional isolated boulders may be found within all habitat types. Habitats are classified and delineations are created using the NMFS guidance document (2021).
4. Replicate stations are displaced for presentation purposes. The symbols do not represent the as-sampled locations for these stations.
5. Refer to Appendix II-B2 for the methodology used in the benthic habitat mapping.





LEGEND

- OCS-A 0544
- BOEM Wind Lease Outlines
- Offshore Export Cable Corridor

Habitat Mapping

- Soft Bottom
- Heterogeneous Complex
- Changes in Acoustic Reflectivity
- Ripples
- Featureless Bottom
- Soft Video Transect
- Complex Mix Video Transect
- Soft Vibracore Station
- Complex Vibracore Station
- Soft Grab Station
- Complex Grab Station
- Soft Displaced Grab Station

Note: Replicate grab locations are displaced for visual purposes and do not represent the as-sampled location.

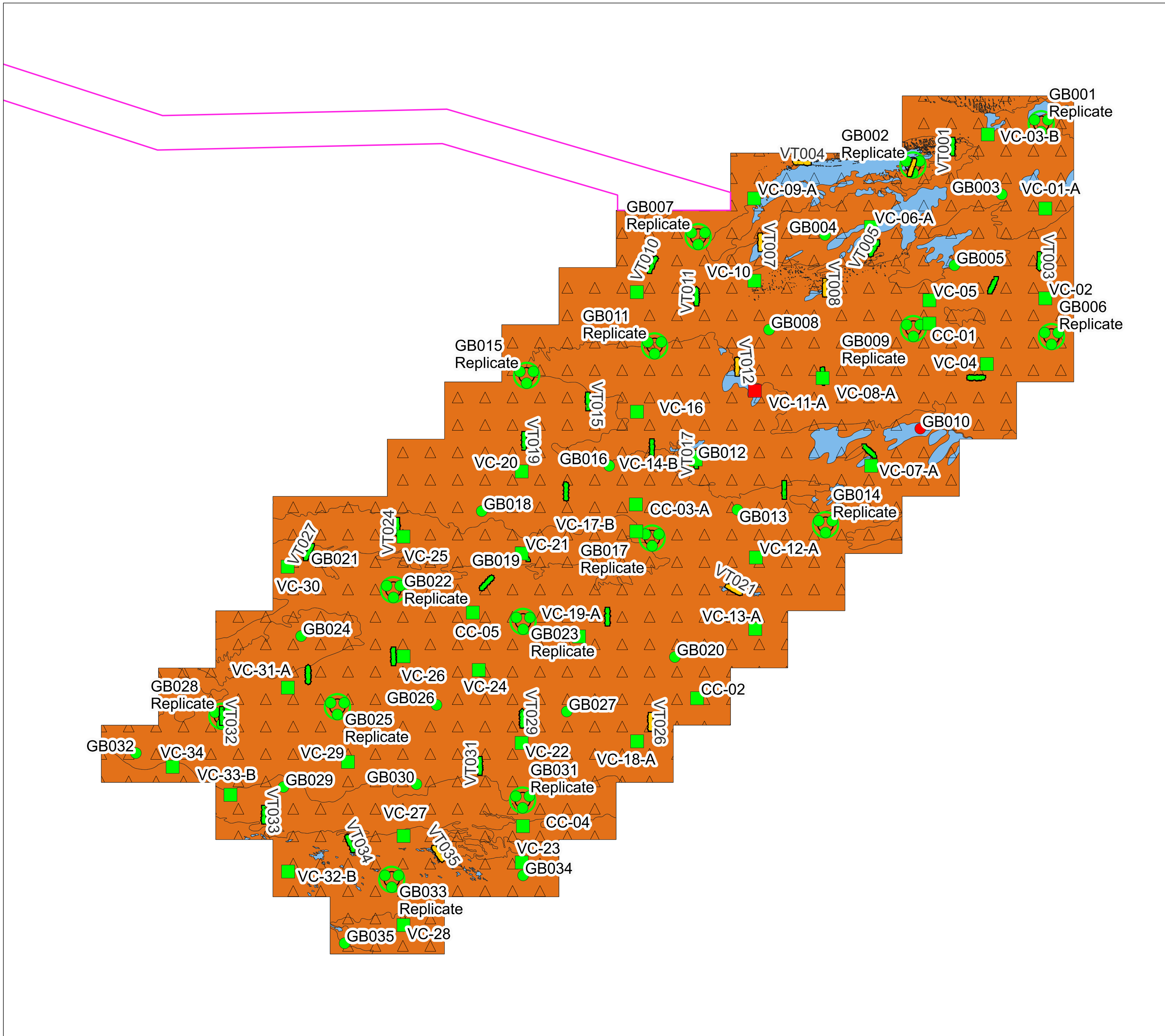
Scale 1:140,000
(1 in = 3.56 km @ 11" x 8.5" paper size

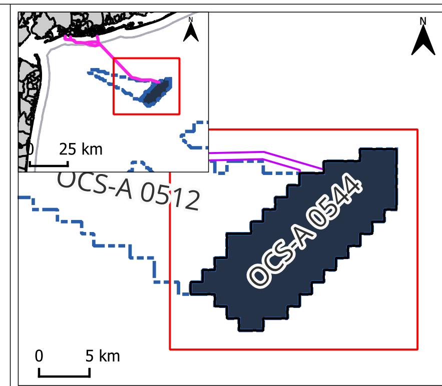
0 1.4 2.8 4.2 5.6 km

Large Scale Maps of Bottom Habitats and Benthic Features Located in the OCS-A 0544 Lease Area

VINEYARD MID-ATLANTIC

VINEYARD OFFSHORE





LEGEND

- OCS-A 0544
- BOEM Wind Lease Outlines
- Offshore Export Cable Corridor

Habitat Mapping

- Soft Bottom
- Heterogeneous Complex
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- Ripples
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- Complex Mix Video Transect
- Soft Vibracore Station
- Complex Vibracore Station
- Soft Grab Station
- Complex Grab Station
- Soft Displaced Grab Station

Note: Replicate grab locations are displaced for visual purposes and do not represent the as-sampled location.

Scale 1:115,000
(1 in = 2.92 km @ 11" x 8.5" paper size

0 1.1 2.2 3.3 4.4 km

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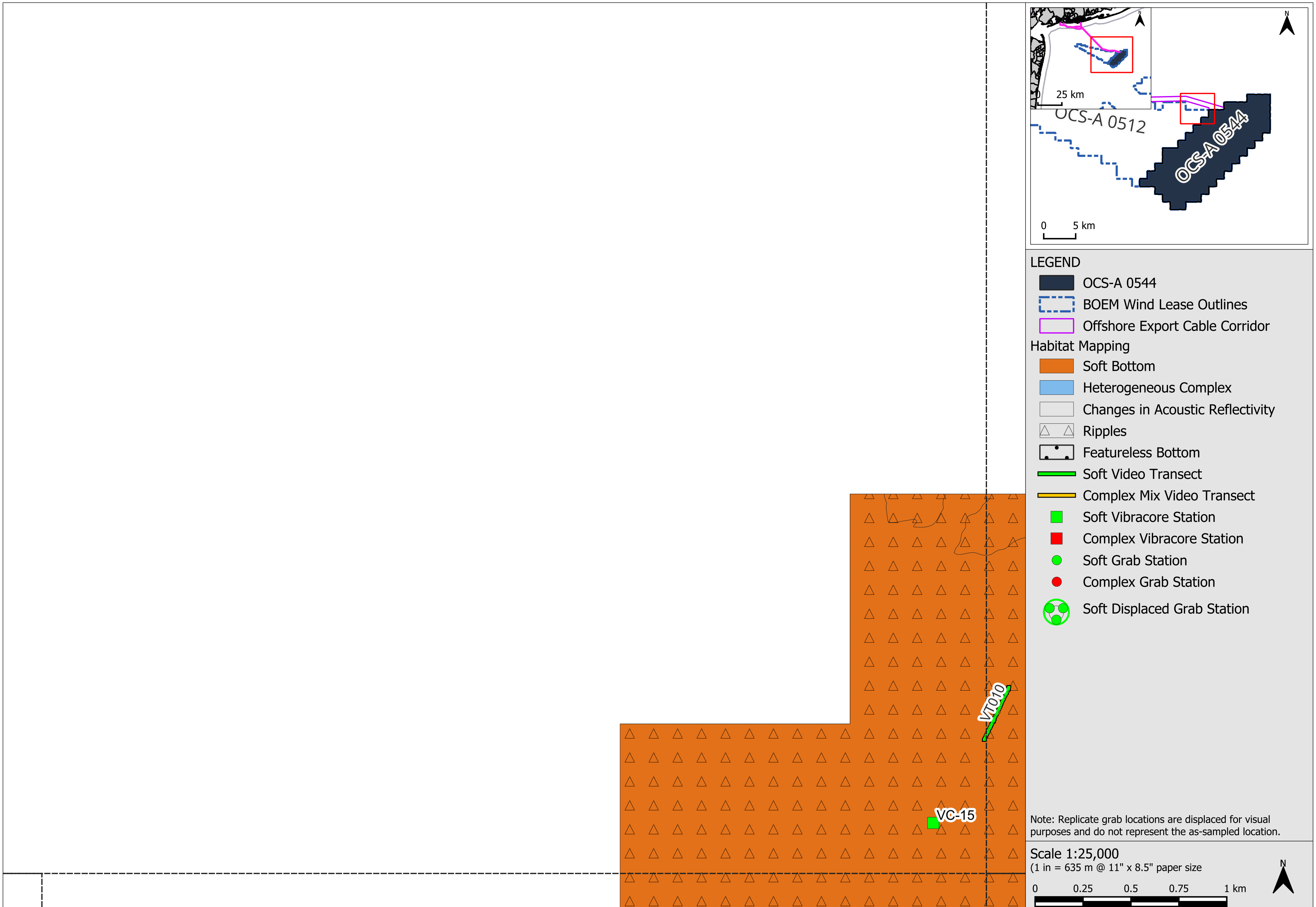
Large Scale Maps of Bottom Habitats and Benthic Features Located in the OCS-A 0544 Lease Area

VINEYARD MID-ATLANTIC

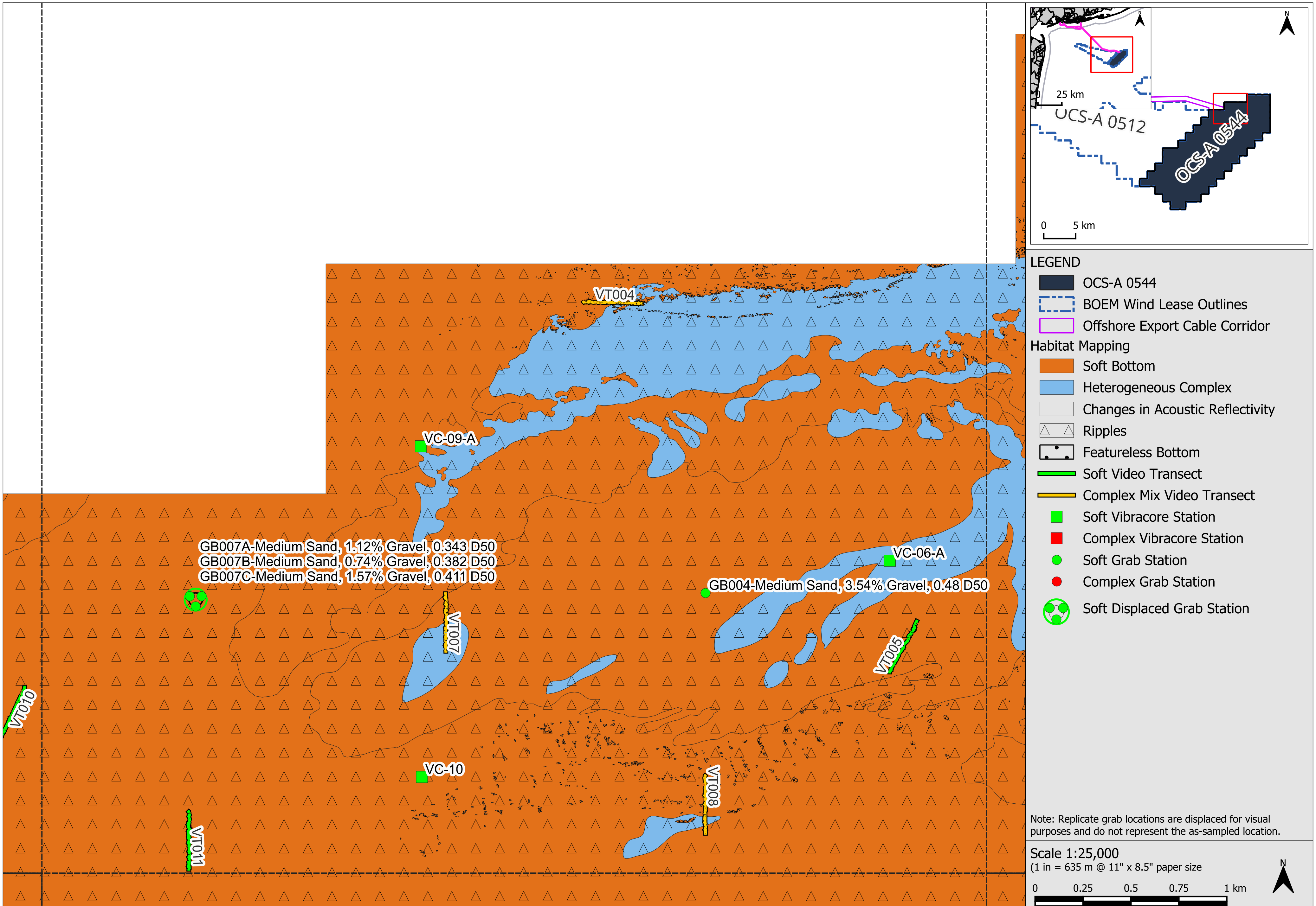
VINEYARD OFFSHORE



Large Scale Maps of Bottom Habitats and Benthic Features Located in the OCS-A 0544 Lease Area

VINEYARD MID-ATLANTIC

VINEYARD OFFSHORE



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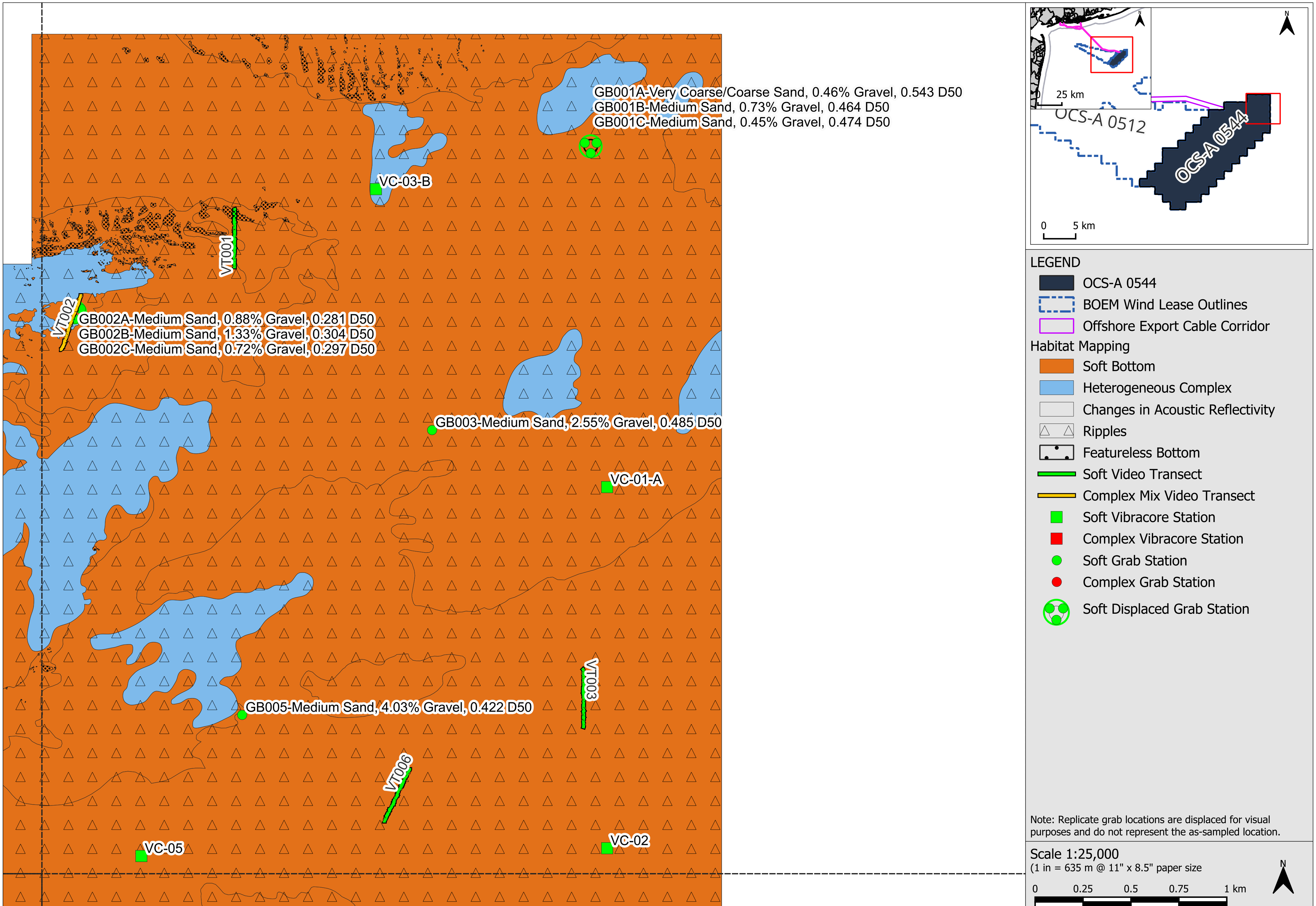
VINEYARD MID-ATLANTIC

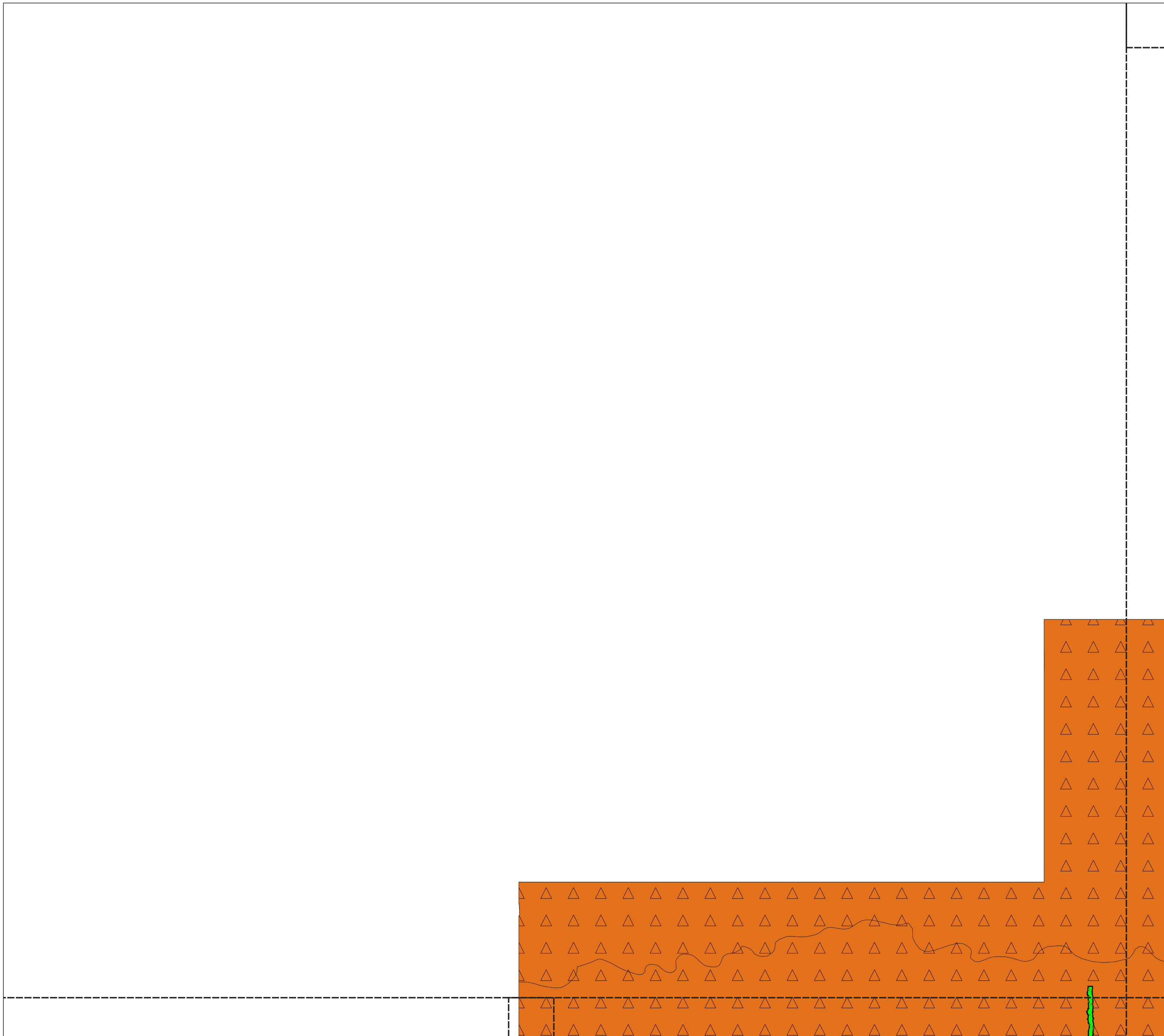
VINEYARD OFFSHORE

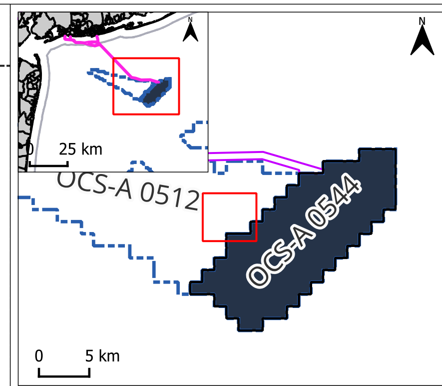


Large Scale Maps of Bottom Habitats and Benthic Features Located in the OCS-A 0544 Lease Area

VINEYARD MID-ATLANTIC

VINEYARD OFFSHORE





LEGEND

- OCS-A 0544
- BOEM Wind Lease Outlines
- Offshore Export Cable Corridor

Habitat Mapping

- Soft Bottom
- Heterogeneous Complex
- Changes in Acoustic Reflectivity
- Ripples
- Featureless Bottom
- Soft Video Transect
- Complex Mix Video Transect
- Soft Vibracore Station
- Complex Vibracore Station
- Soft Grab Station
- Complex Grab Station
- Soft Displaced Grab Station

Note: Replicate grab locations are displaced for visual purposes and do not represent the as-sampled location.

Scale 1:25,000
(1 in = 635 m @ 11" x 8.5" paper size

0 0.25 0.5 0.75 1 km

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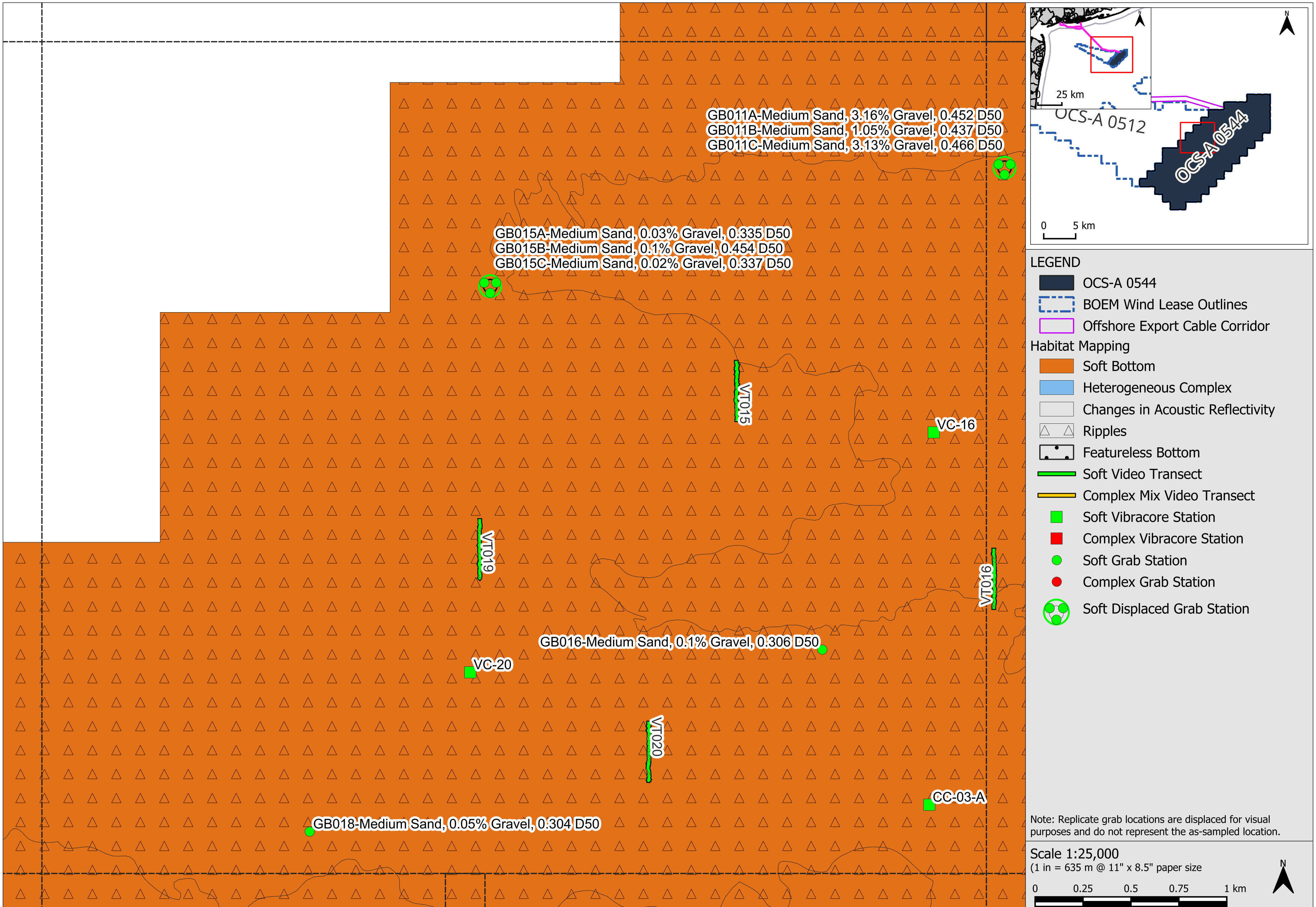
Large Scale Maps of Bottom Habitats and Benthic Features Located in the OCS-A 0544 Lease Area

VINEYARD MID-ATLANTIC

VINEYARD OFFSHORE



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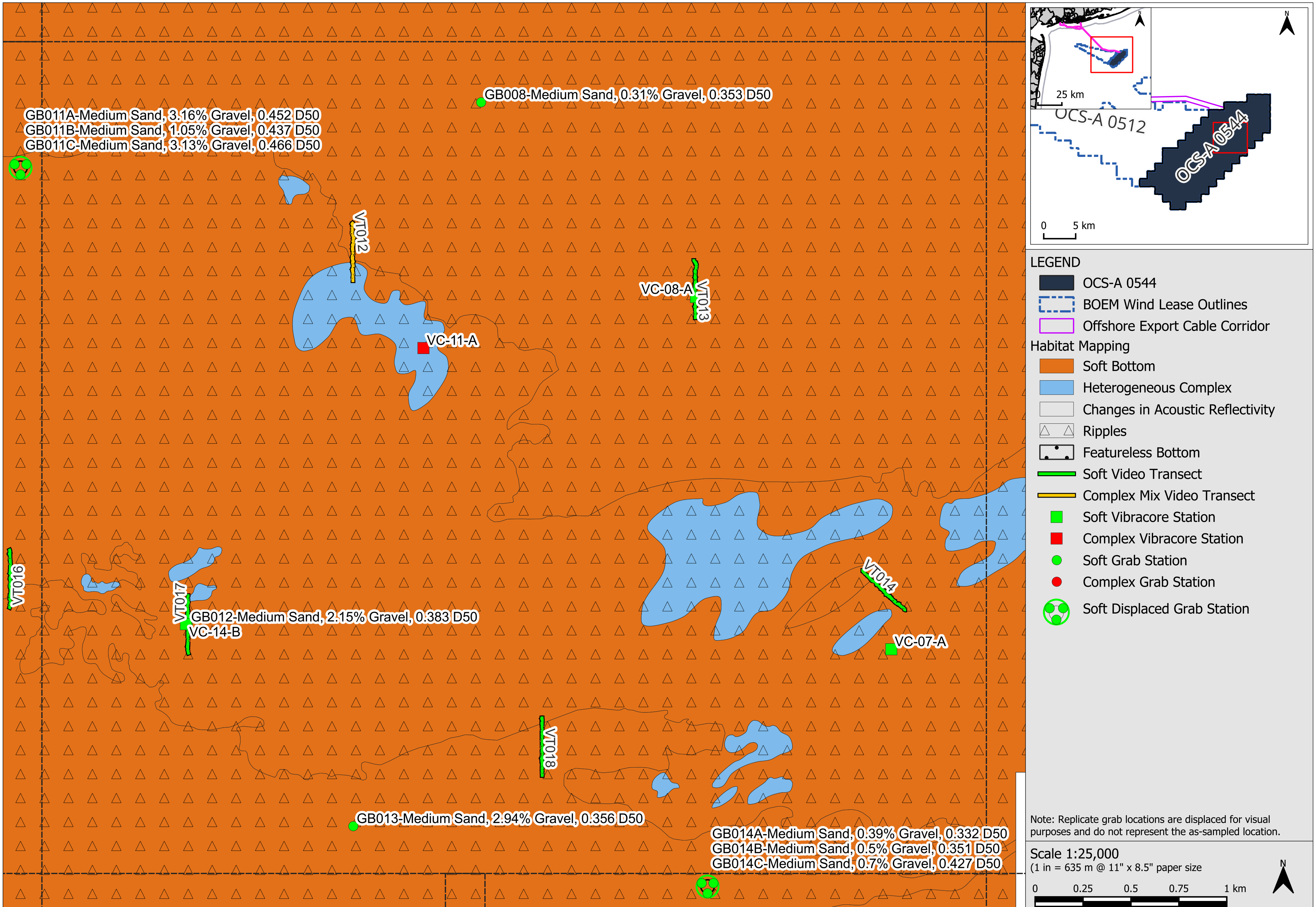

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VINEYARD MID-ATLANTIC

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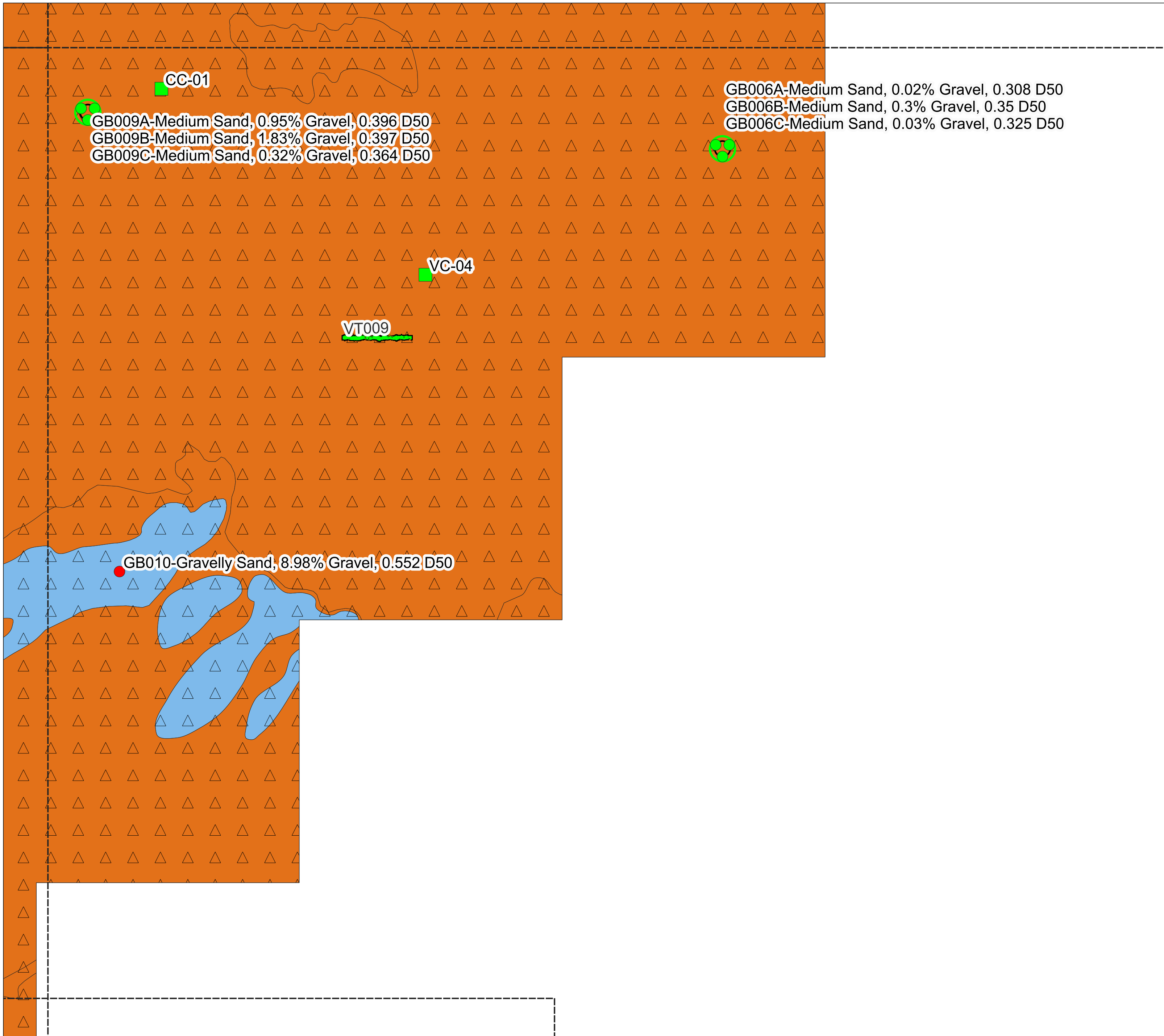

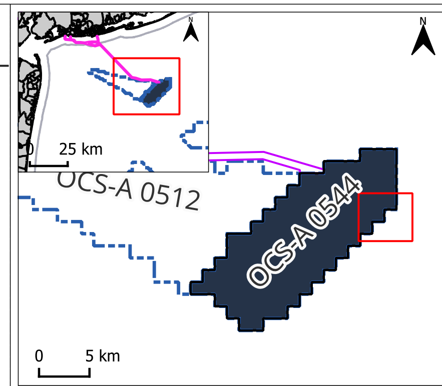

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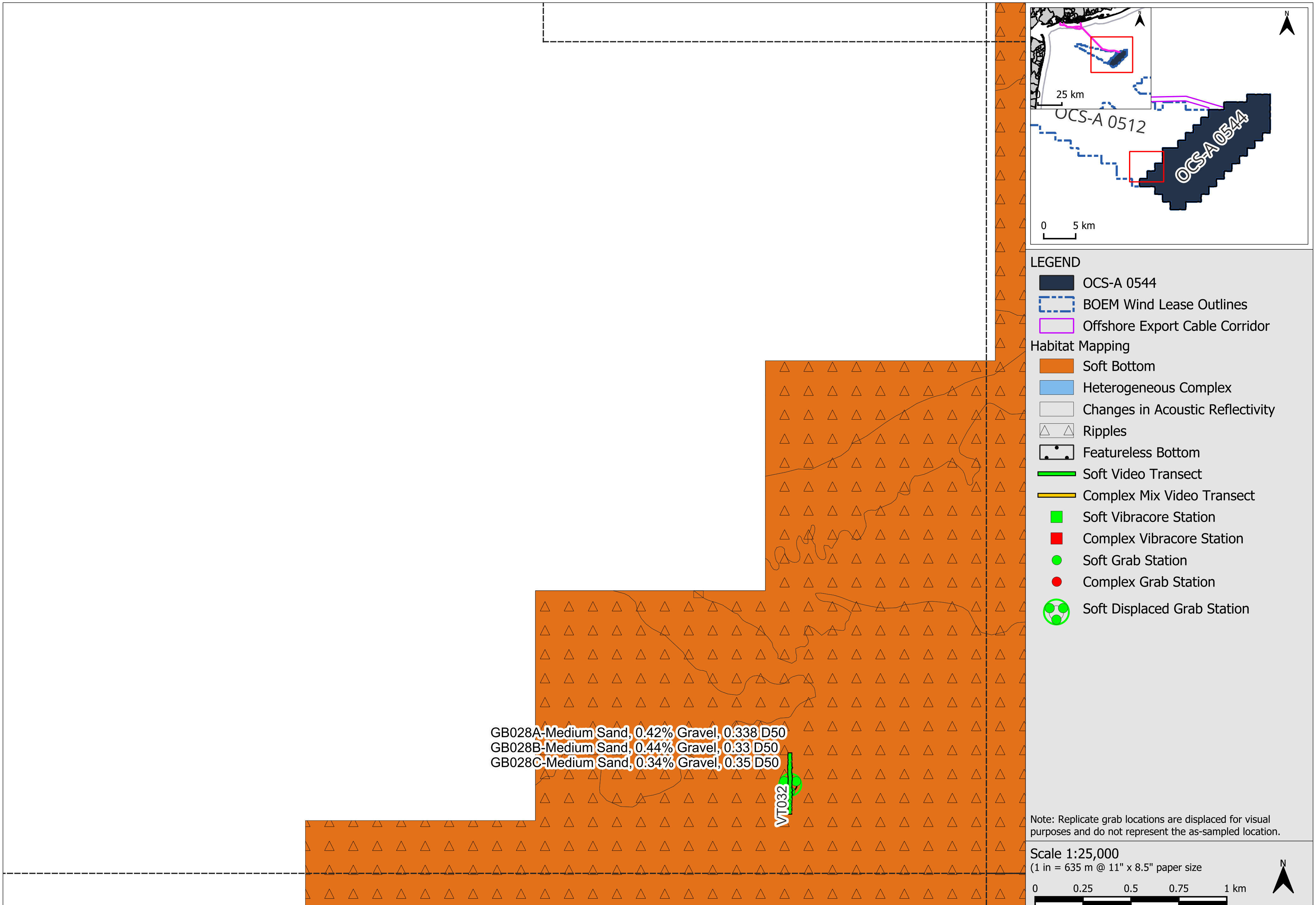

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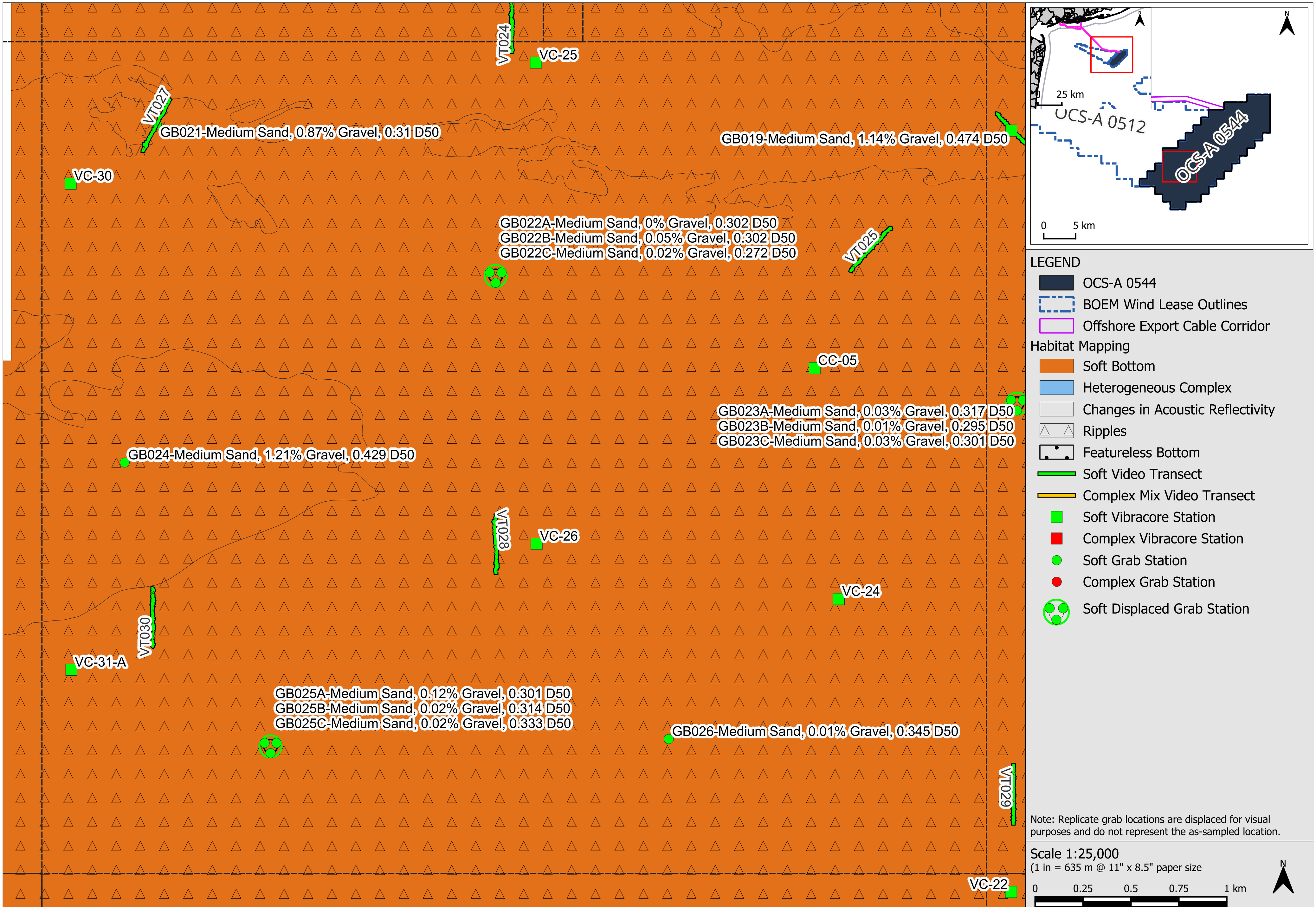

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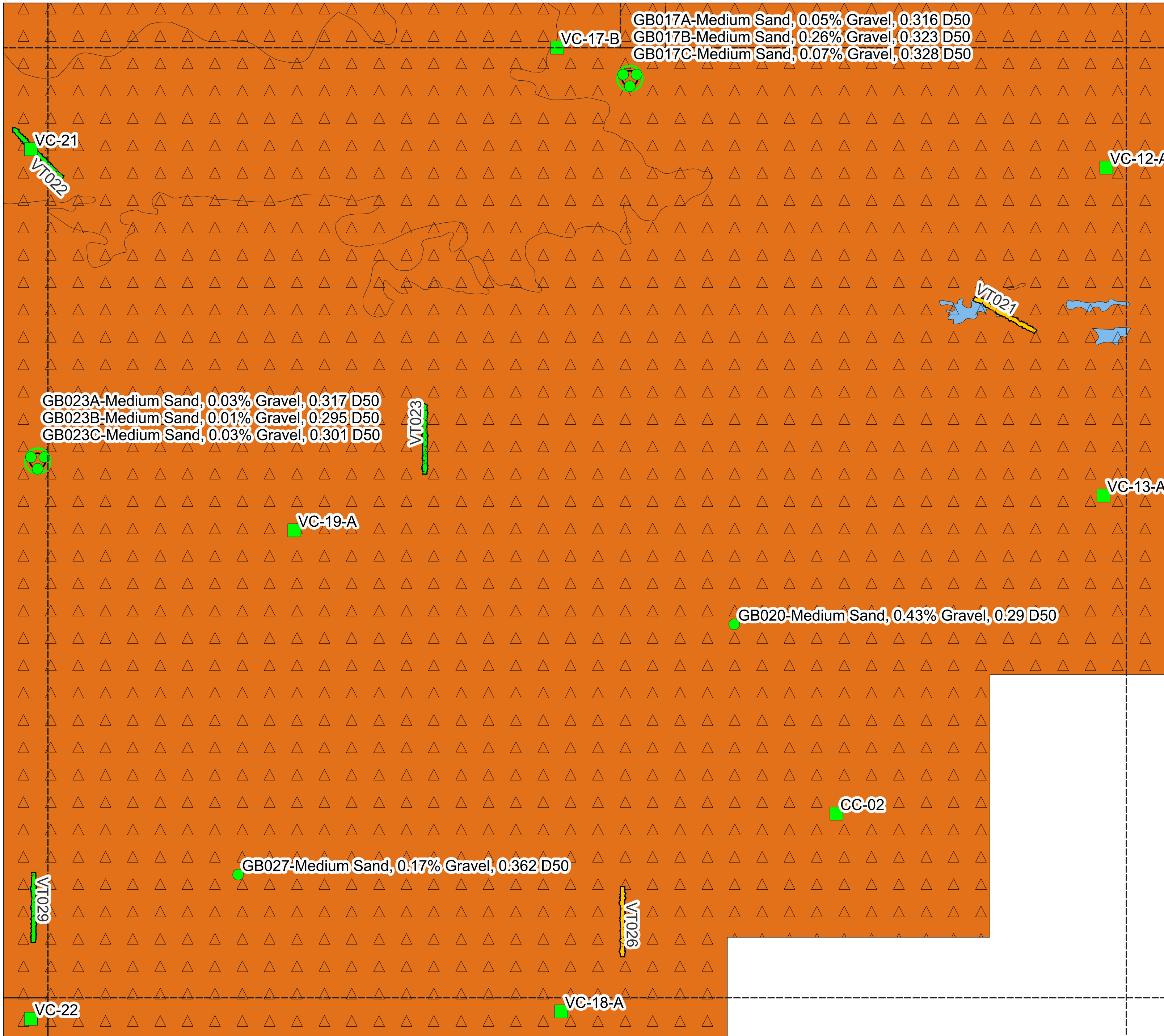

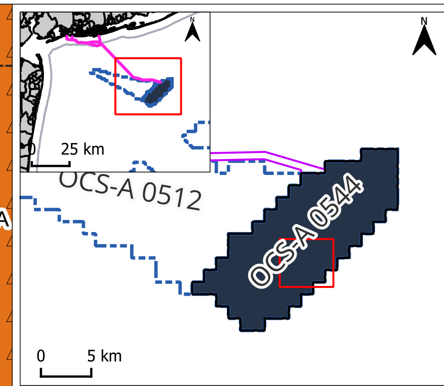

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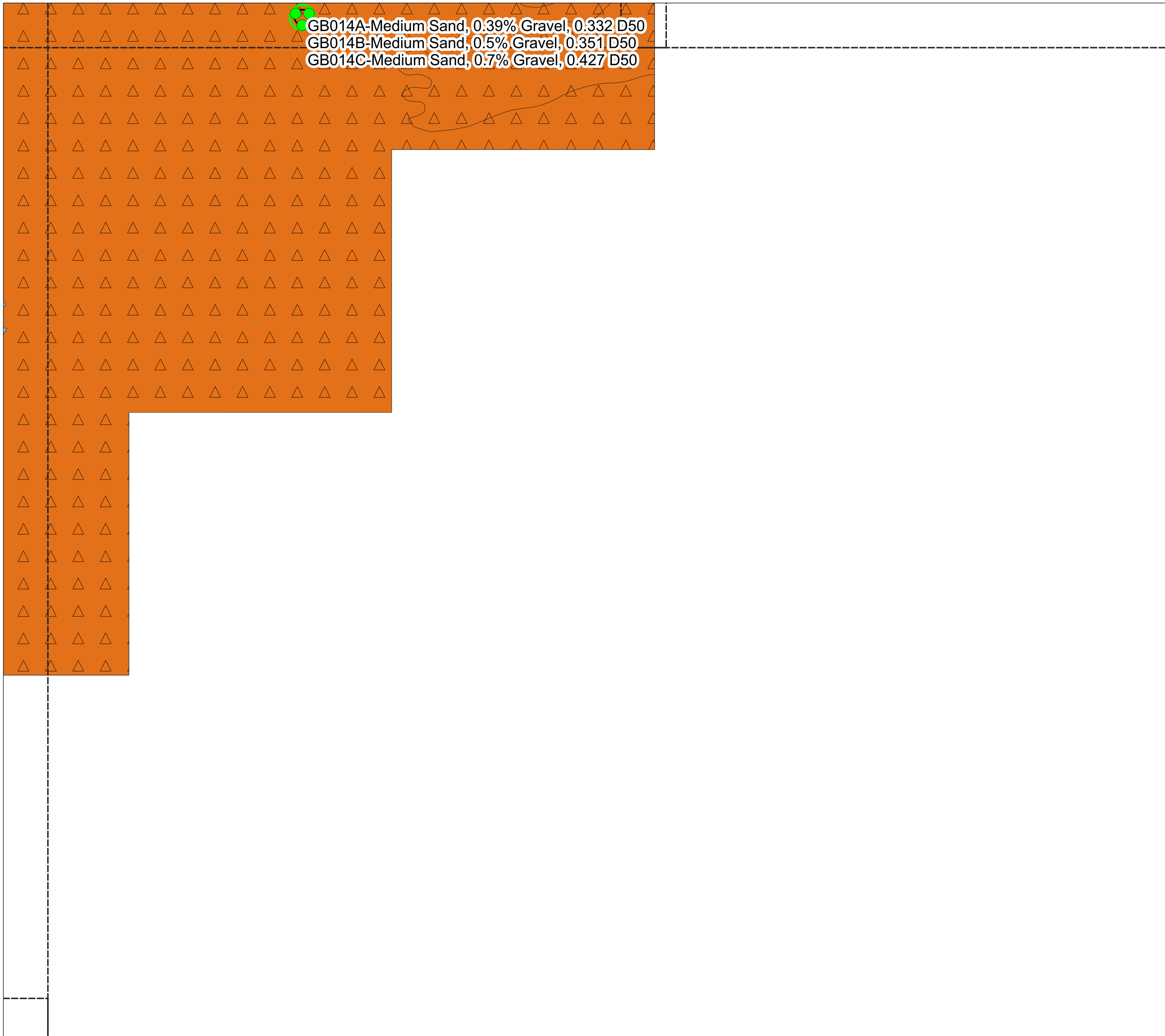

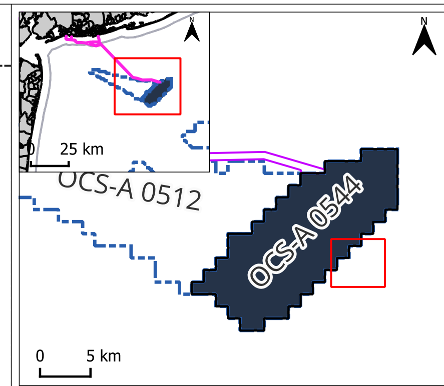

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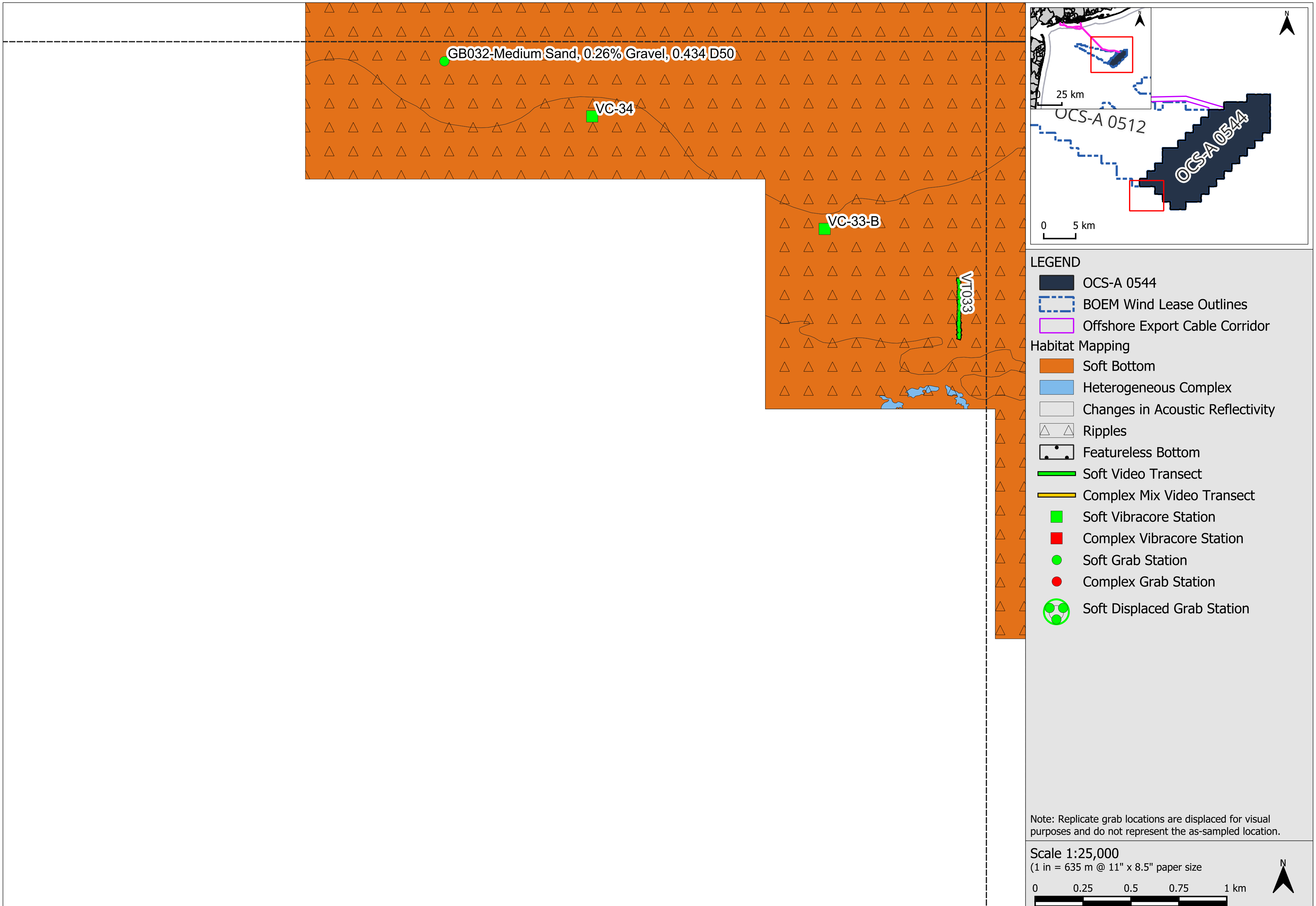
Large Scale Maps of Bottom Habitats and Benthic Features Located in the OCS-A 0544 Lease Area

VINEYARD MID-ATLANTIC

VINEYARD OFFSHORE



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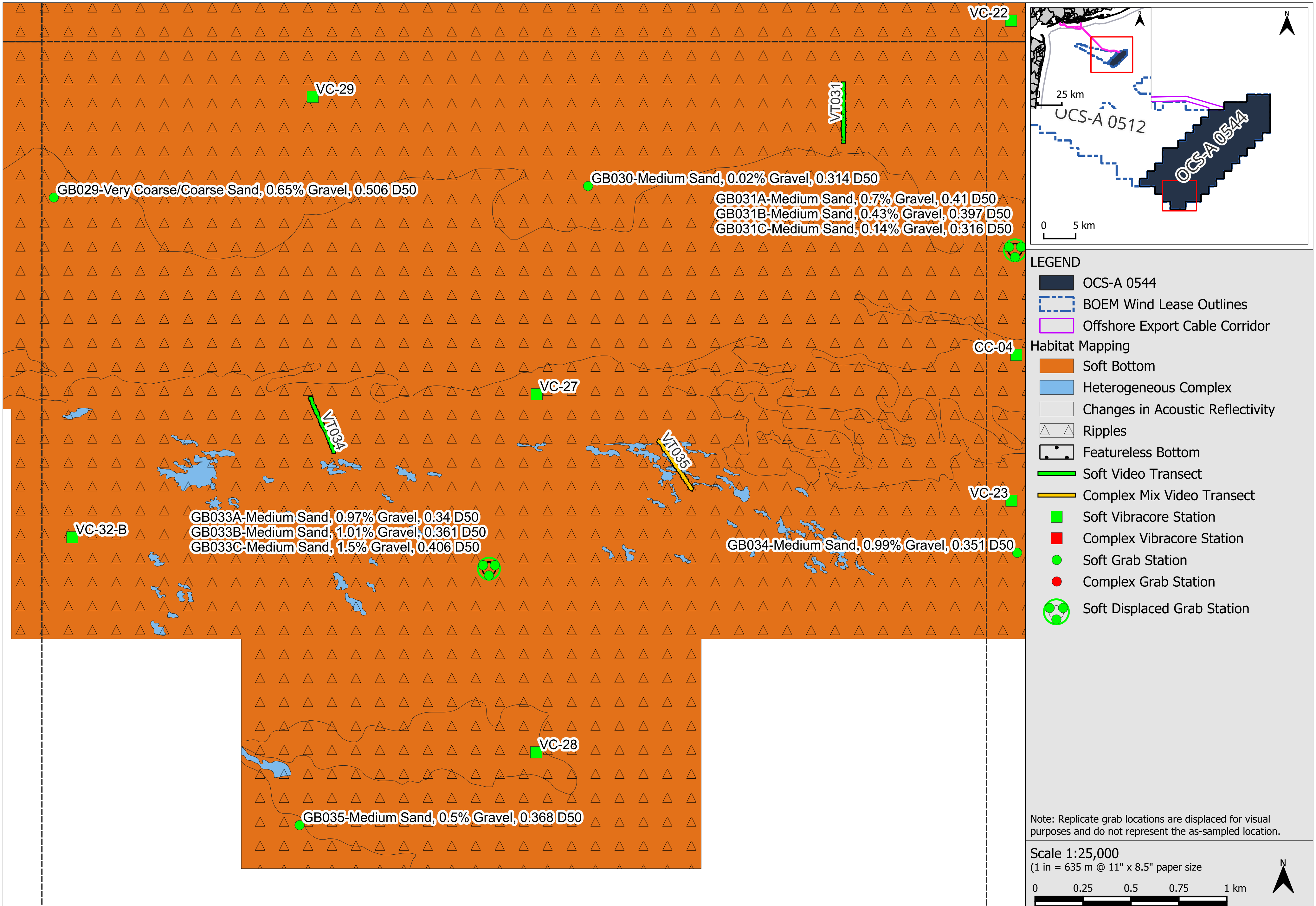

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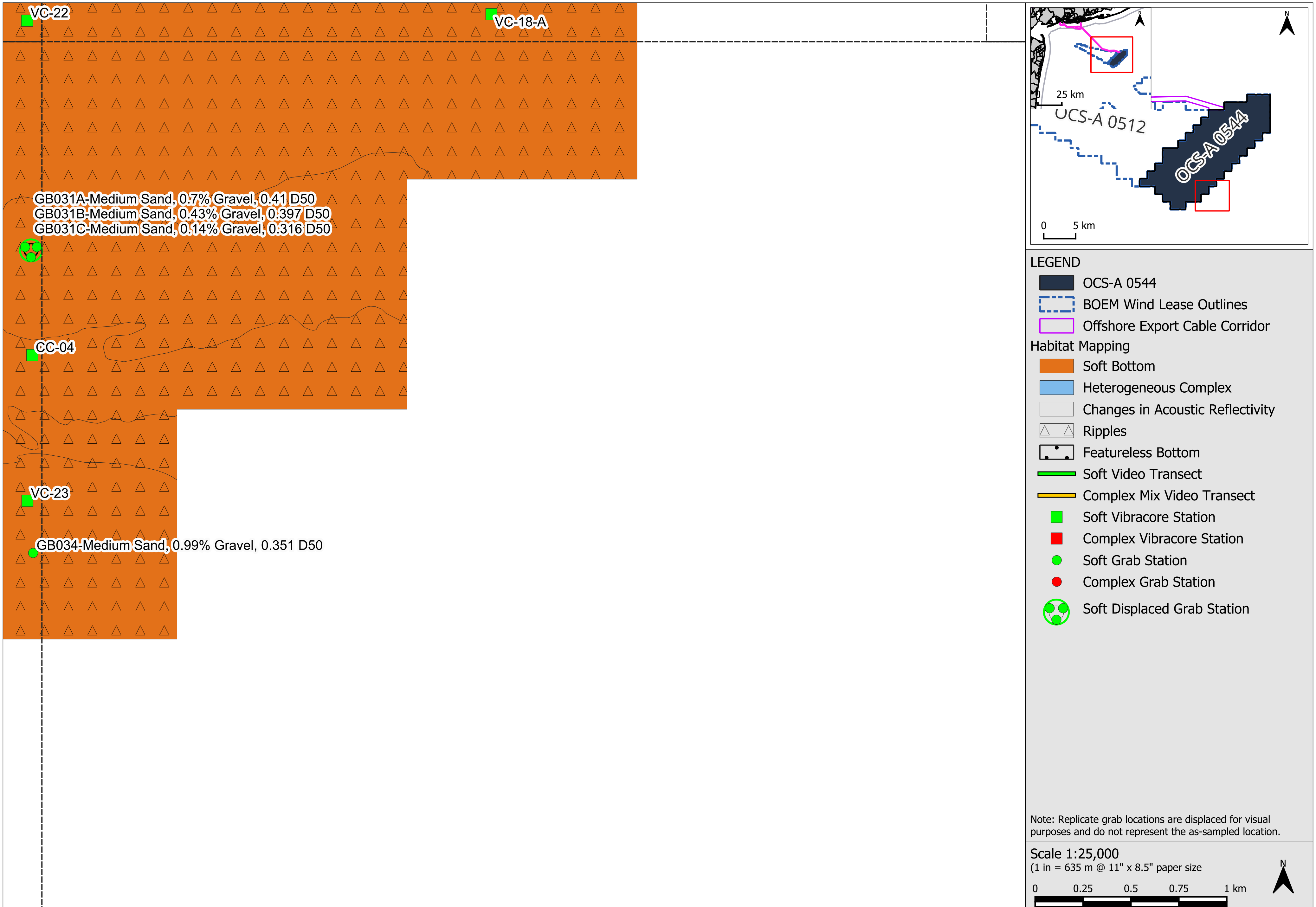

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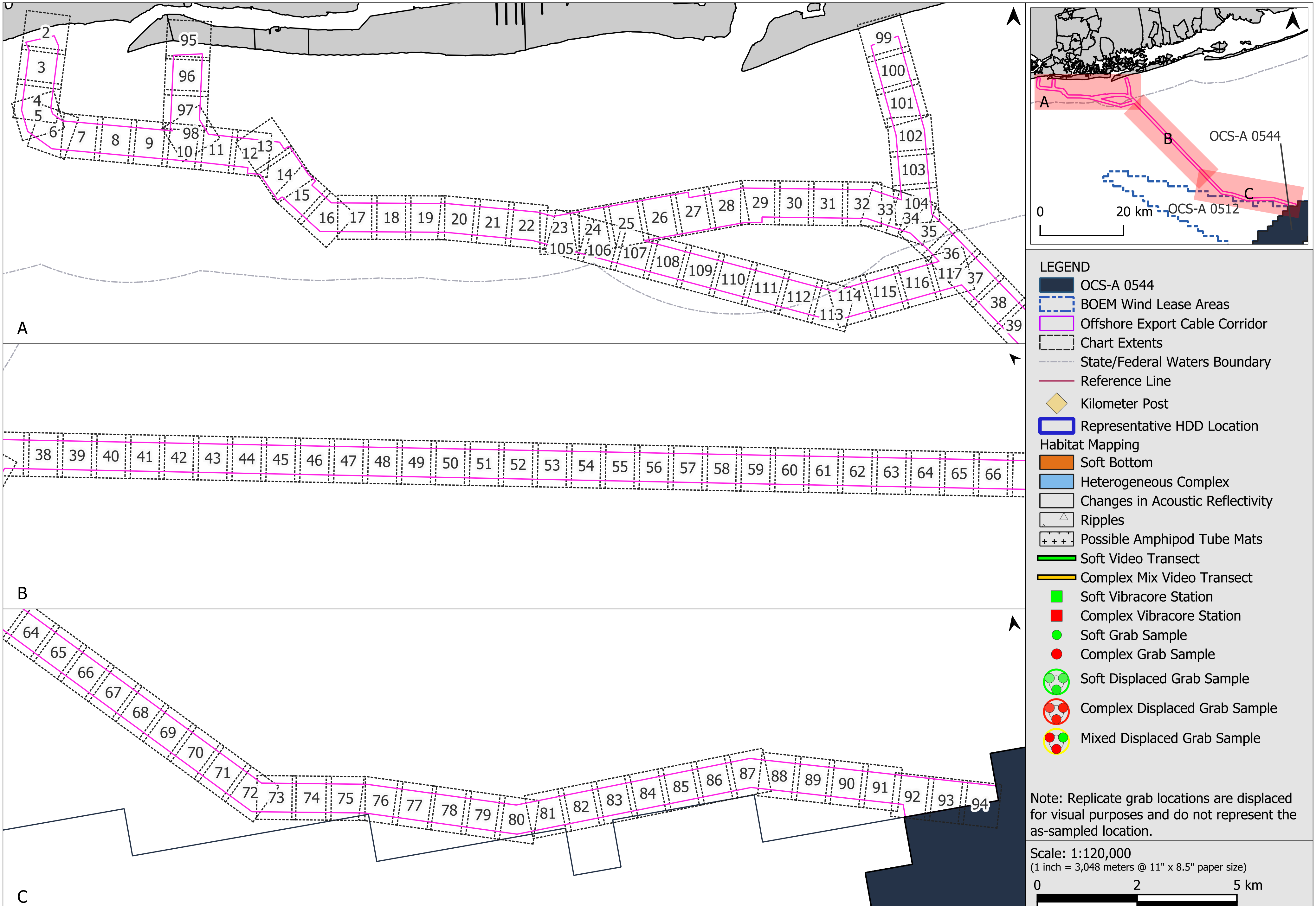

Large Scale Maps of Bottom Habitats and Benthic Features Located in the OECC

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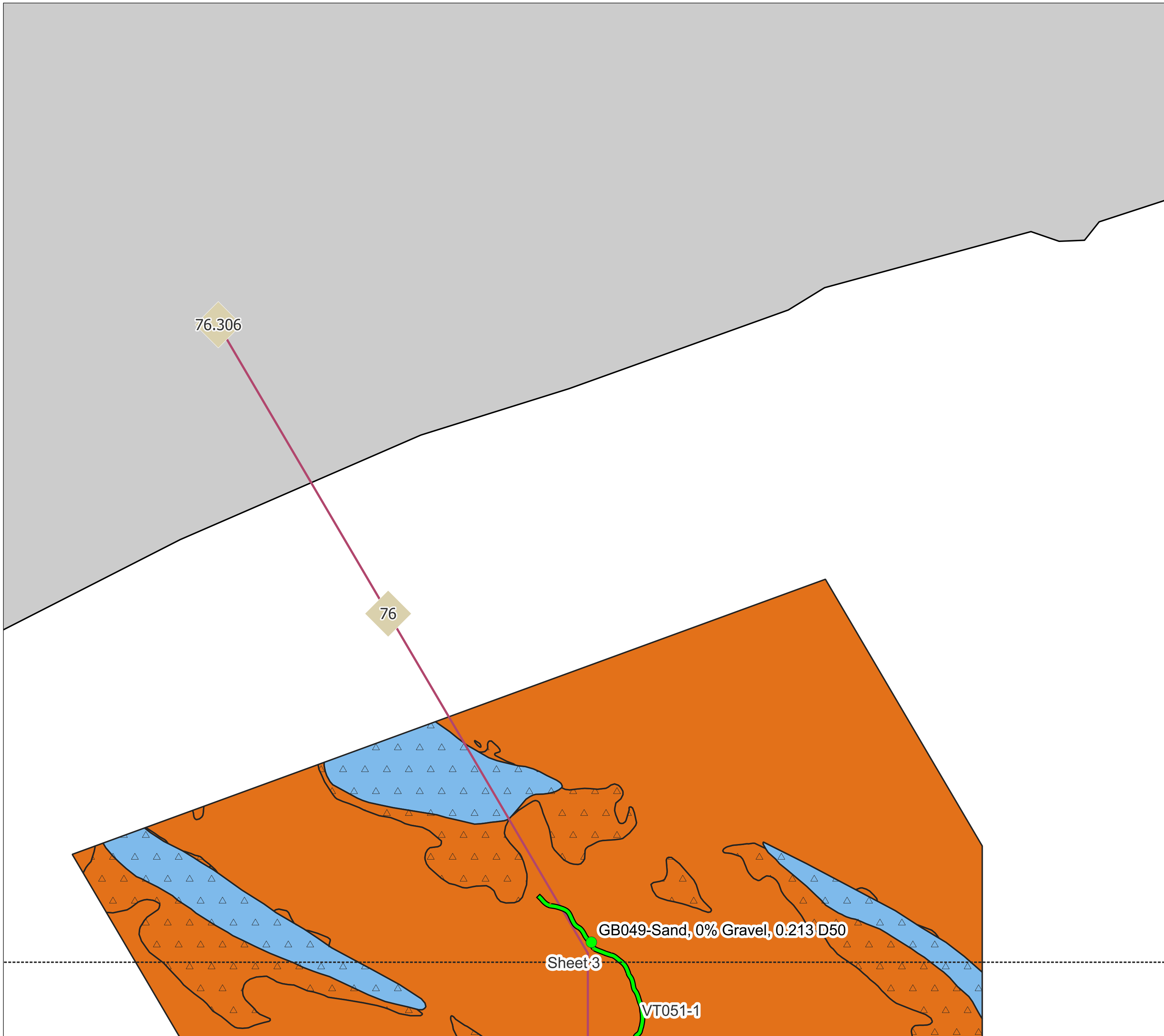
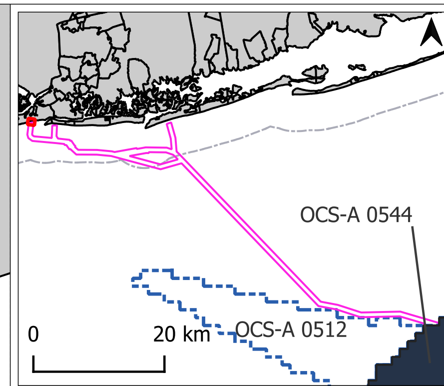
VINEYARD MID-ATLANTIC

VINEYARD OFFSHORE





LEGEND

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Note: Replicate grab locations are displaced for visual purposes and do not represent the as-sampled location.

Scale: 1:5,000
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0 50 100 150 200 m

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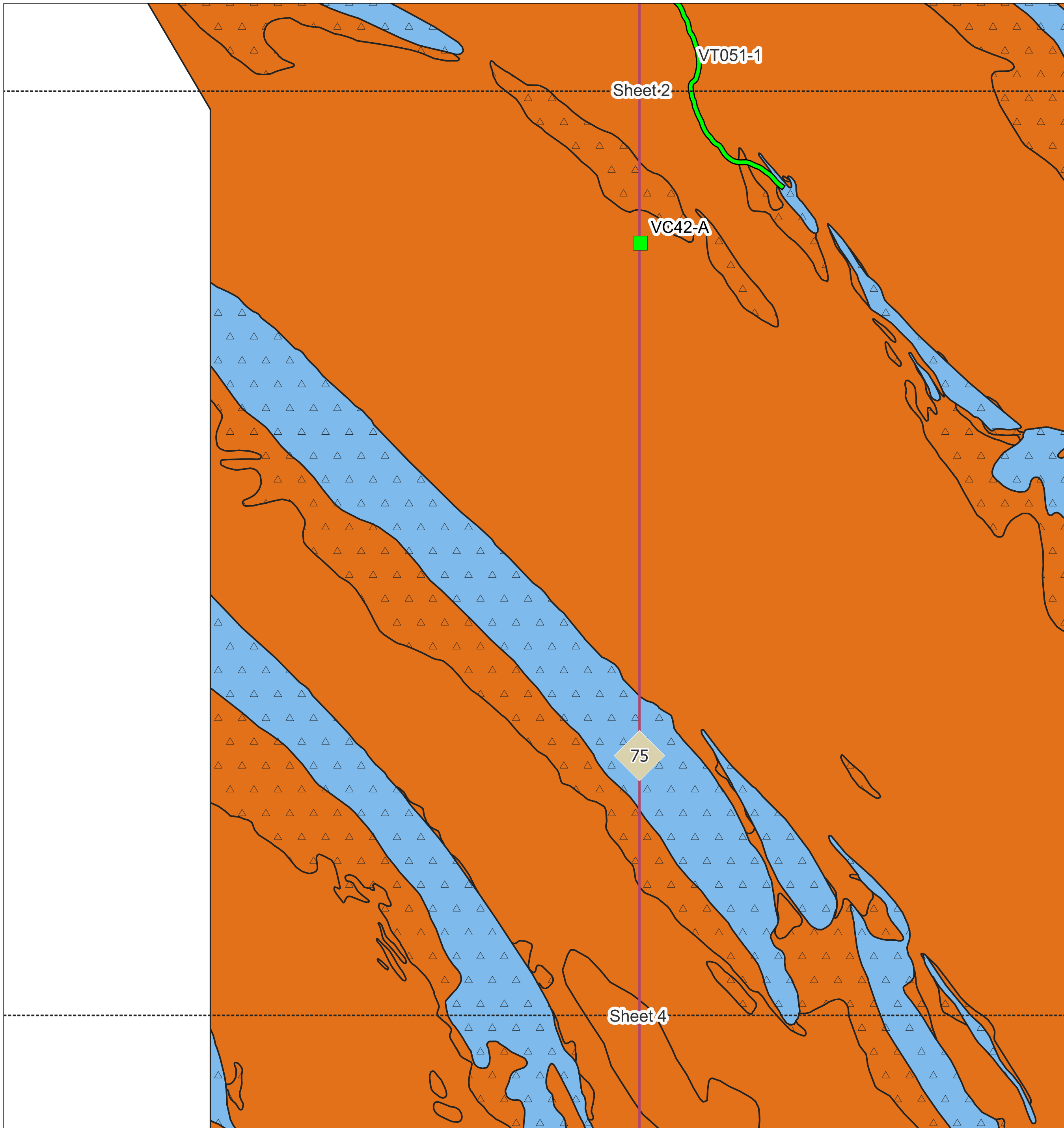

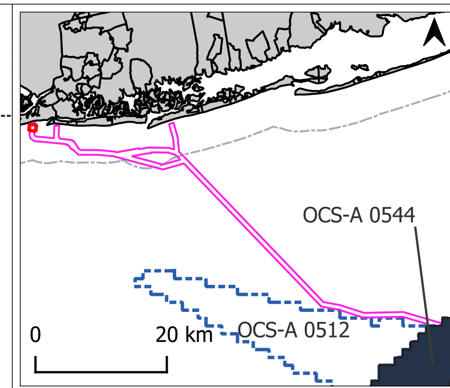

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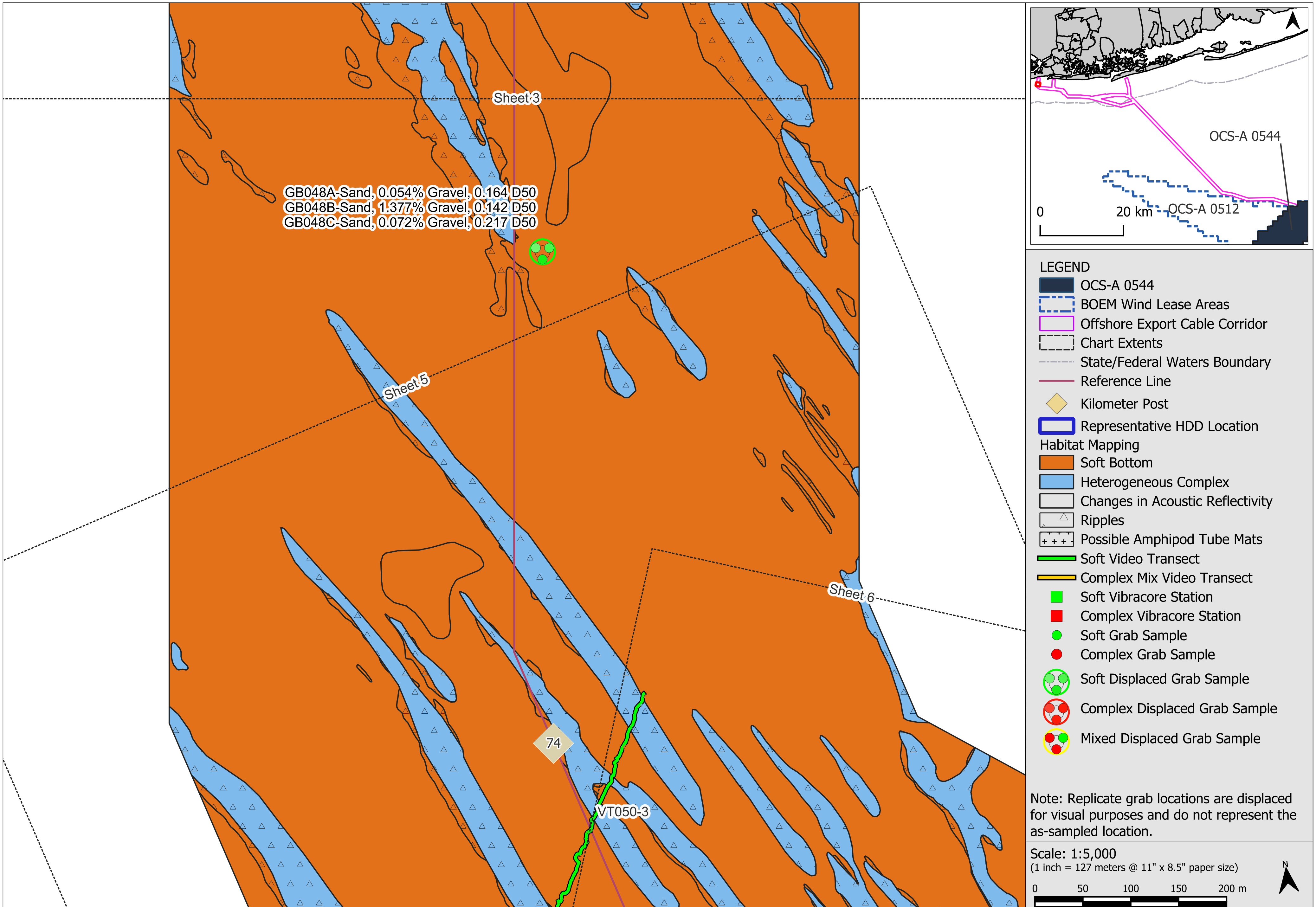

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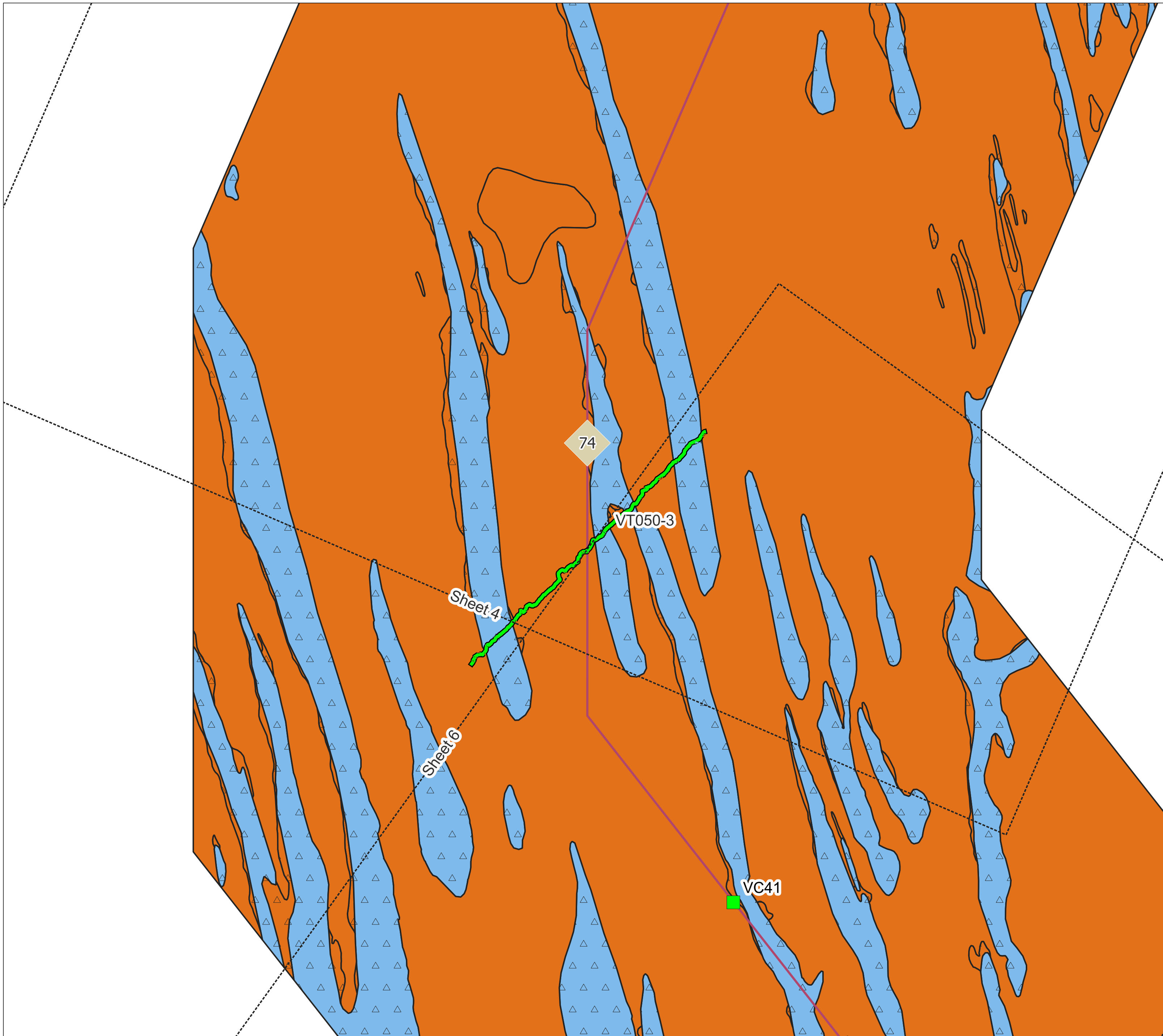

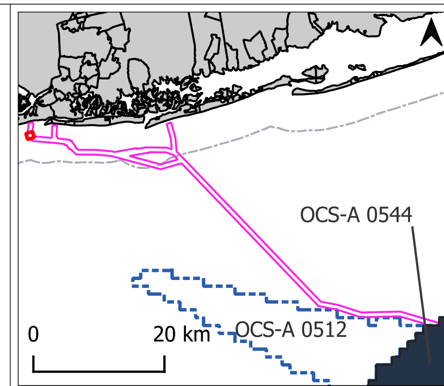

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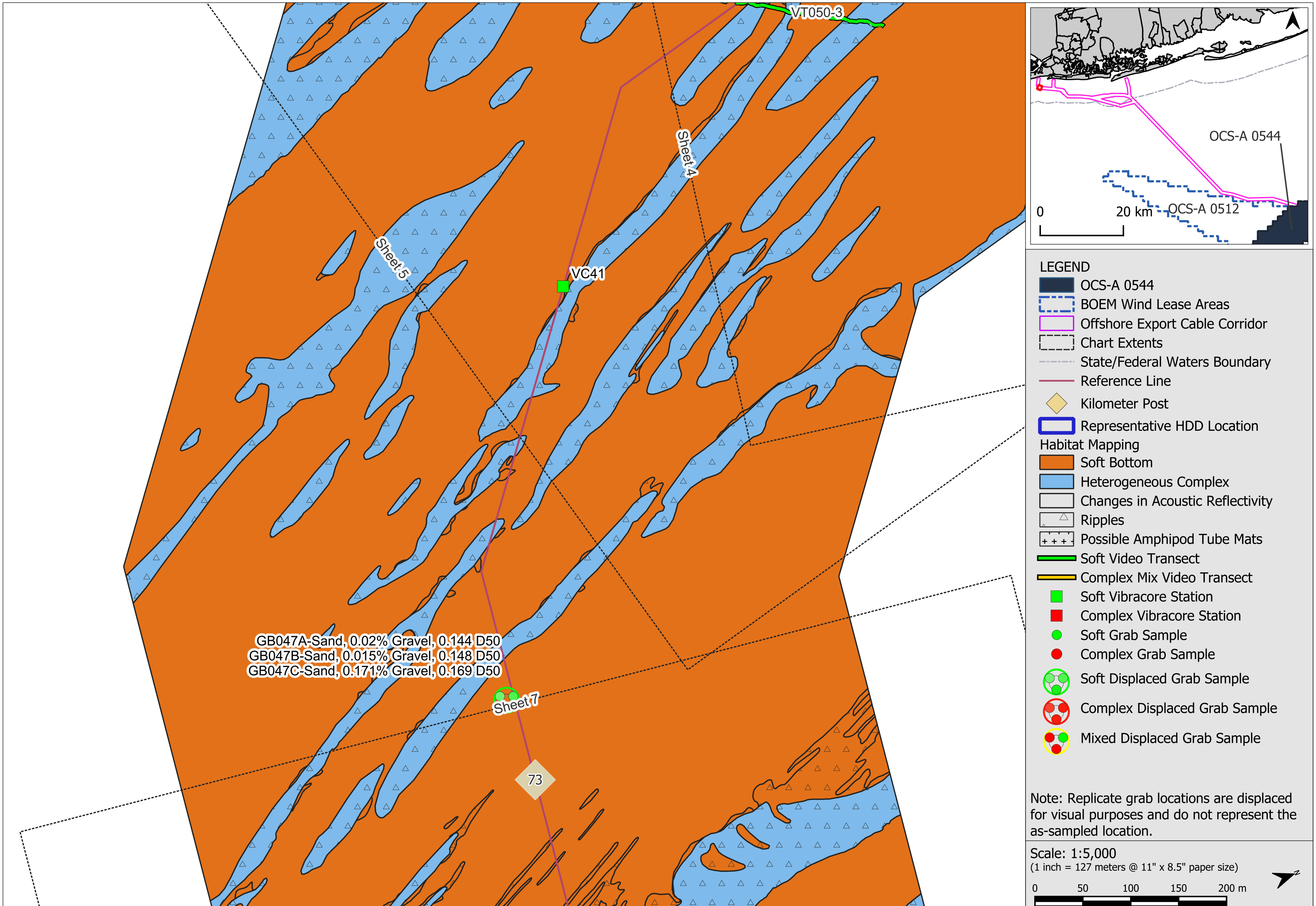

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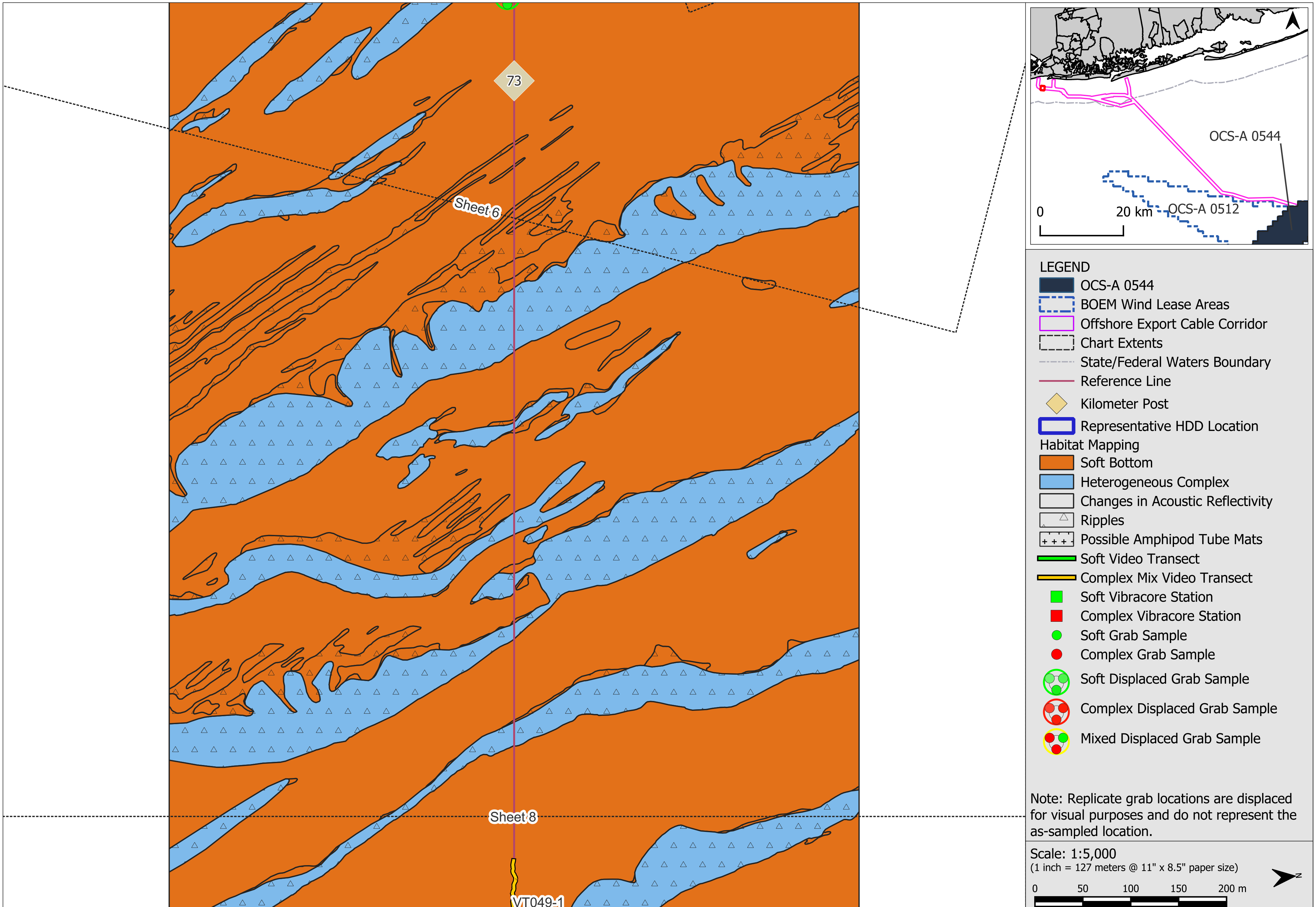

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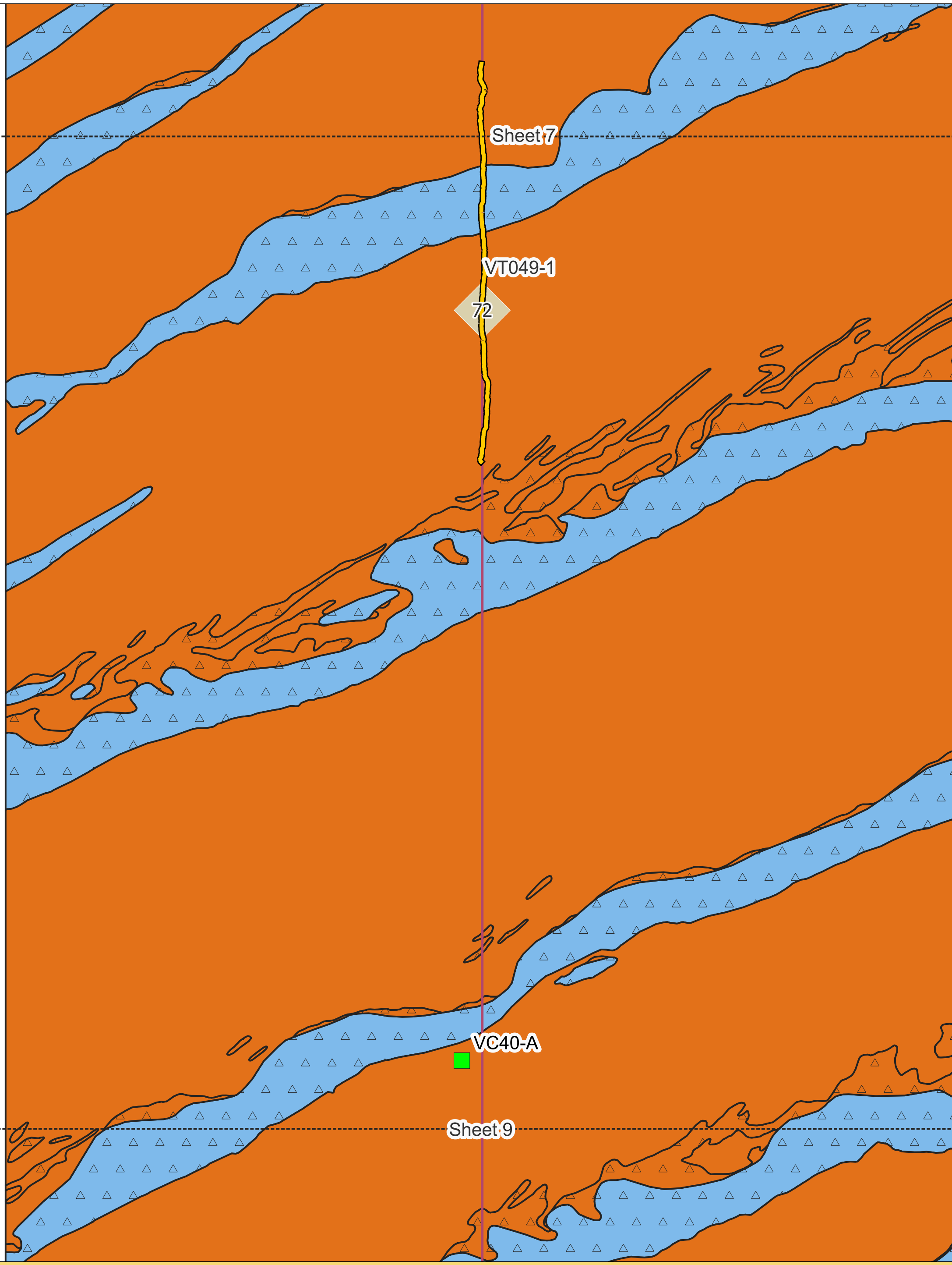

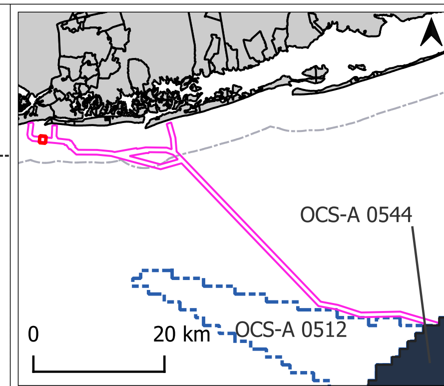

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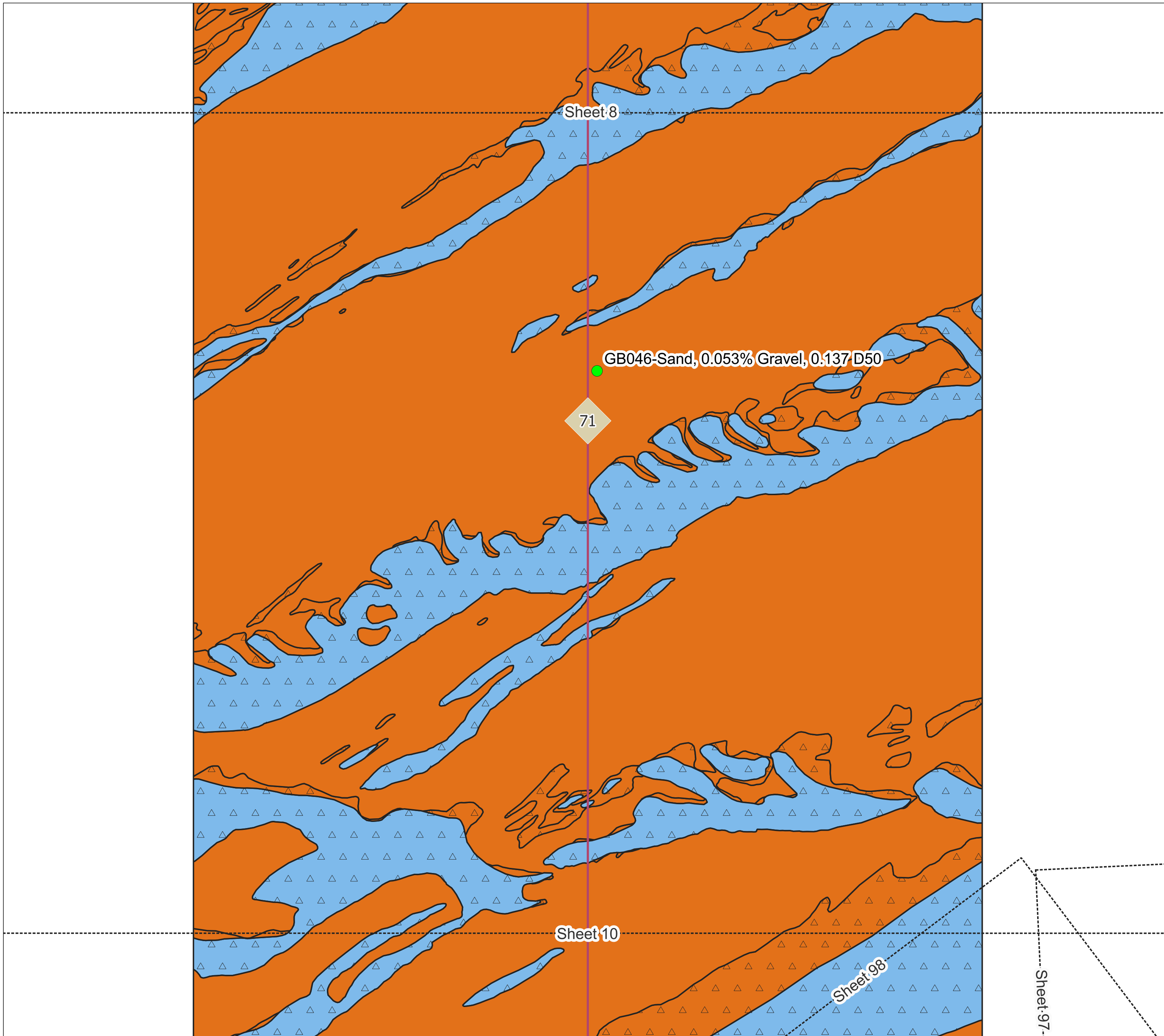

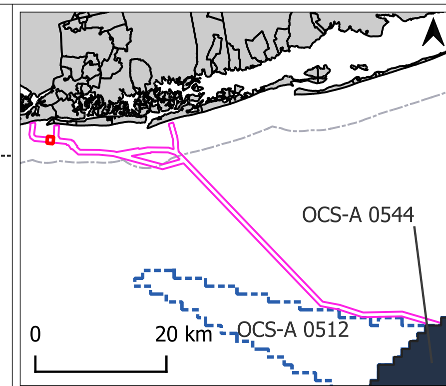

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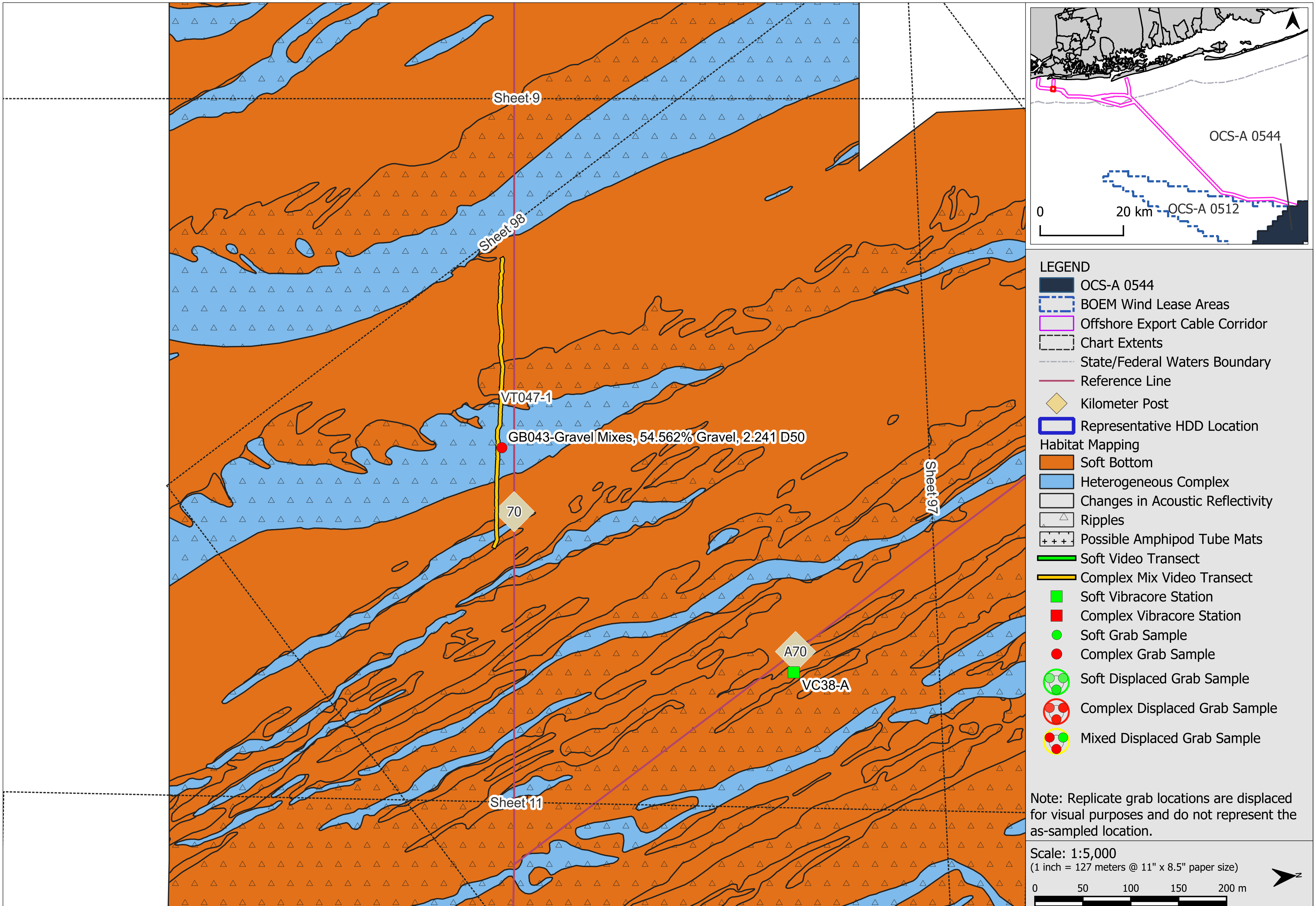

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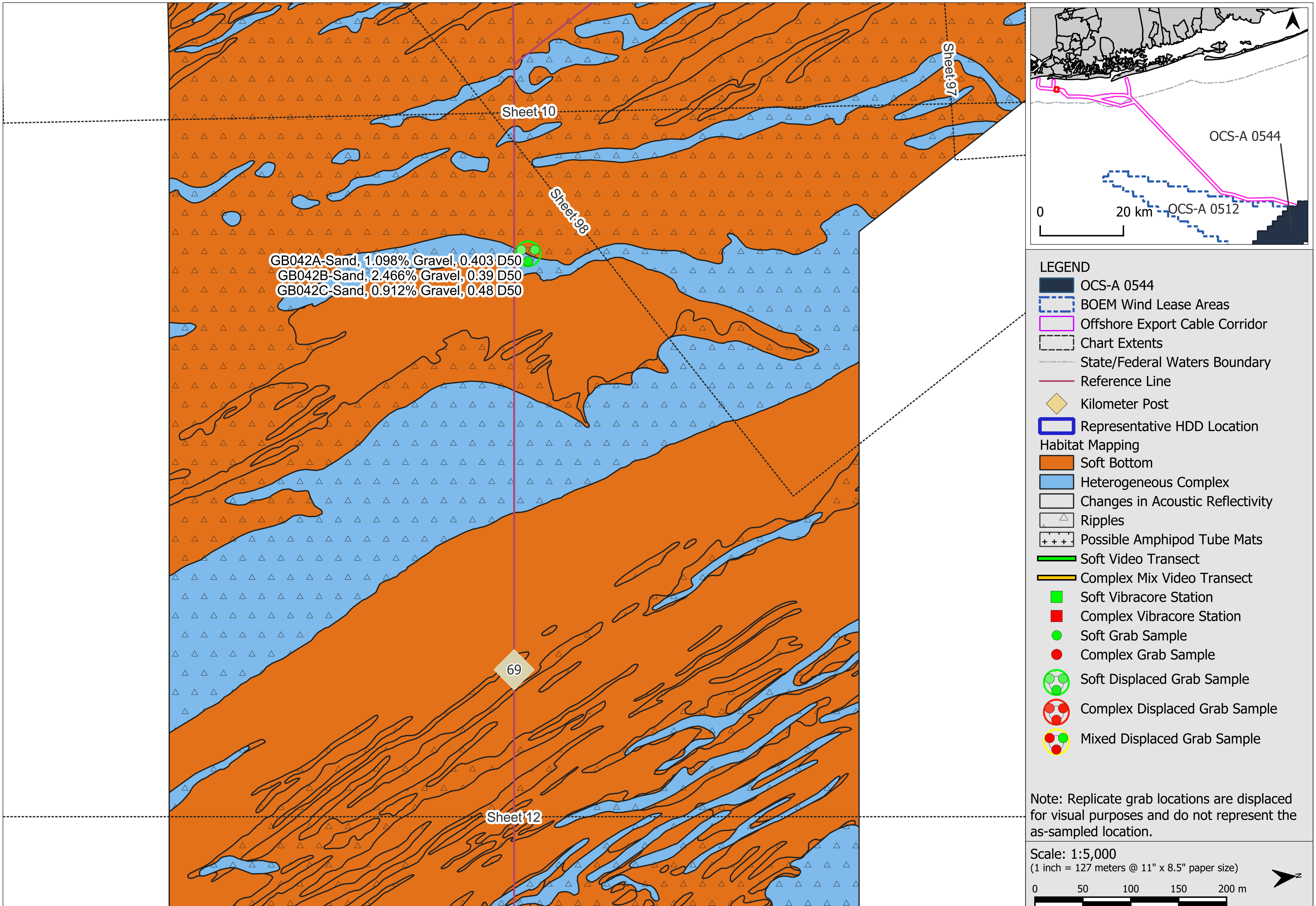

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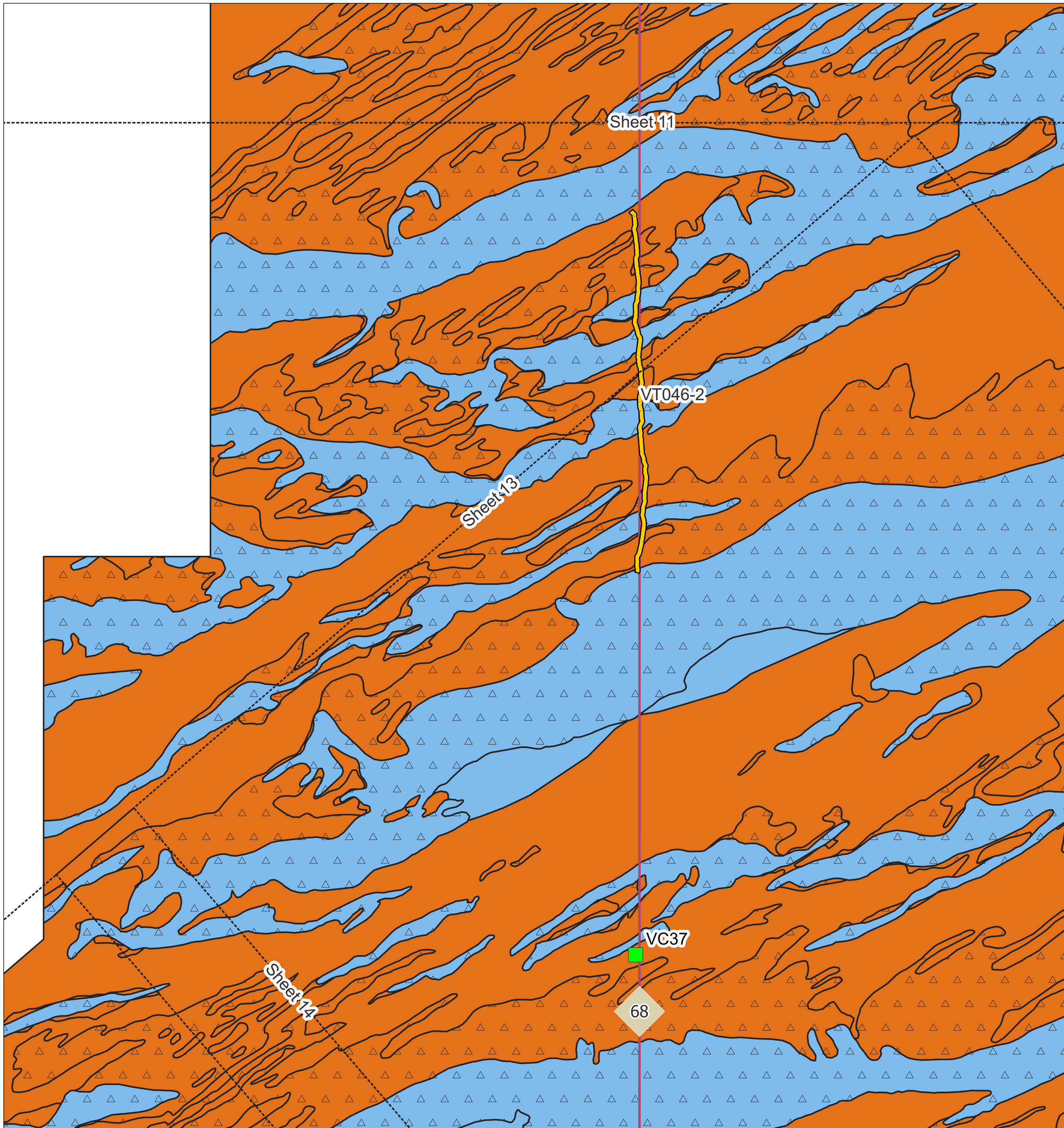

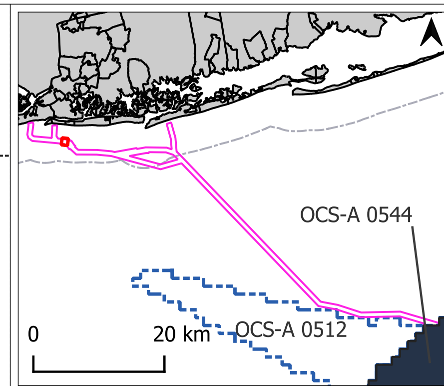

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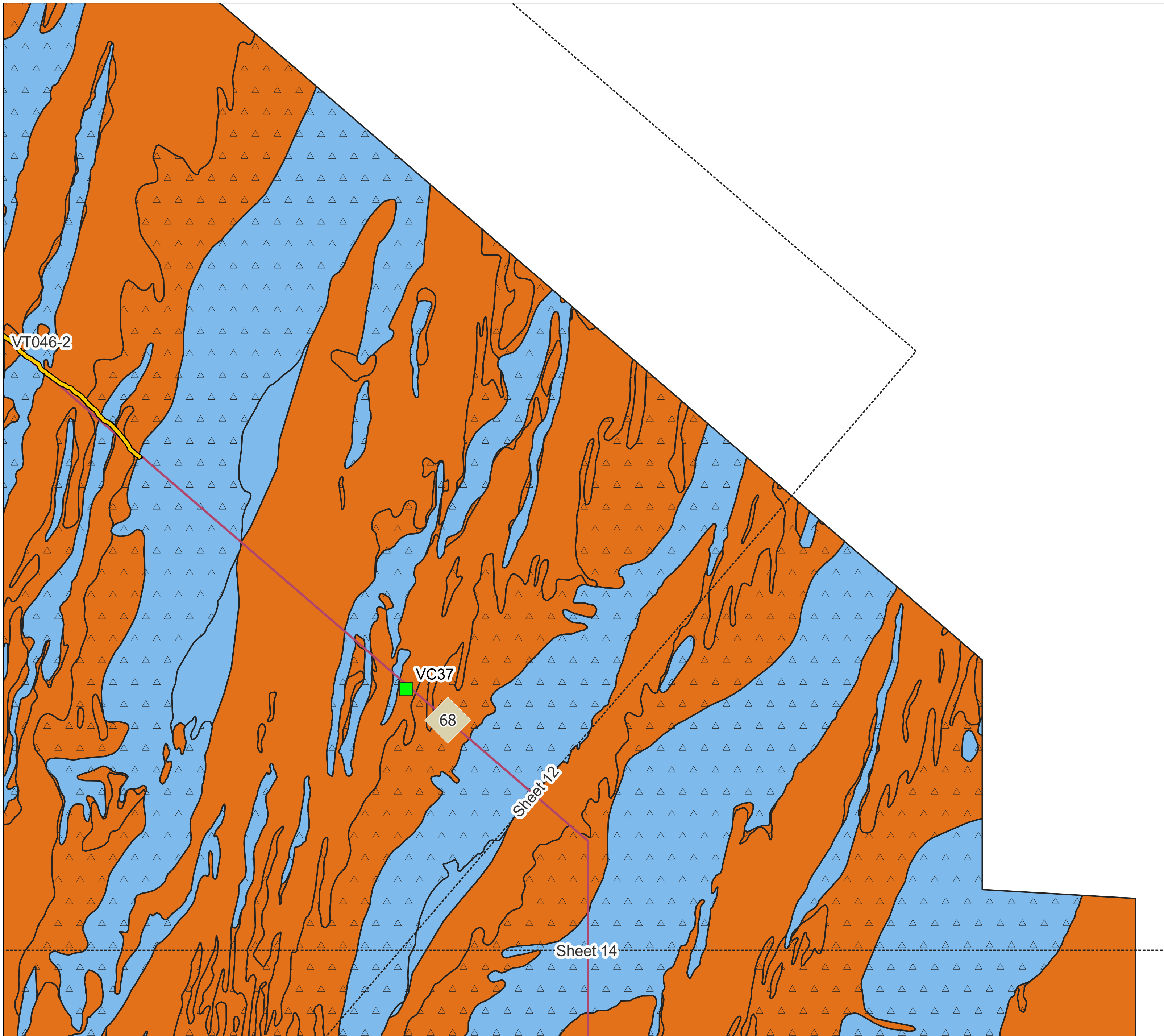

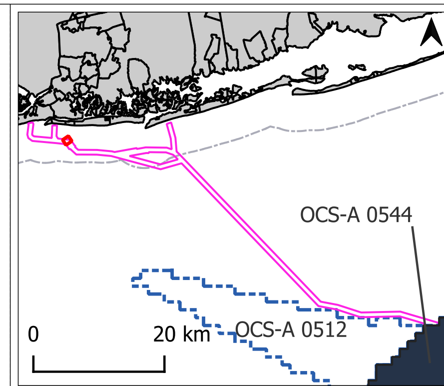

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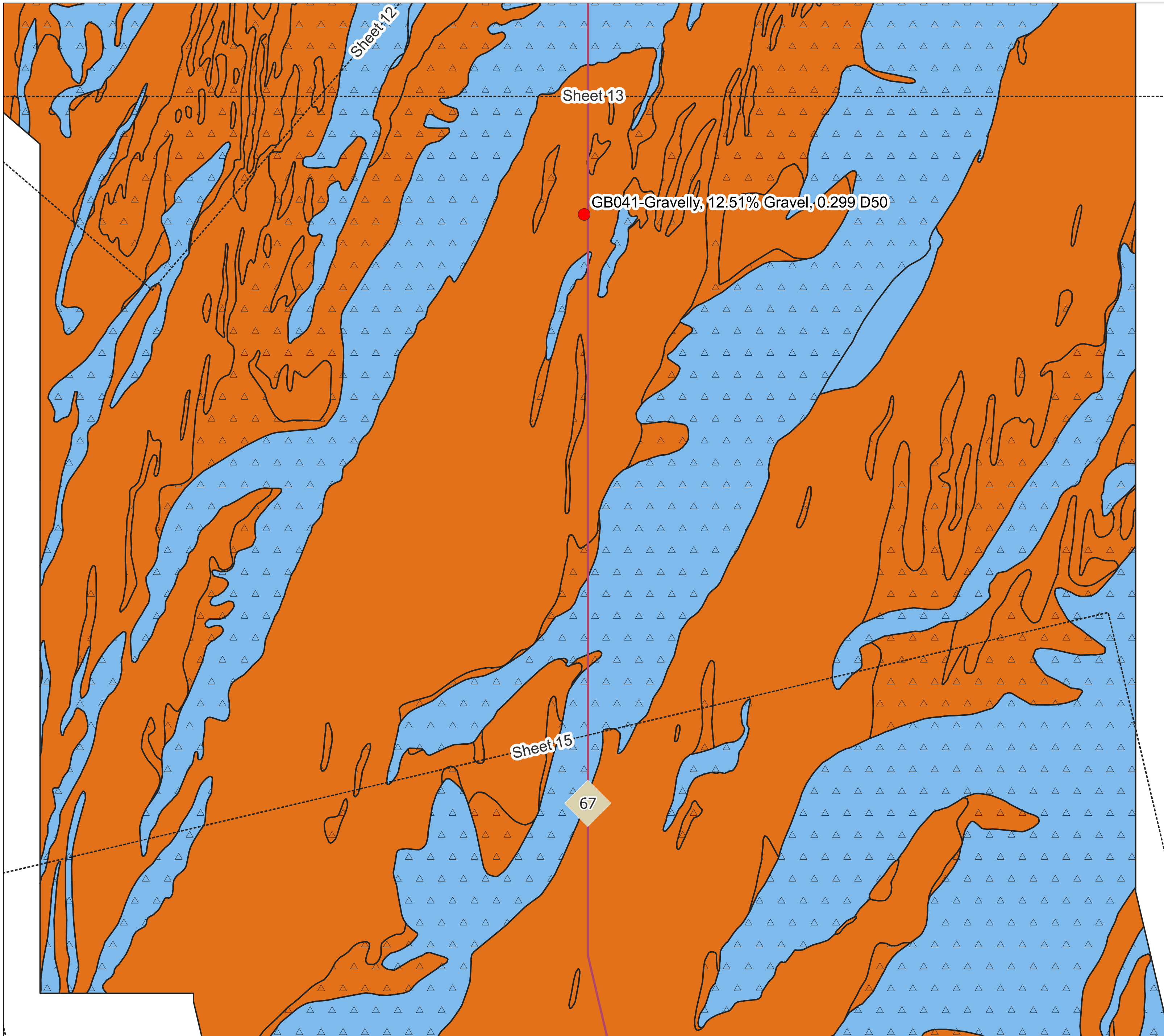

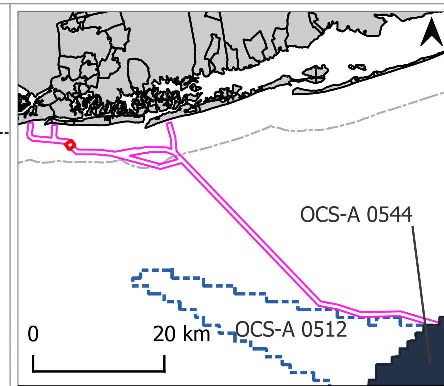

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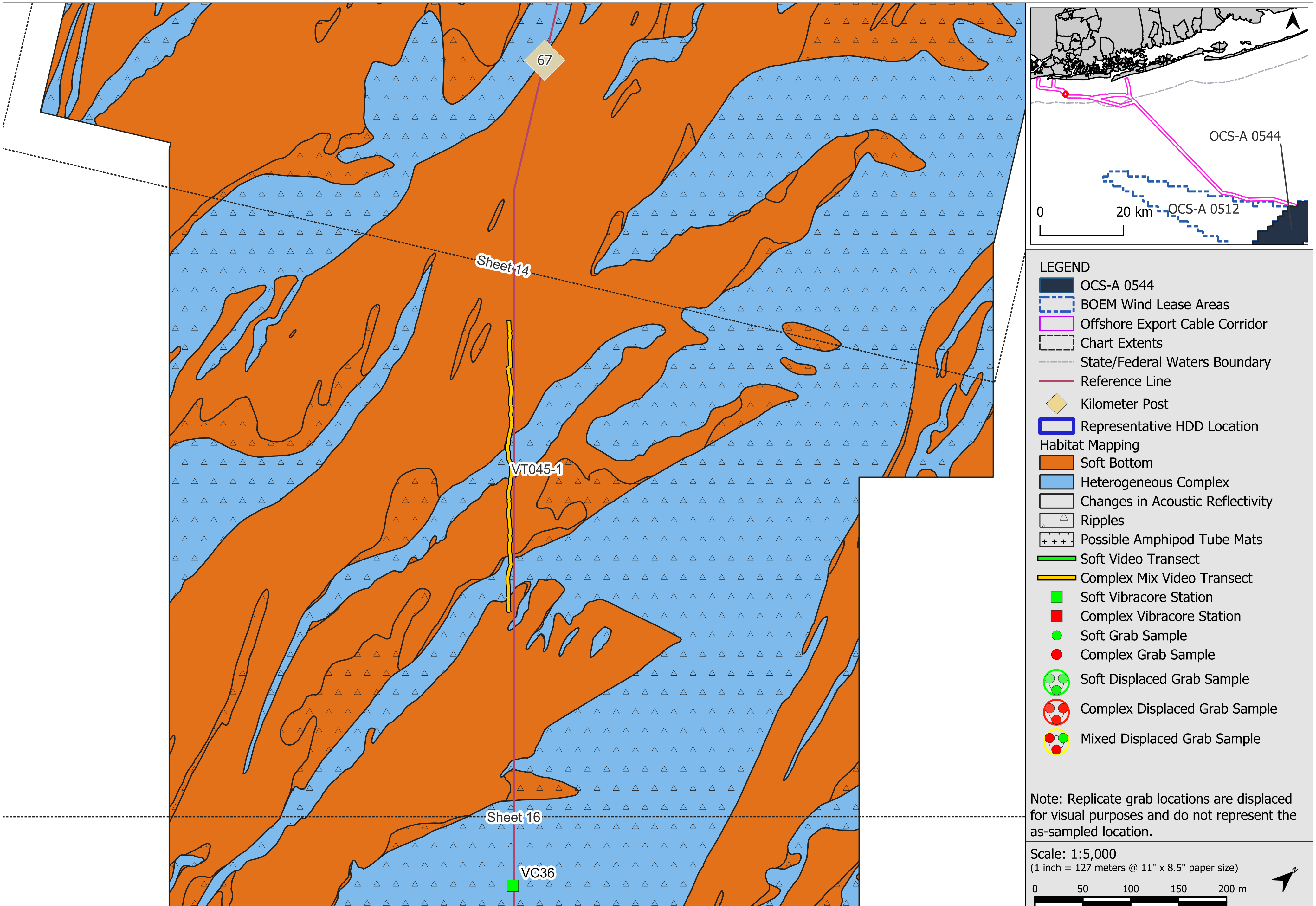

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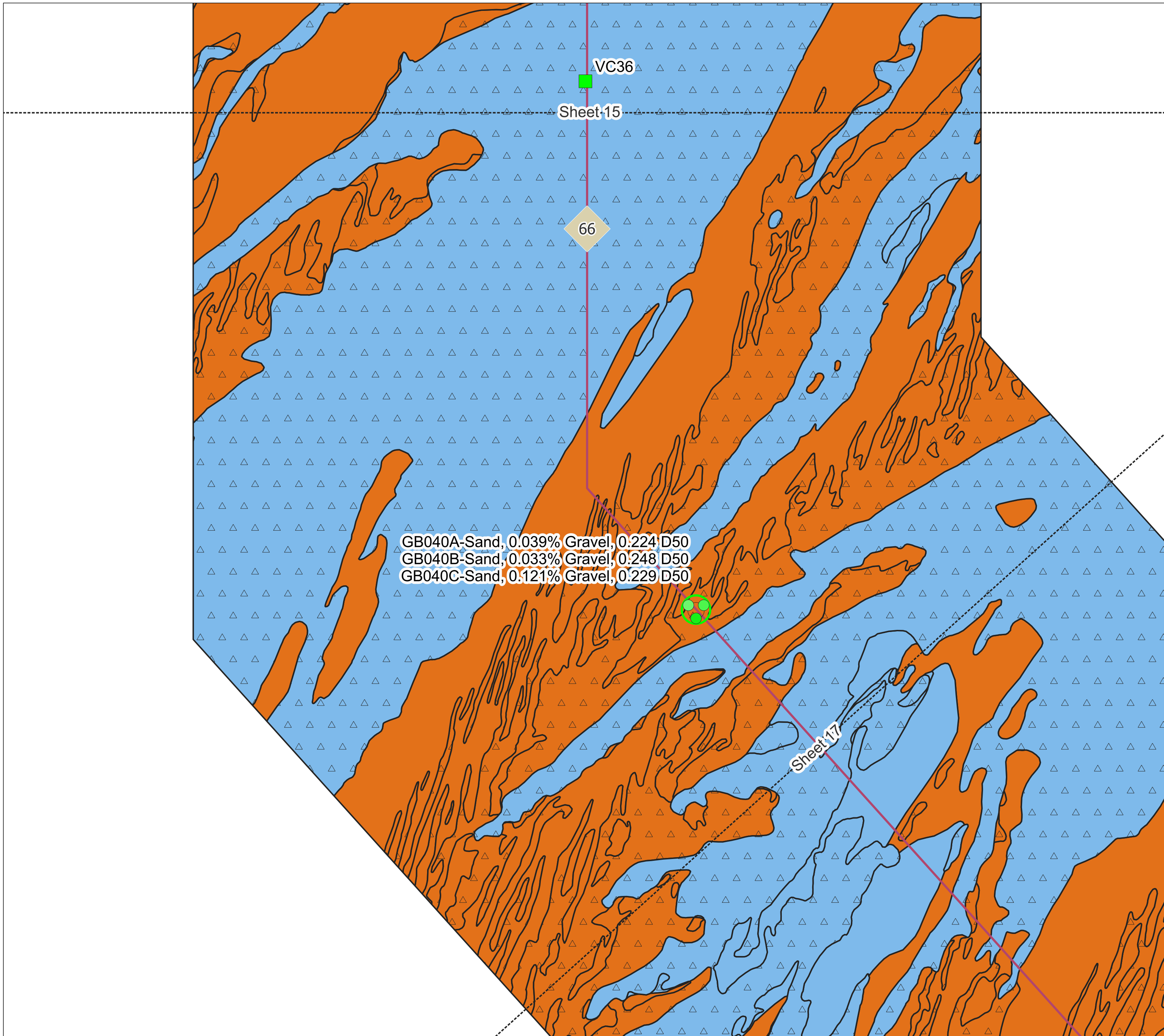

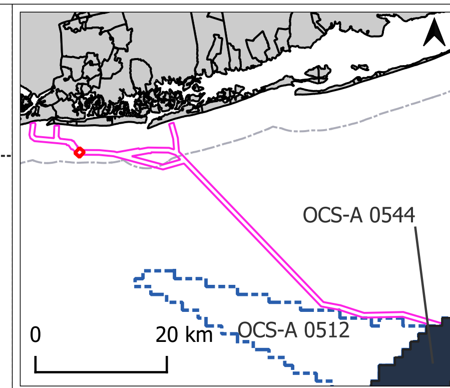

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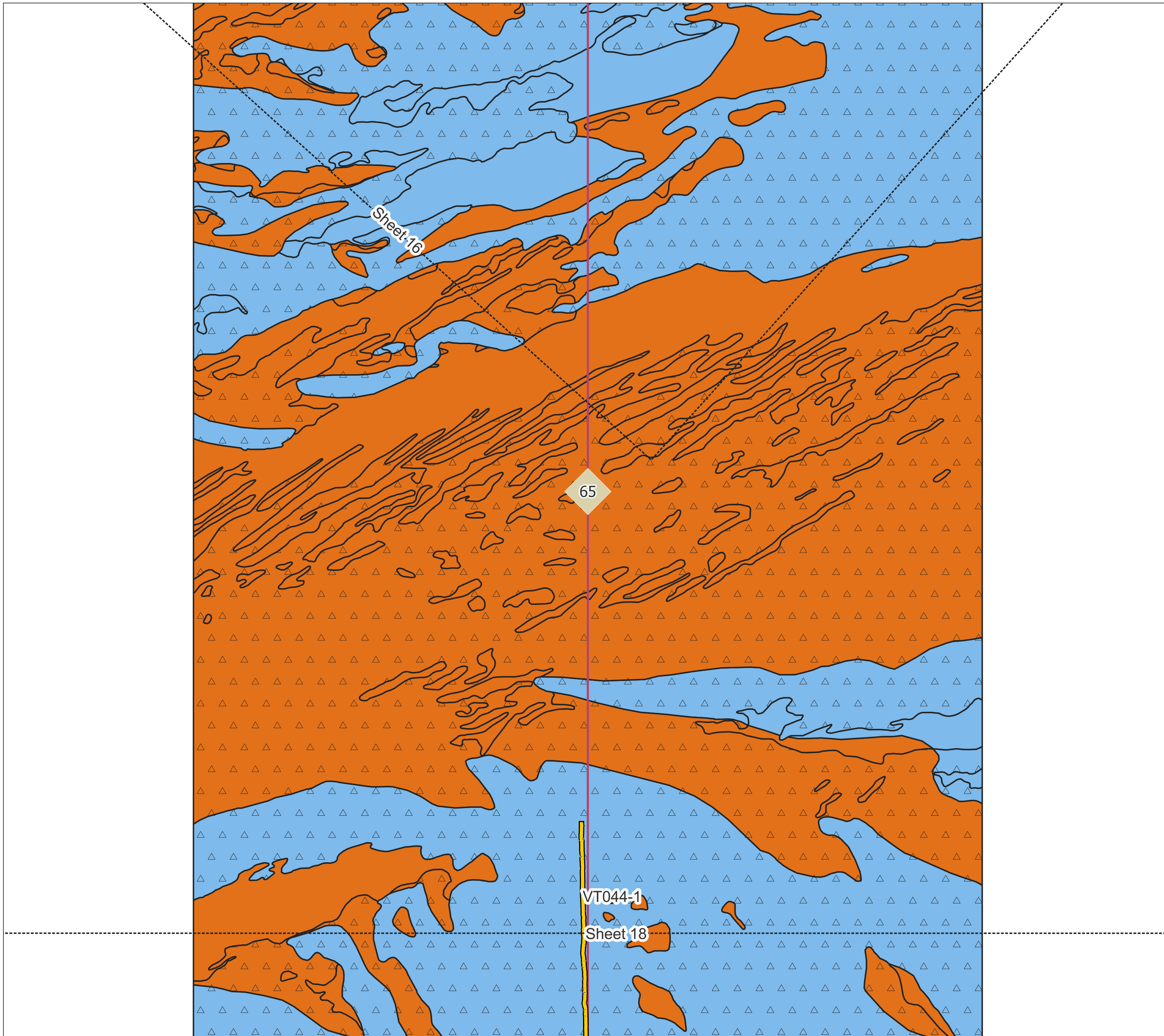

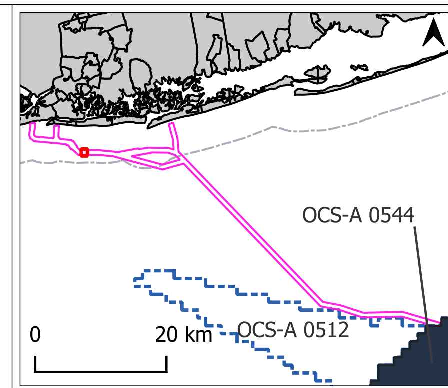

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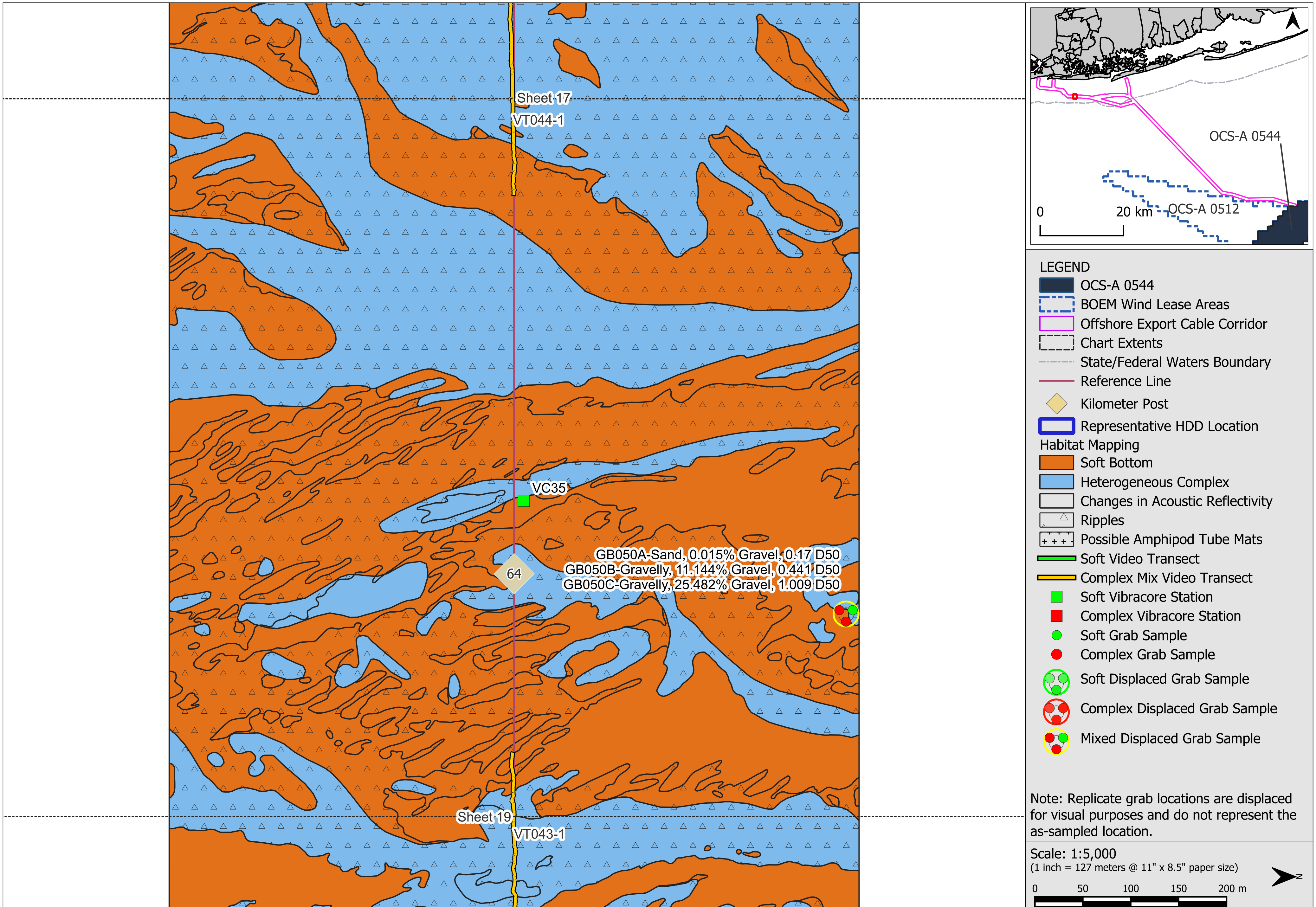

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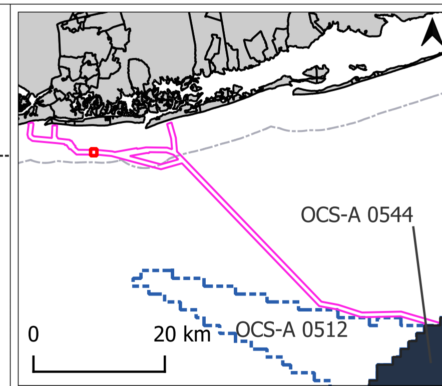

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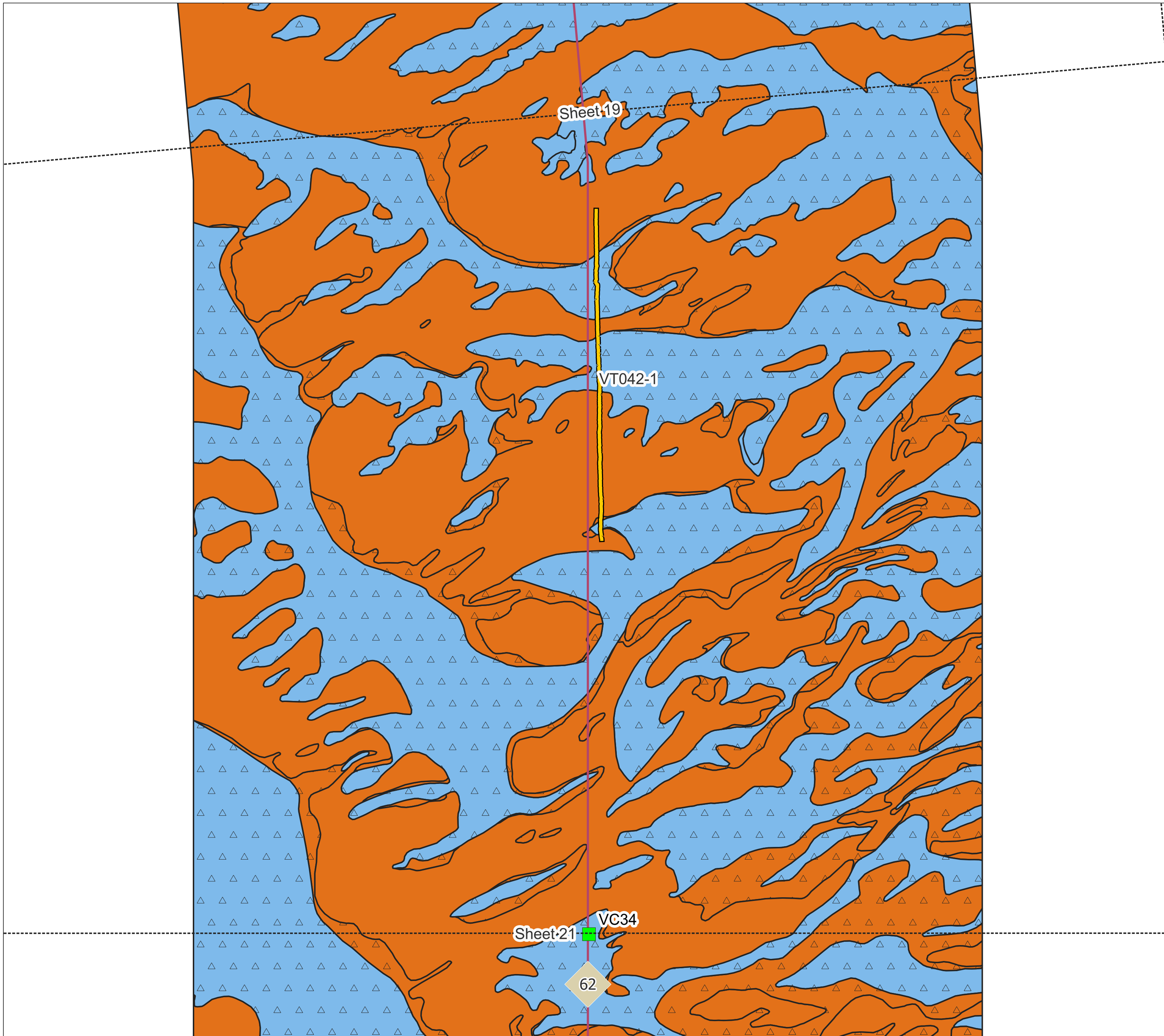

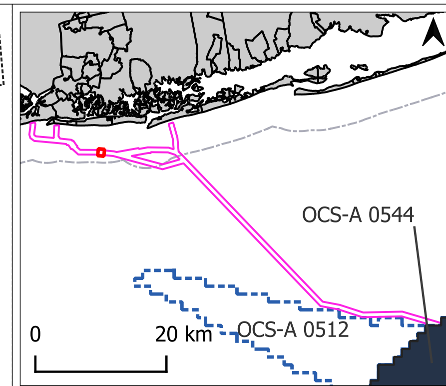

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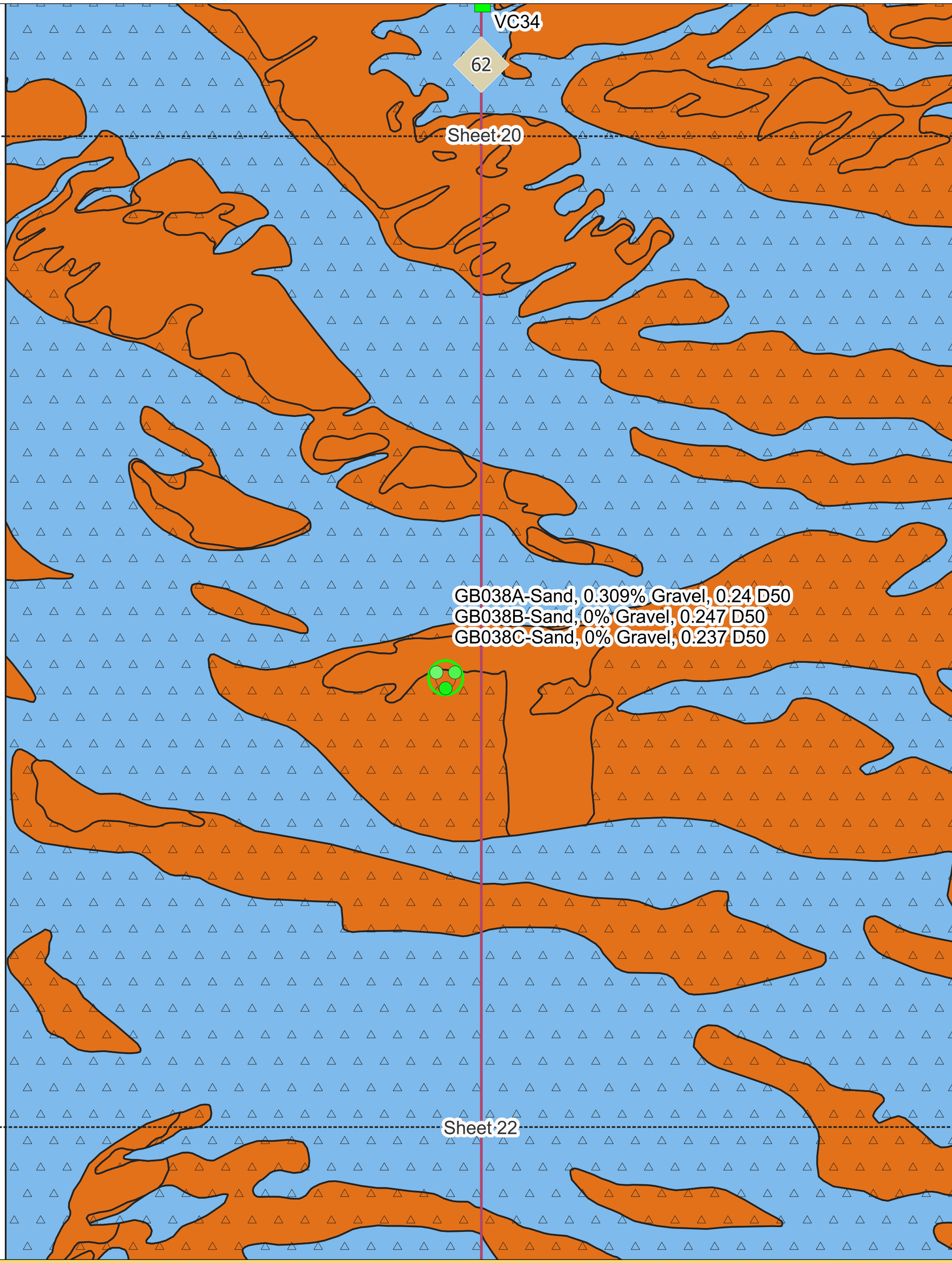

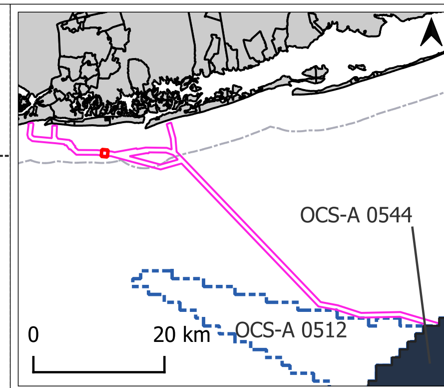

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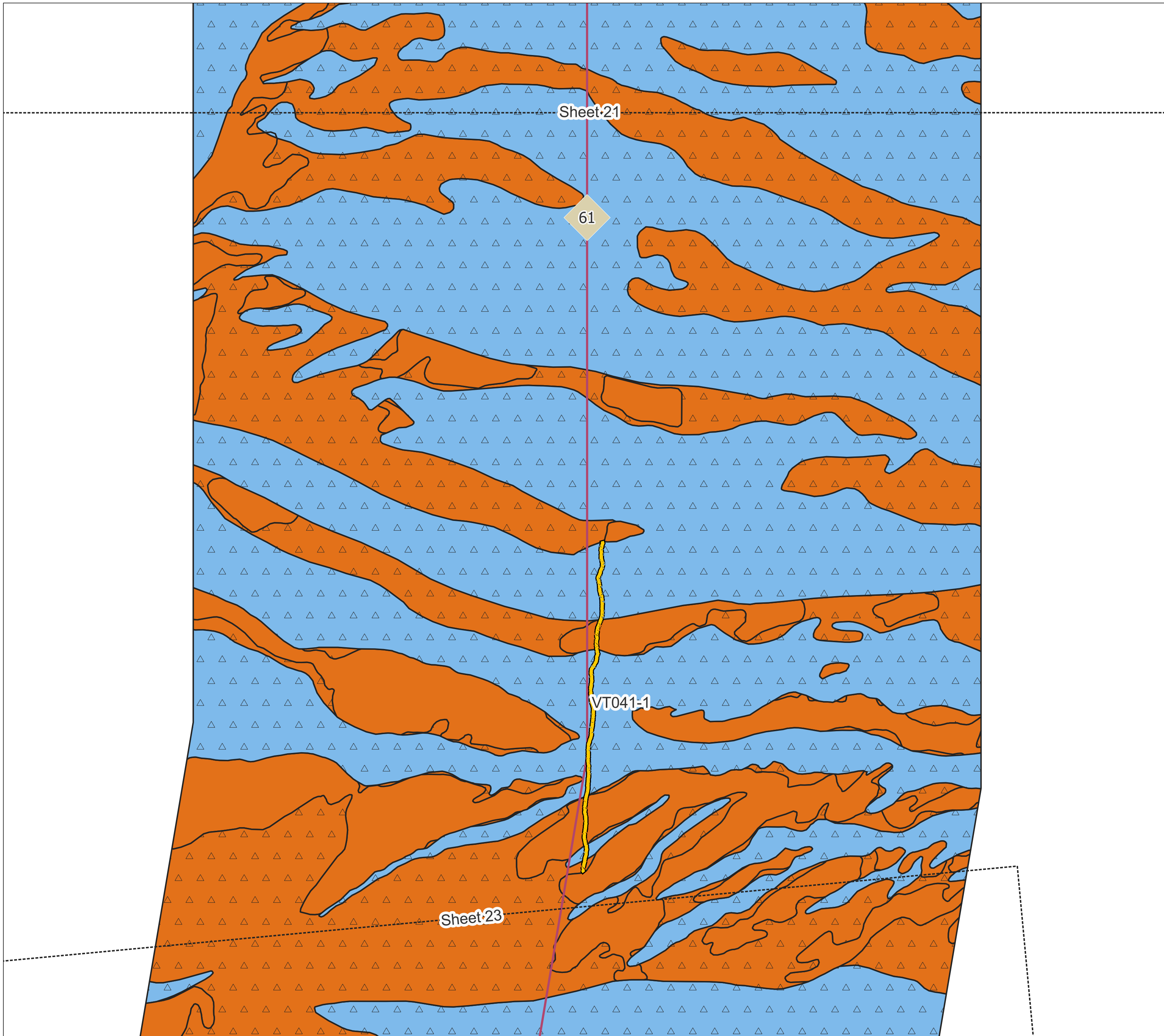
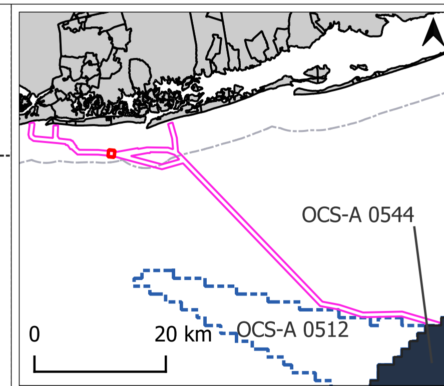
VINEYARD MID-ATLANTIC
VINEYARD OFFSHORE





LEGEND
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- BOEM Wind Lease Areas
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- Kilometer Post
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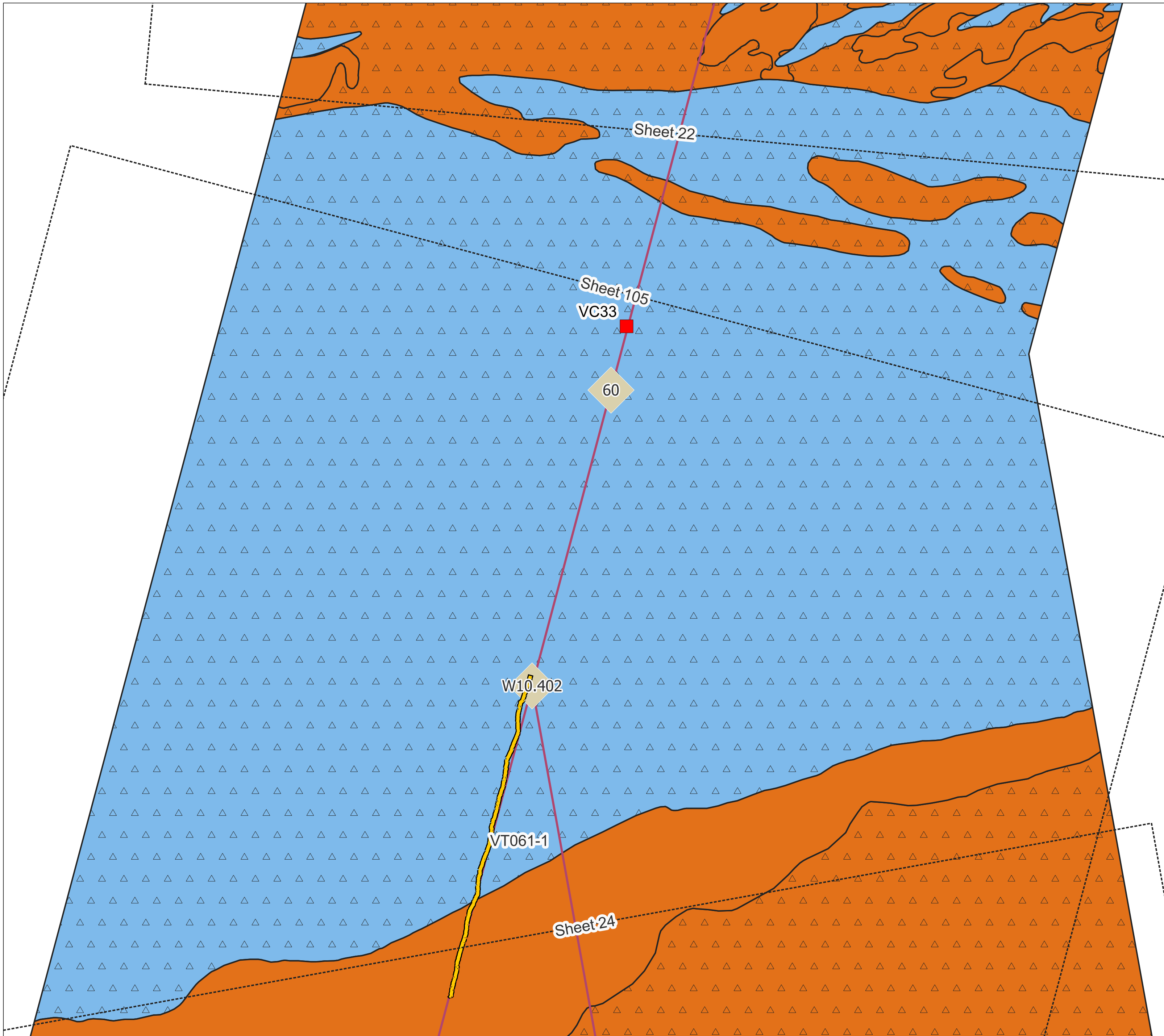

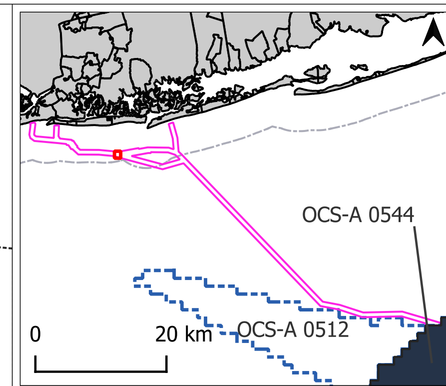

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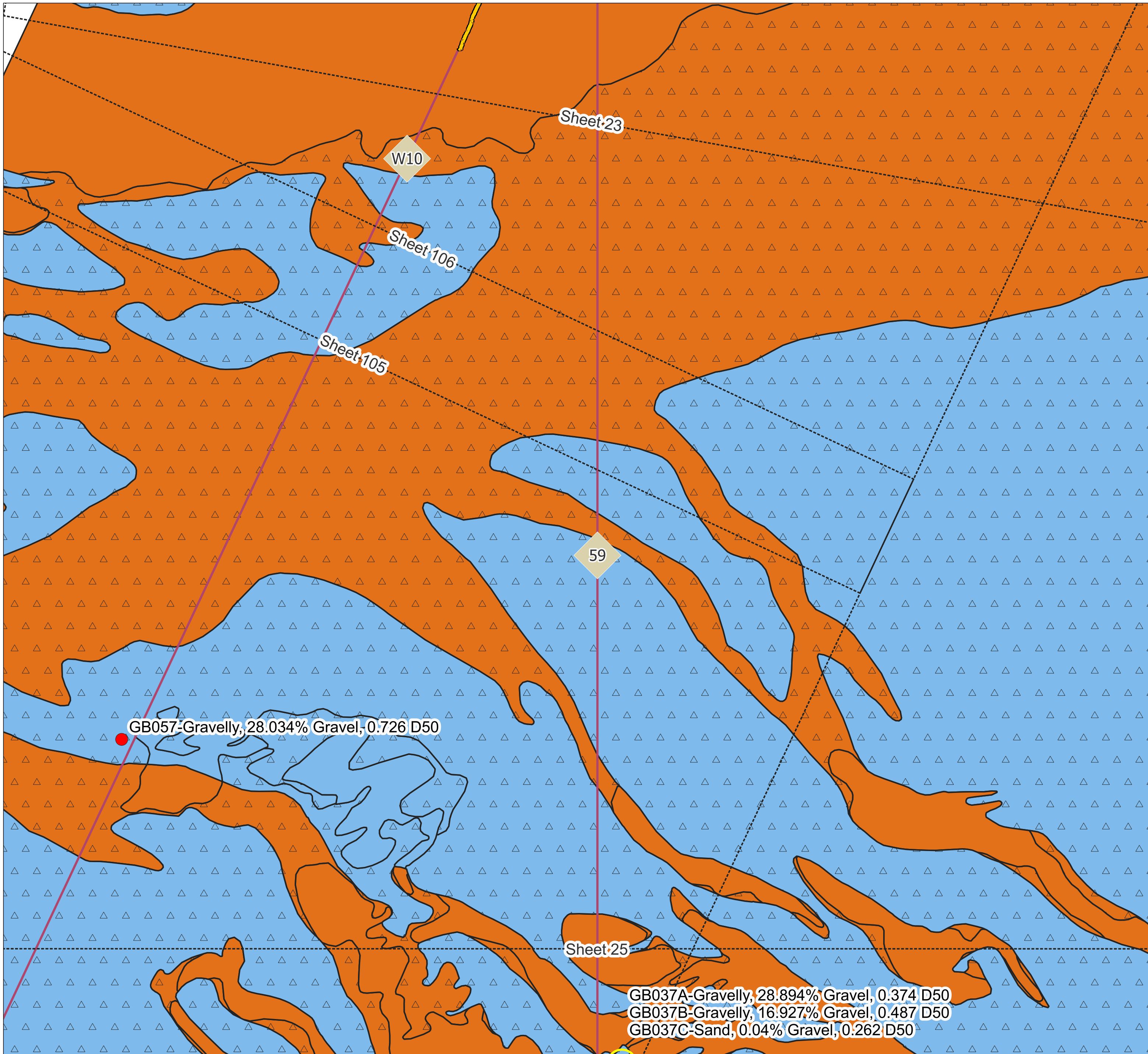

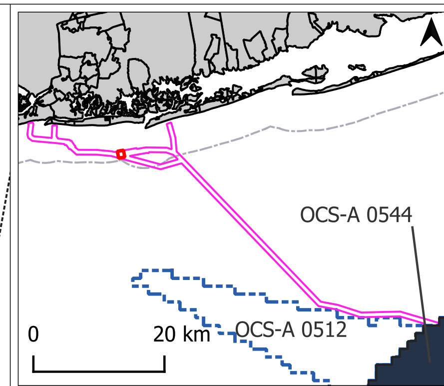

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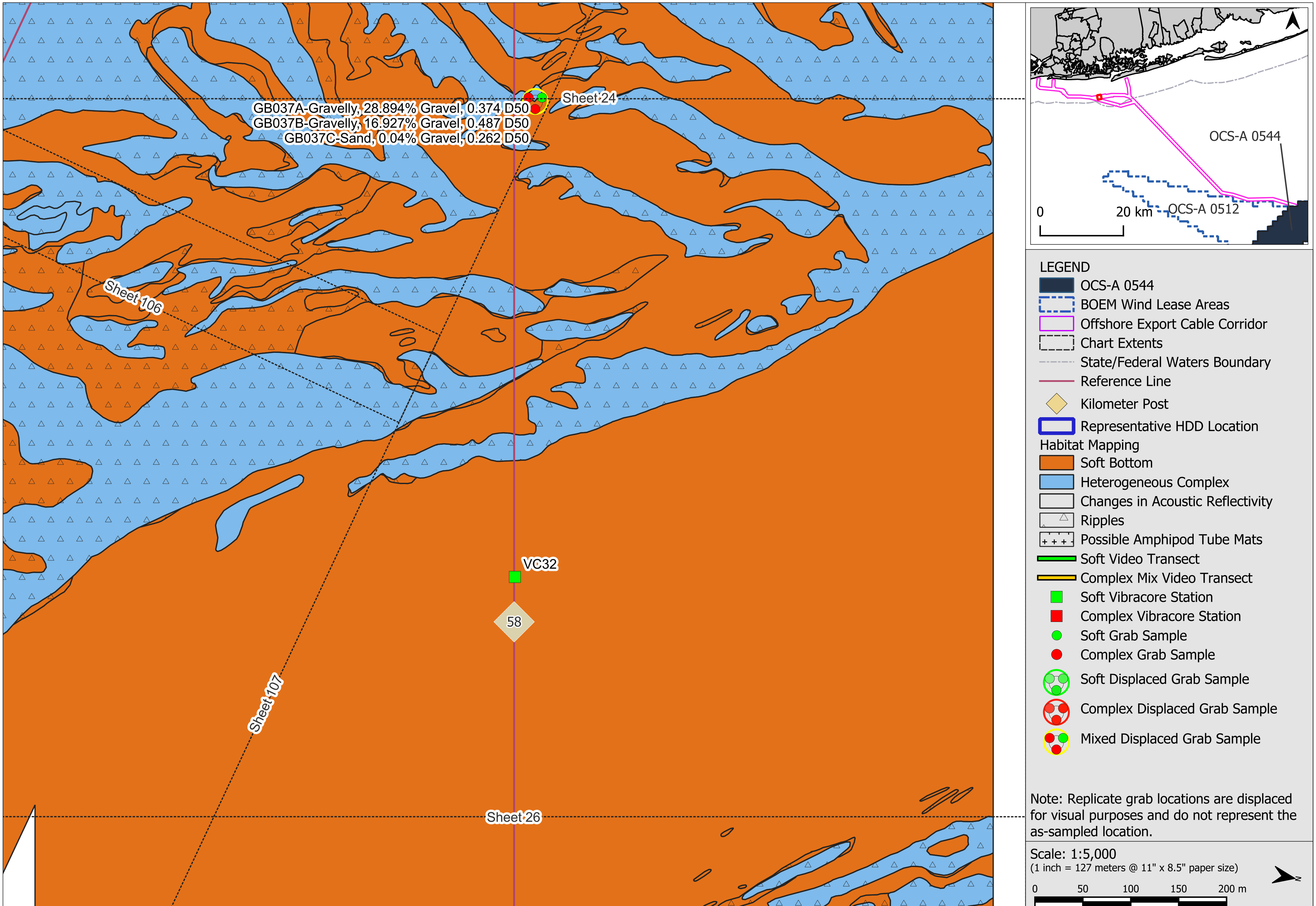

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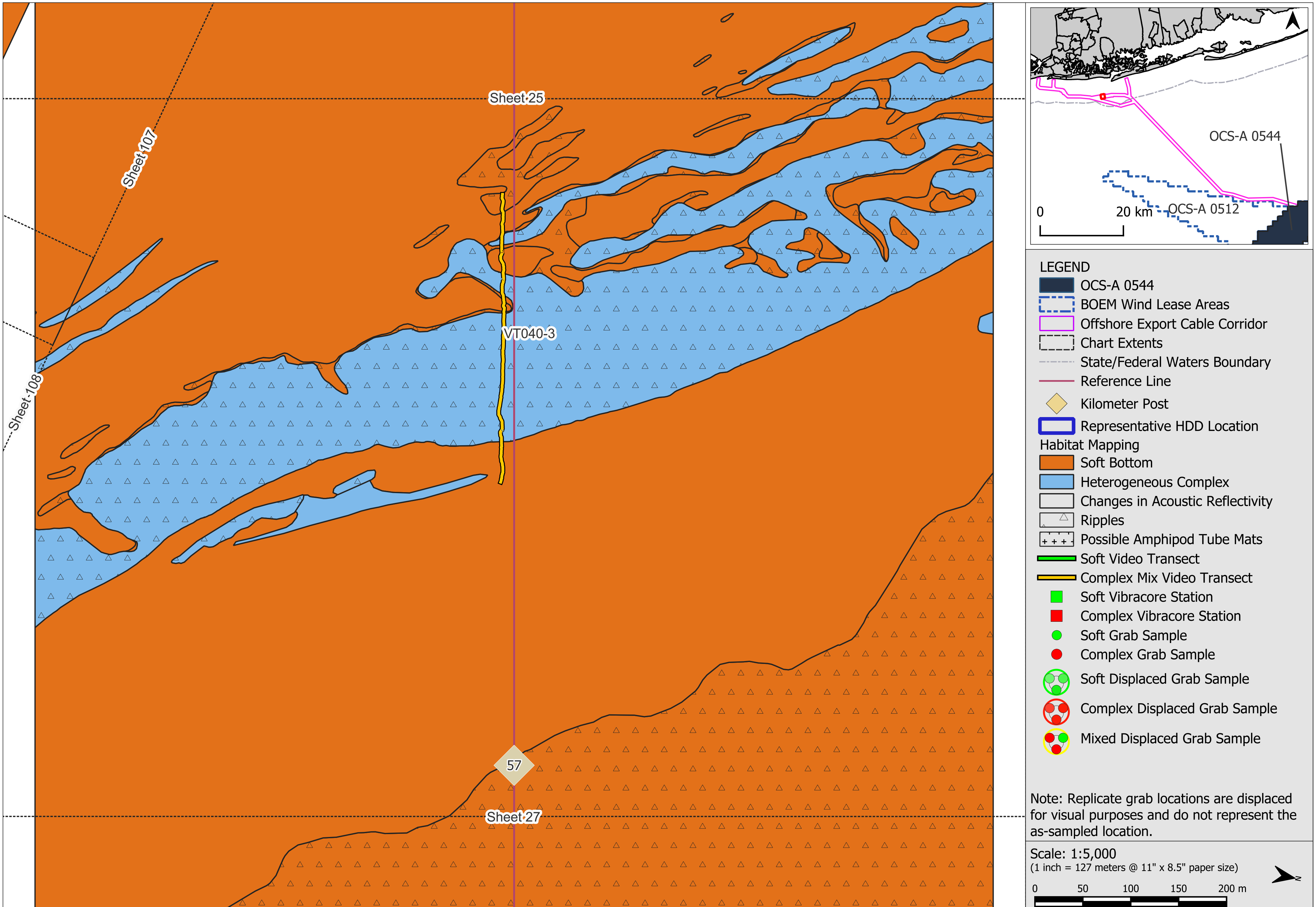

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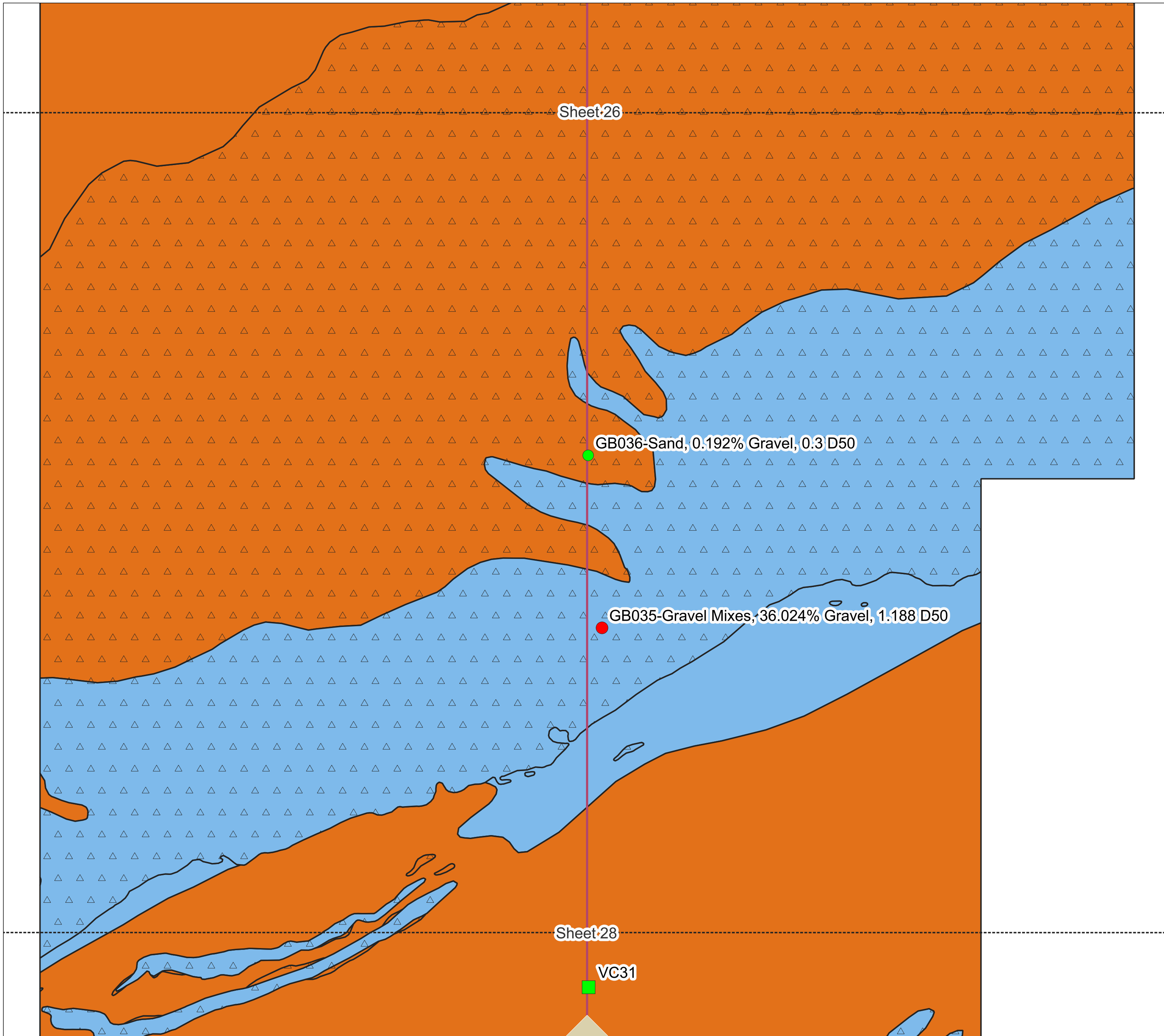

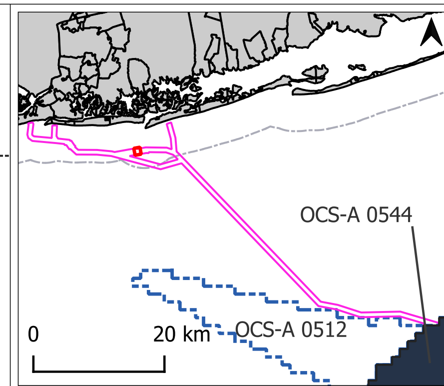

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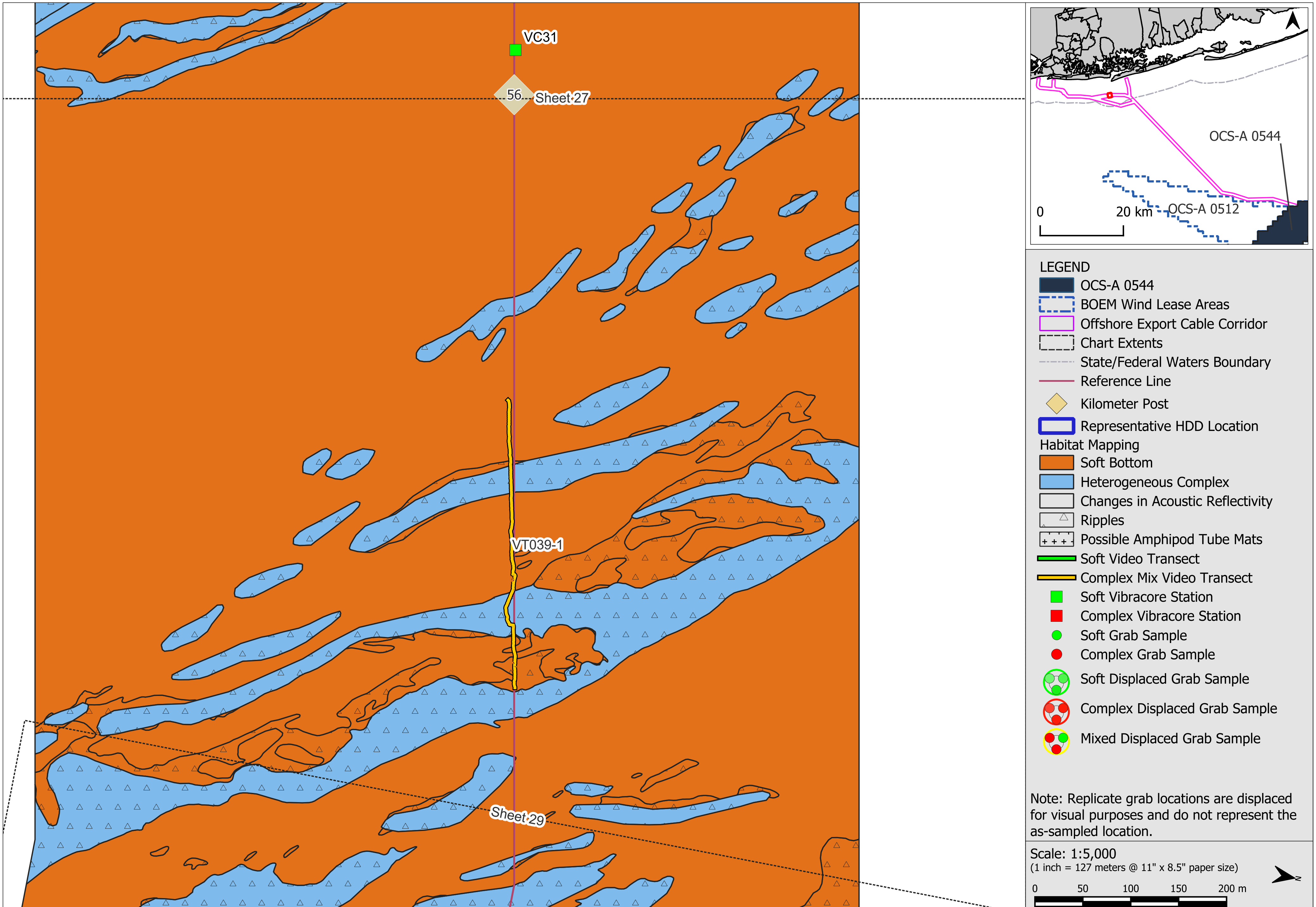

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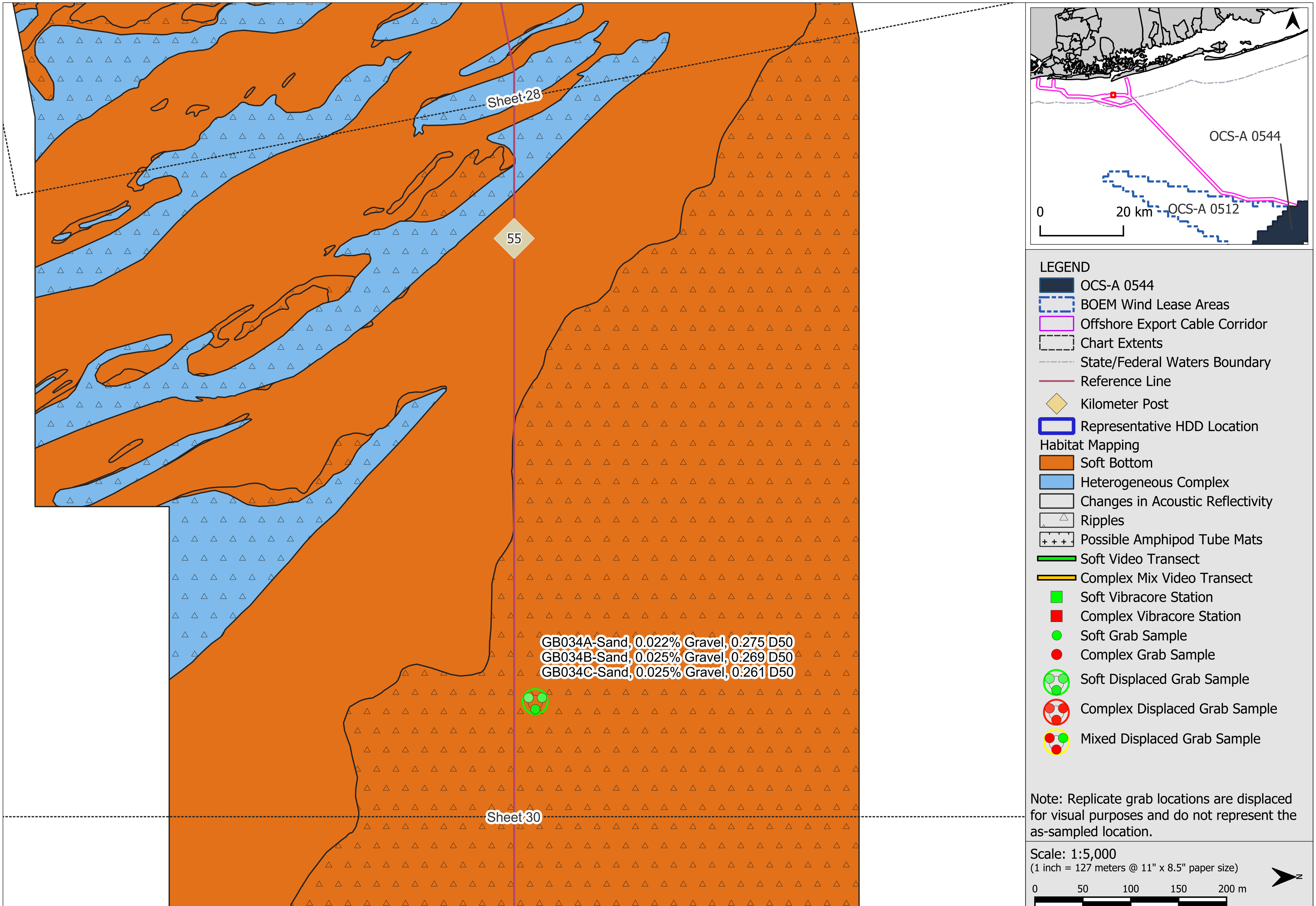

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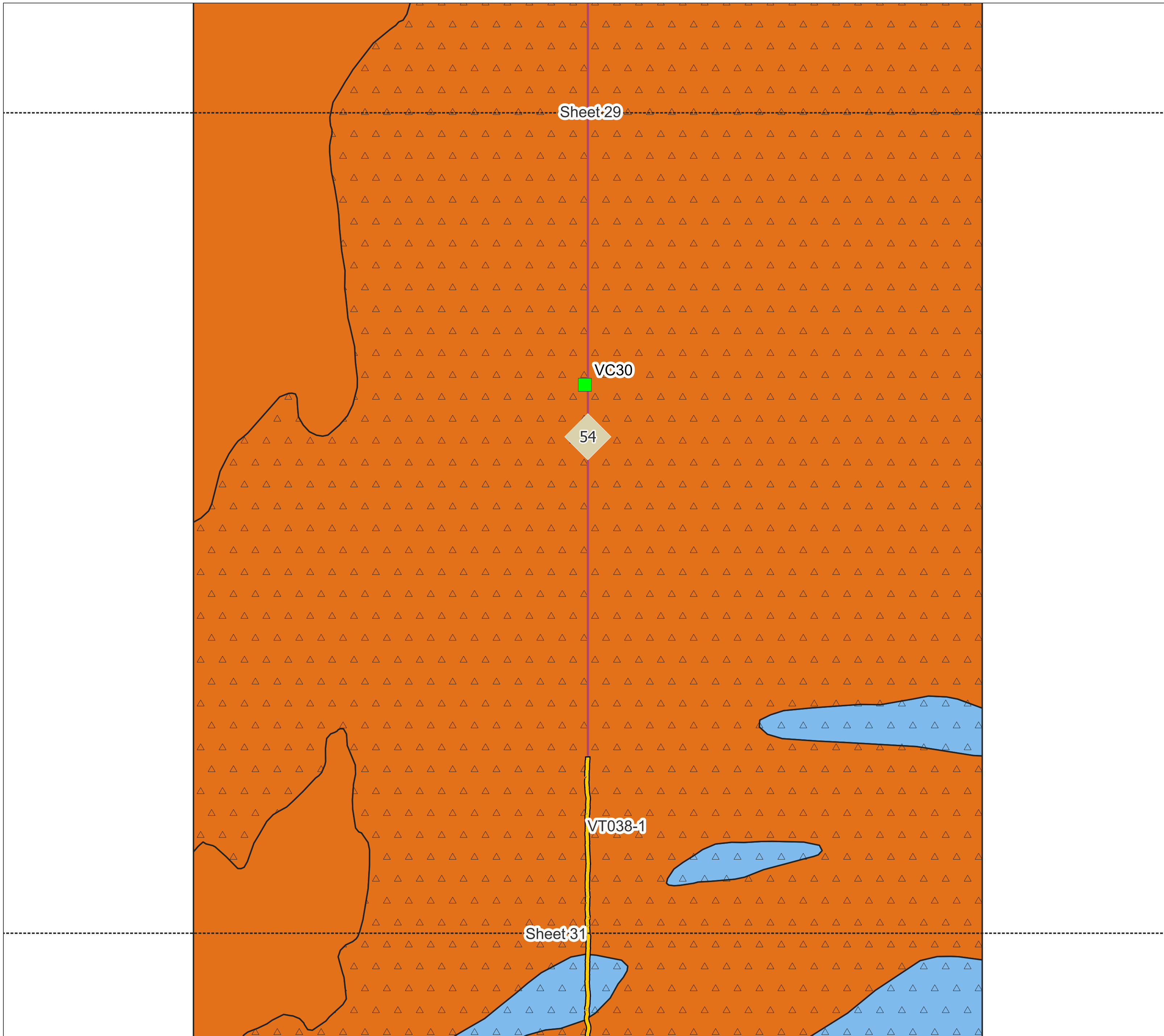

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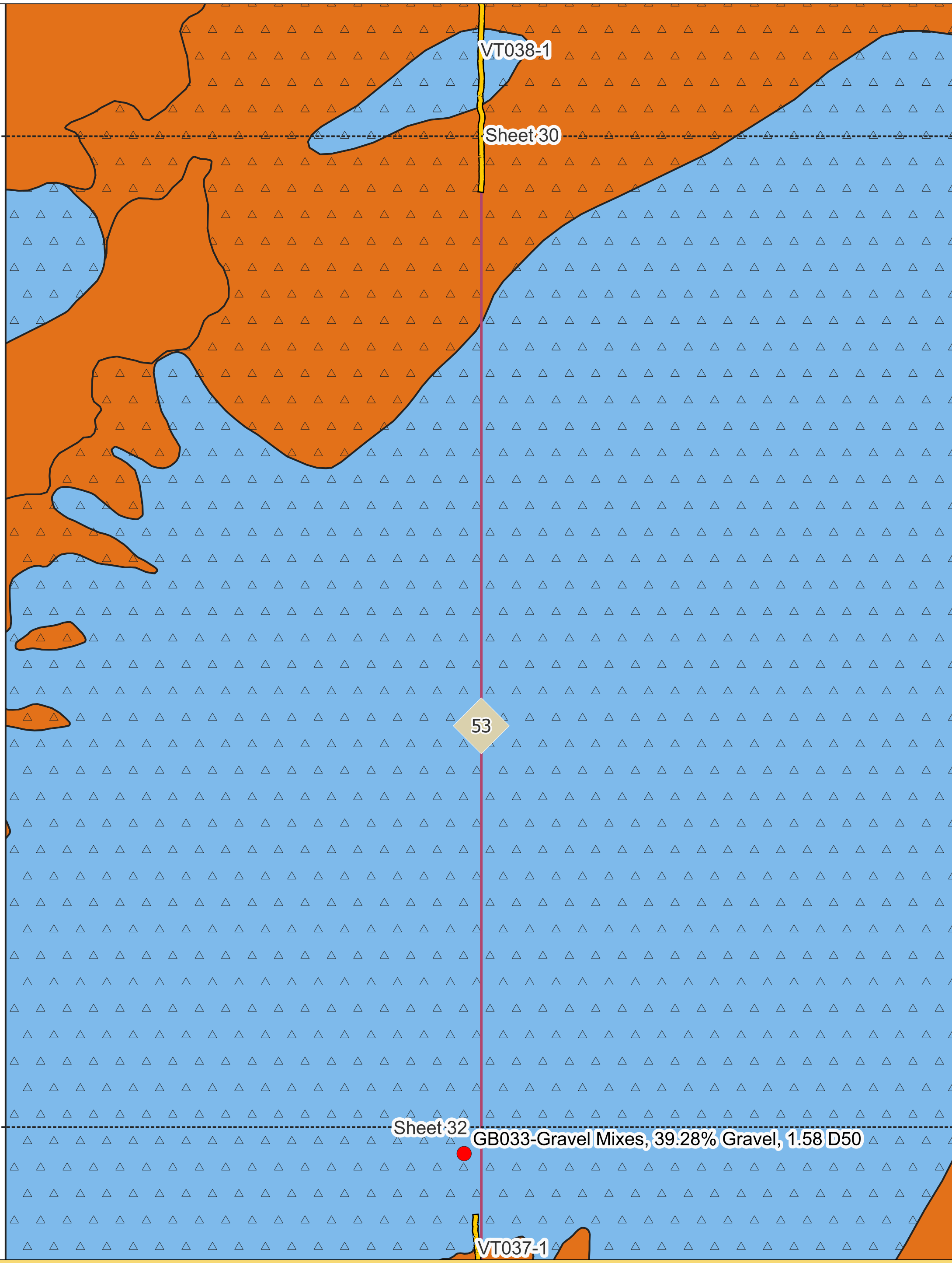

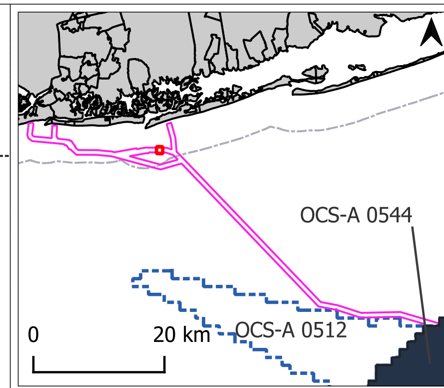

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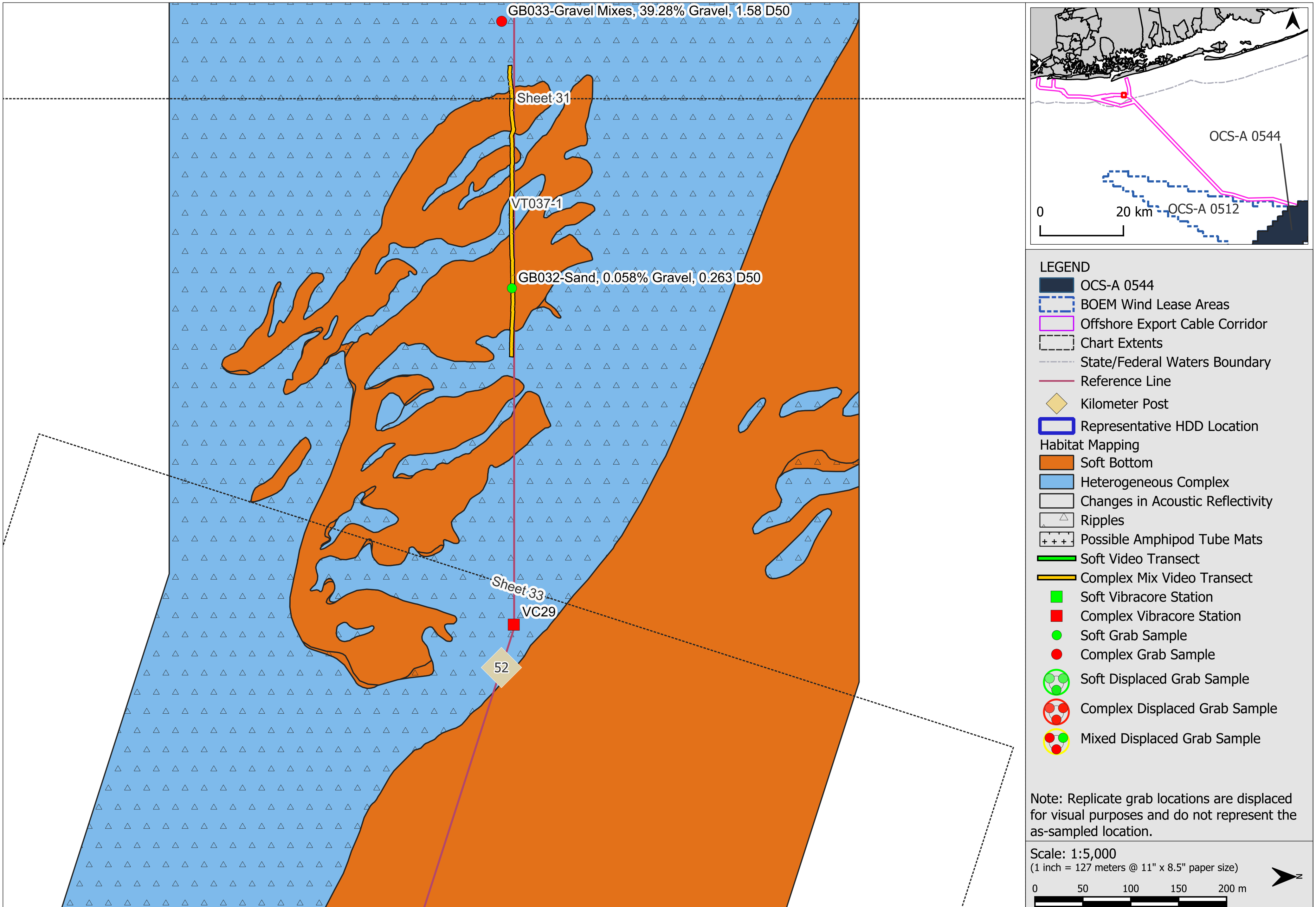

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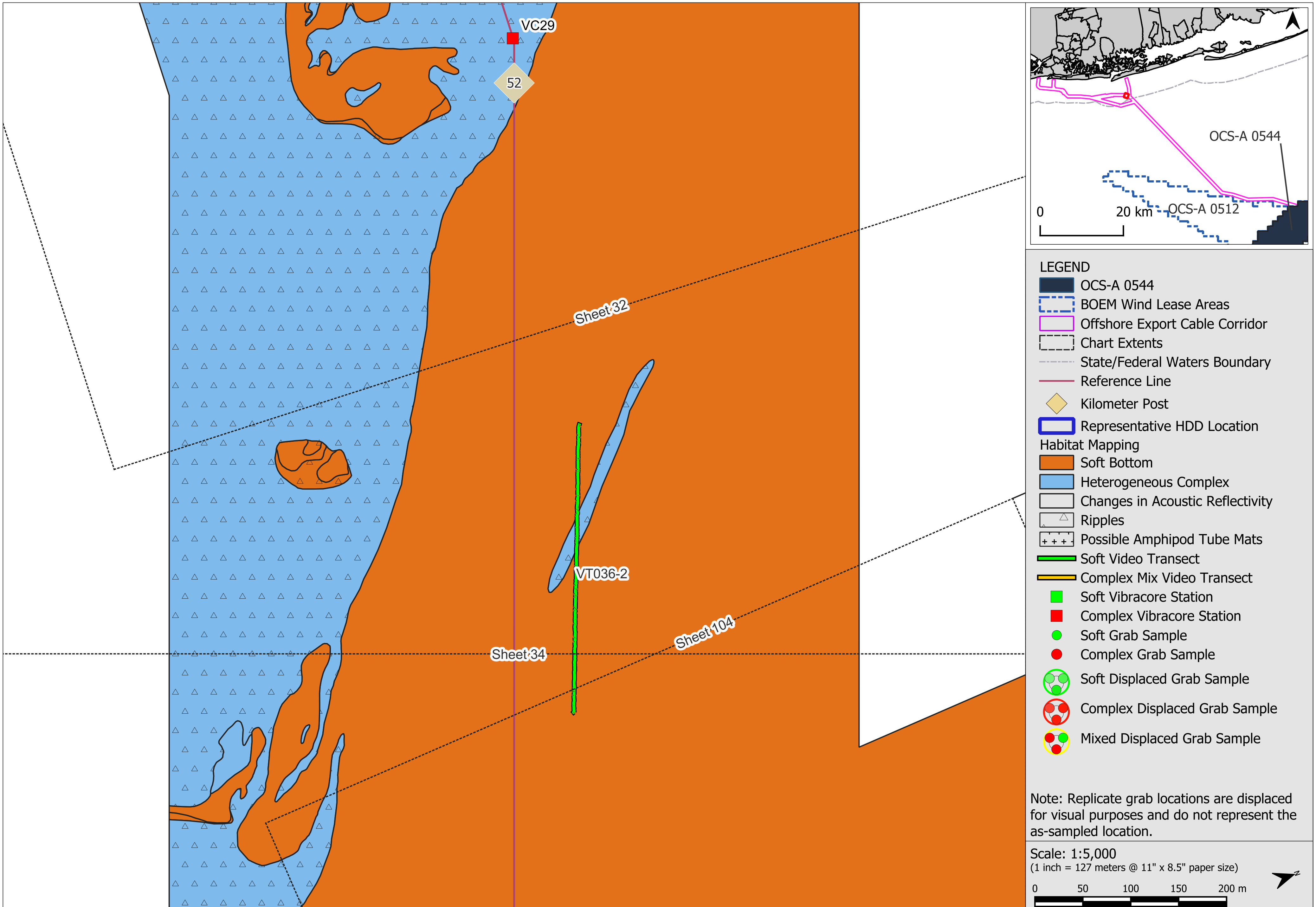

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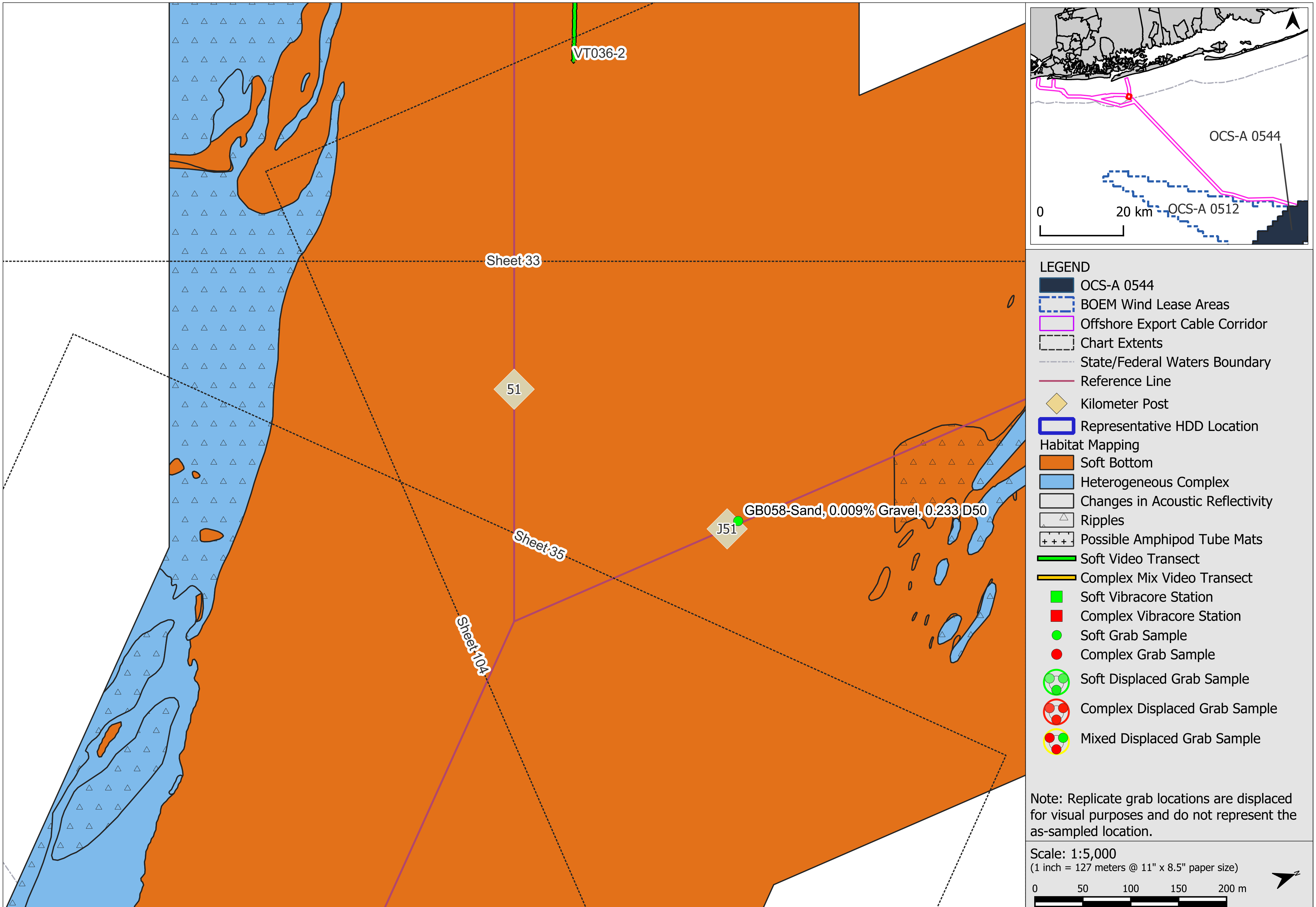

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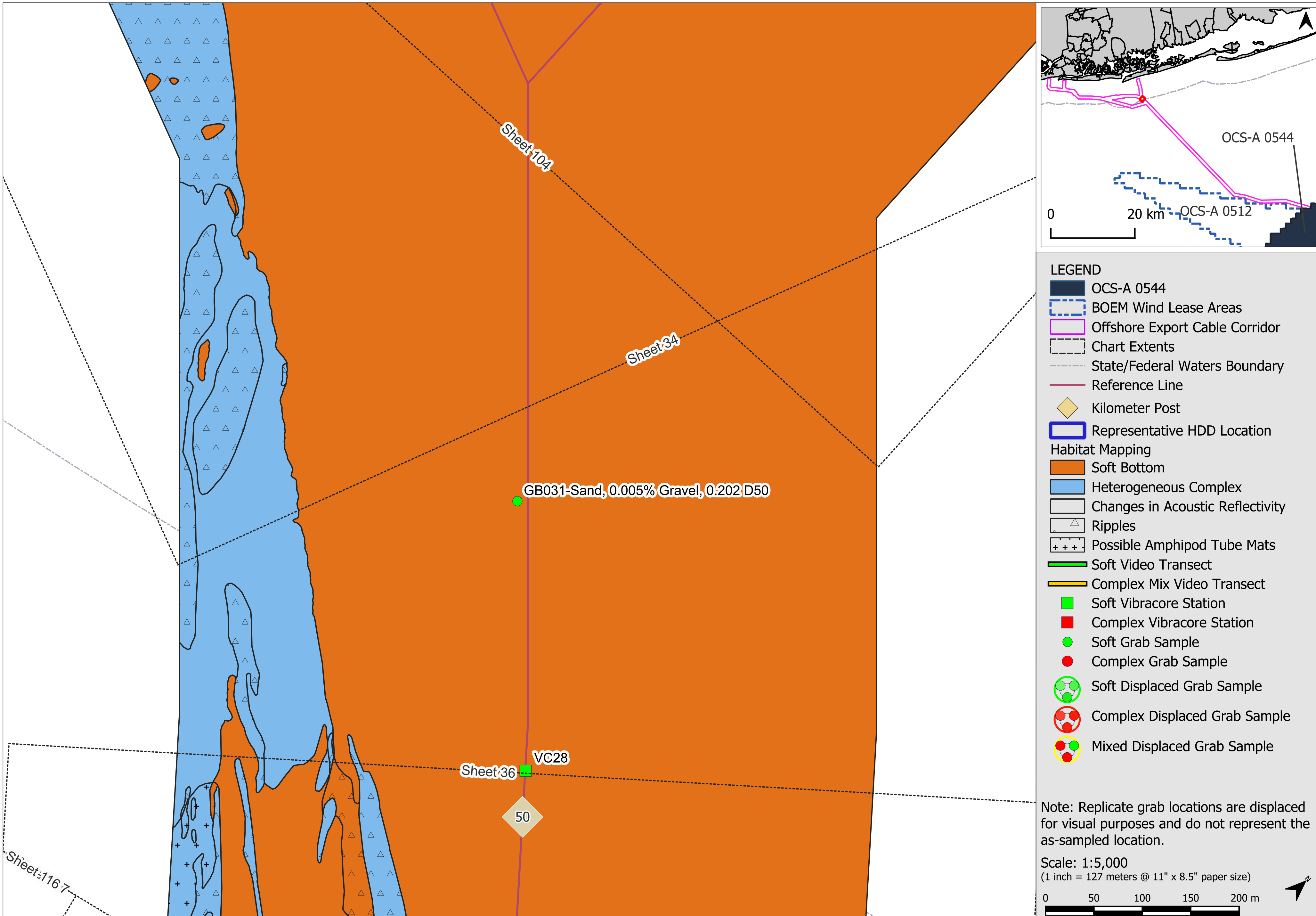

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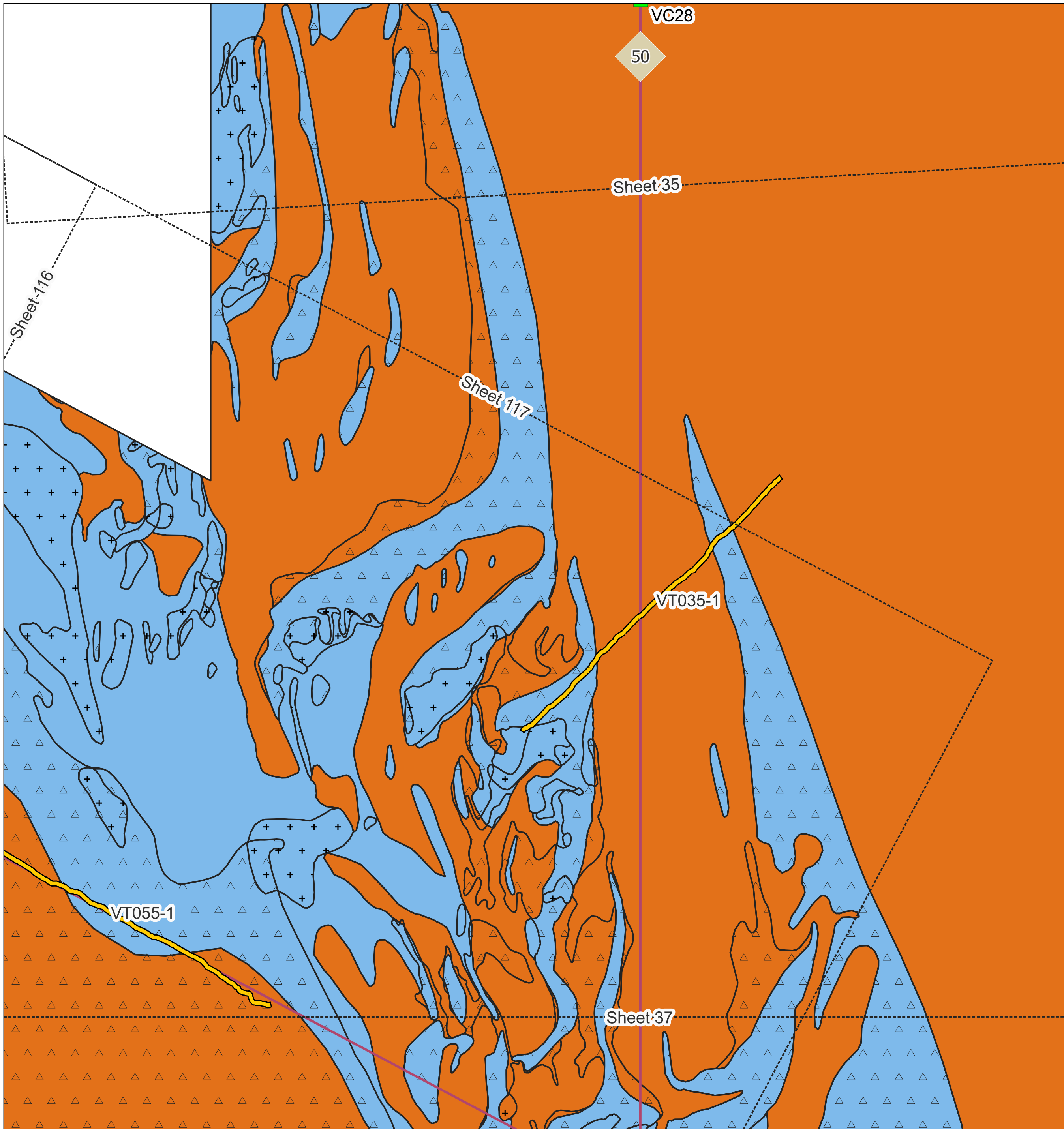

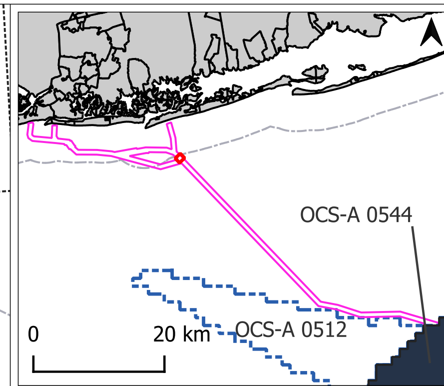

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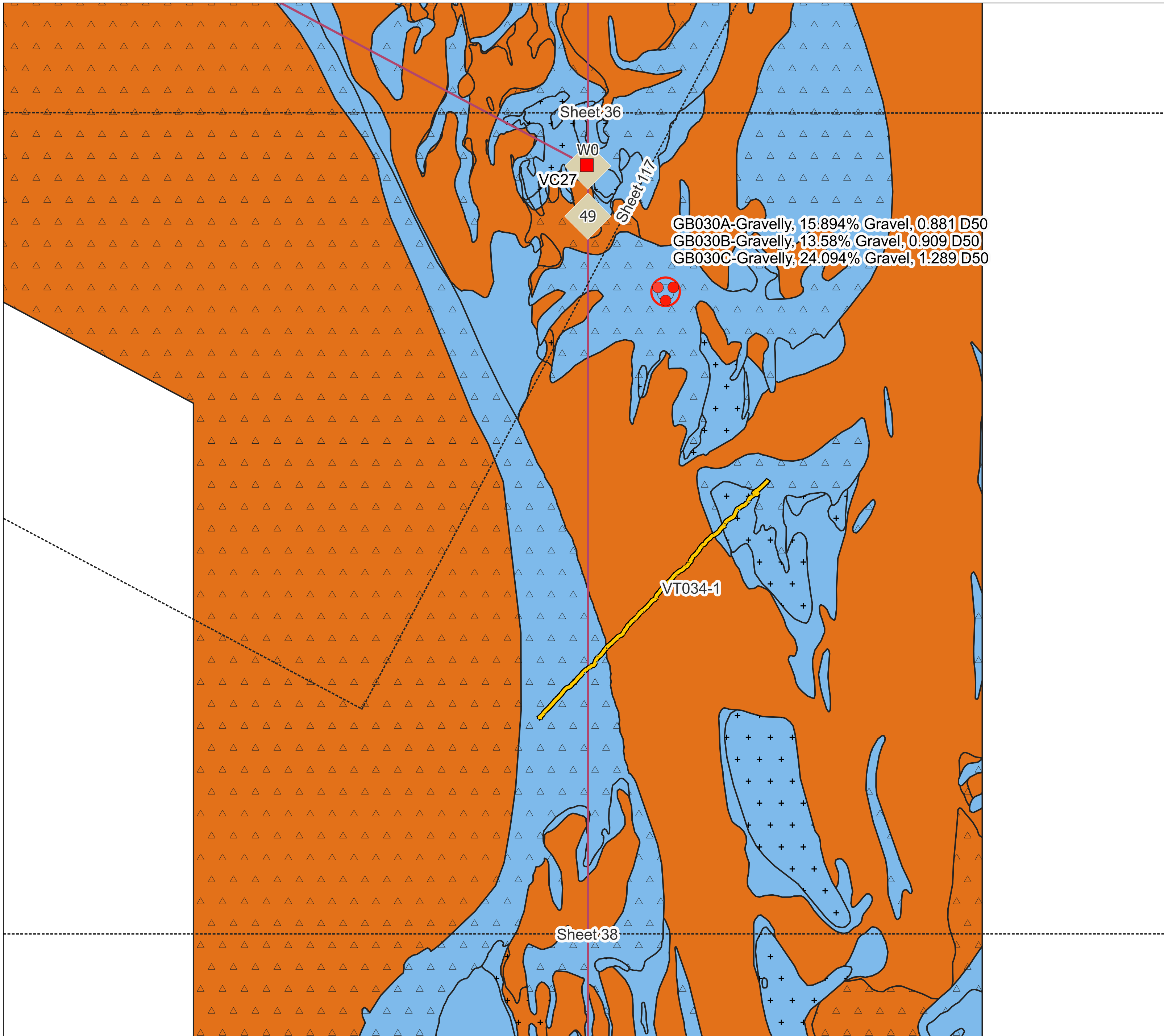

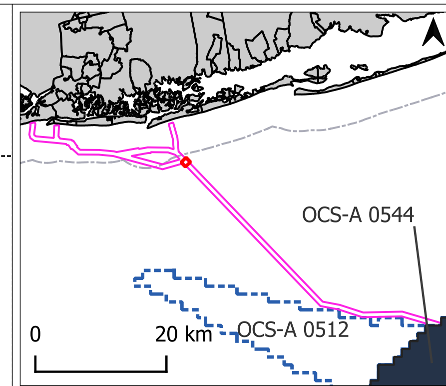

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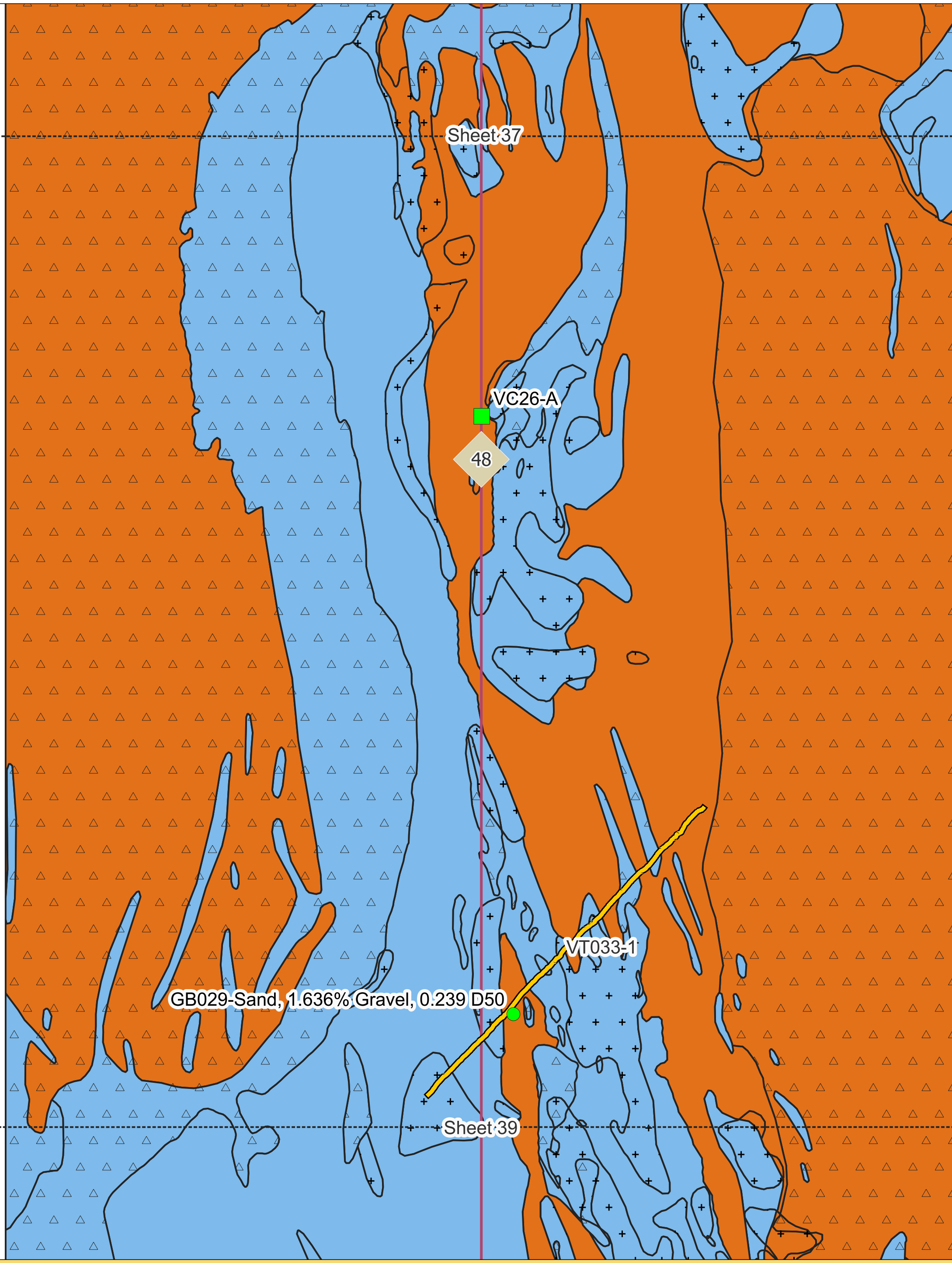

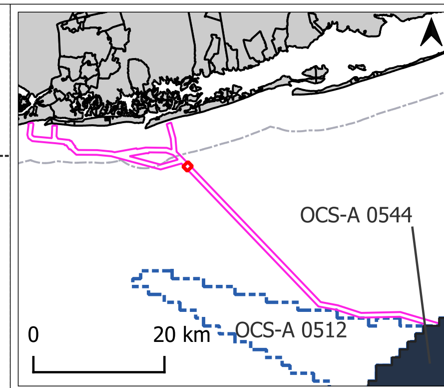

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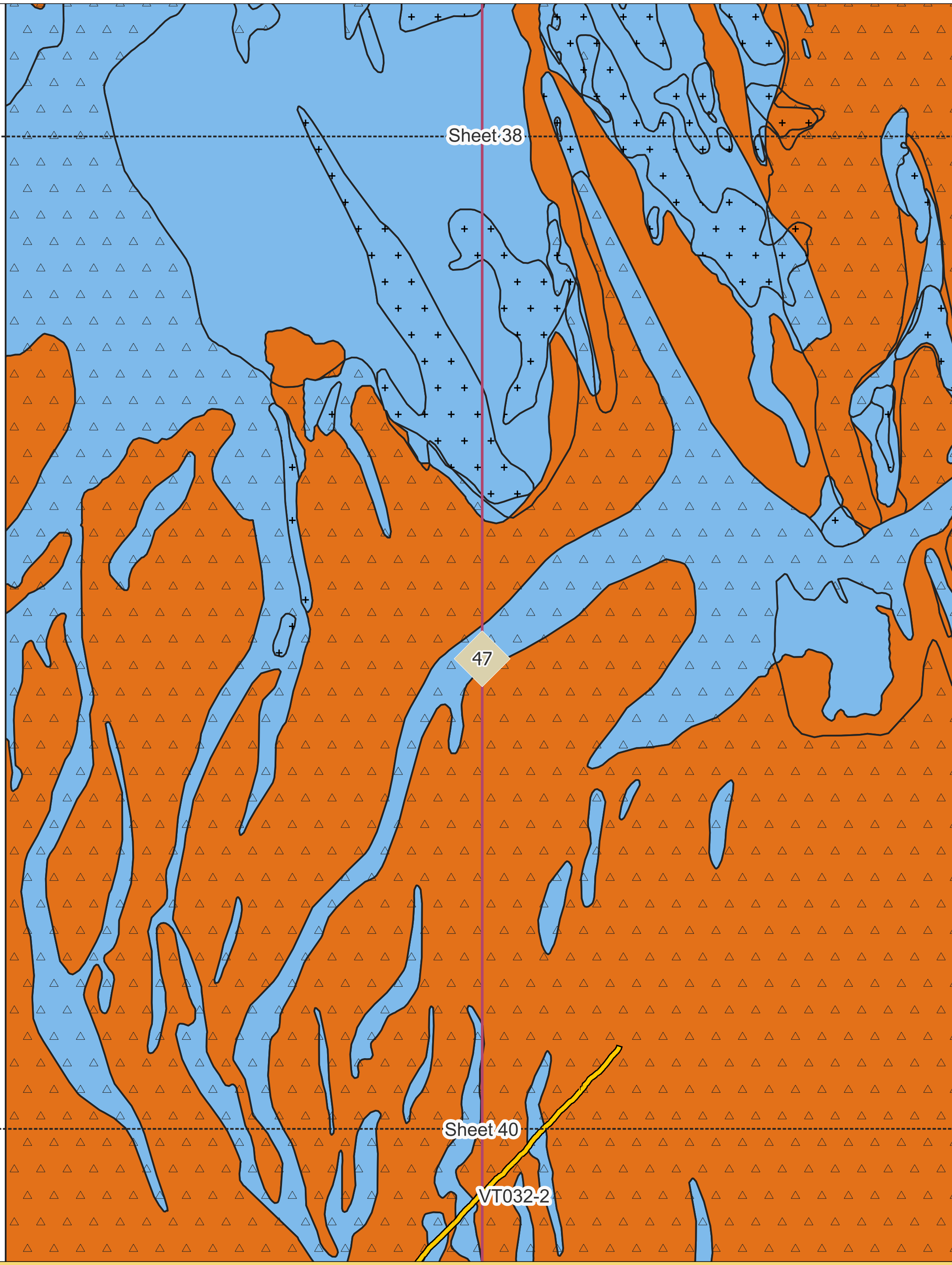

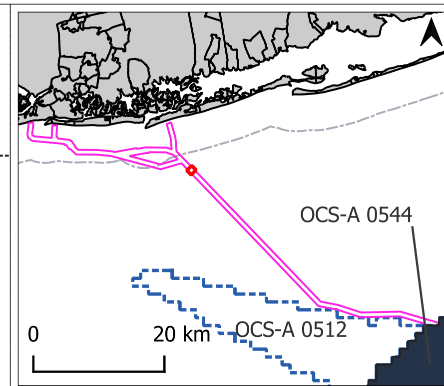

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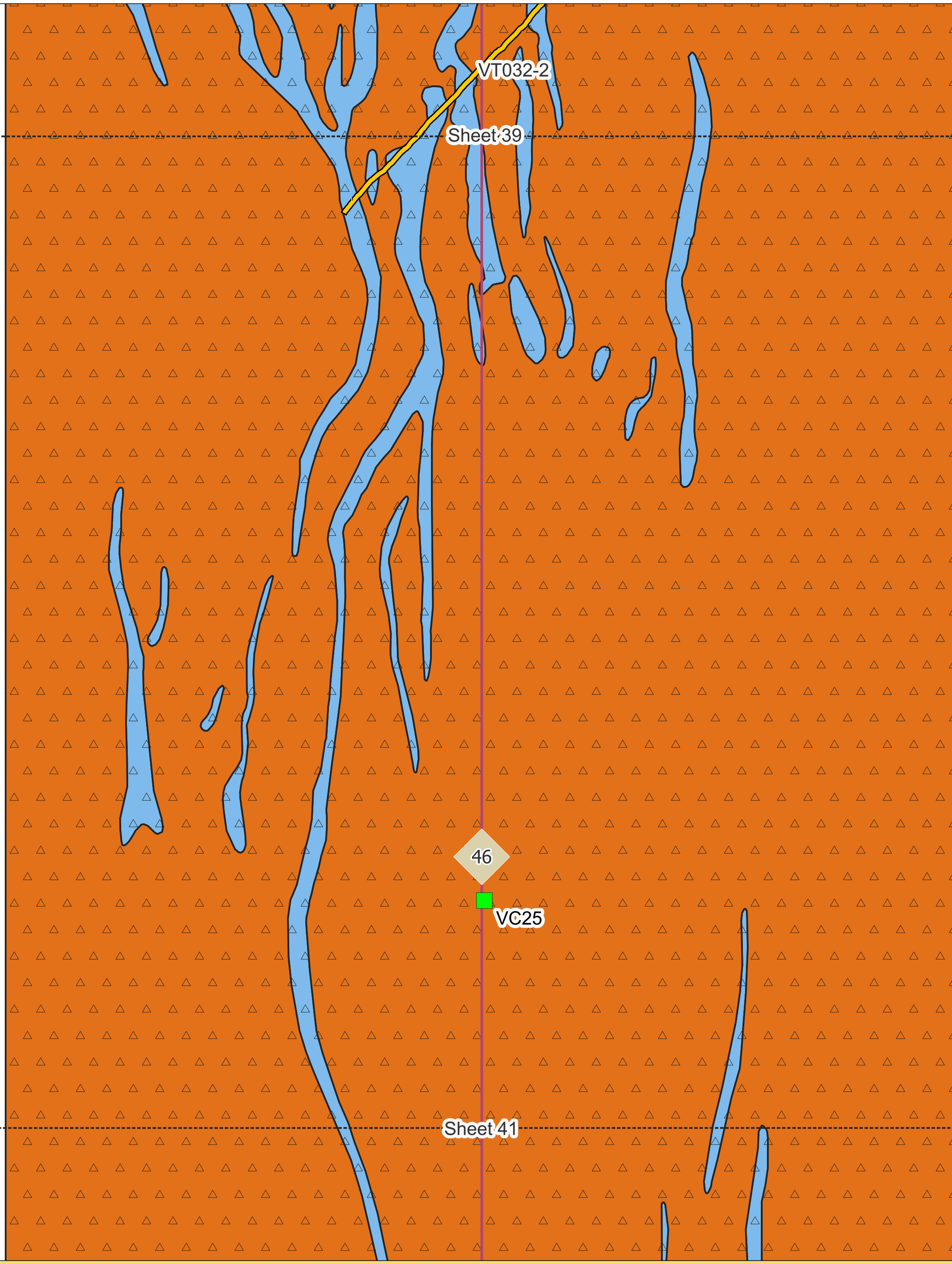

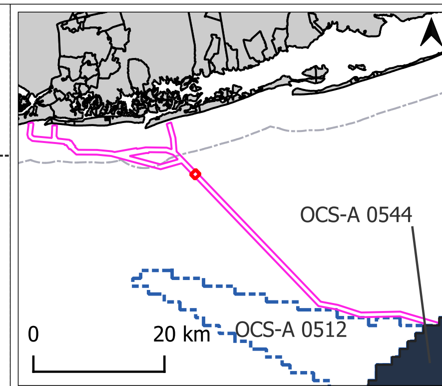

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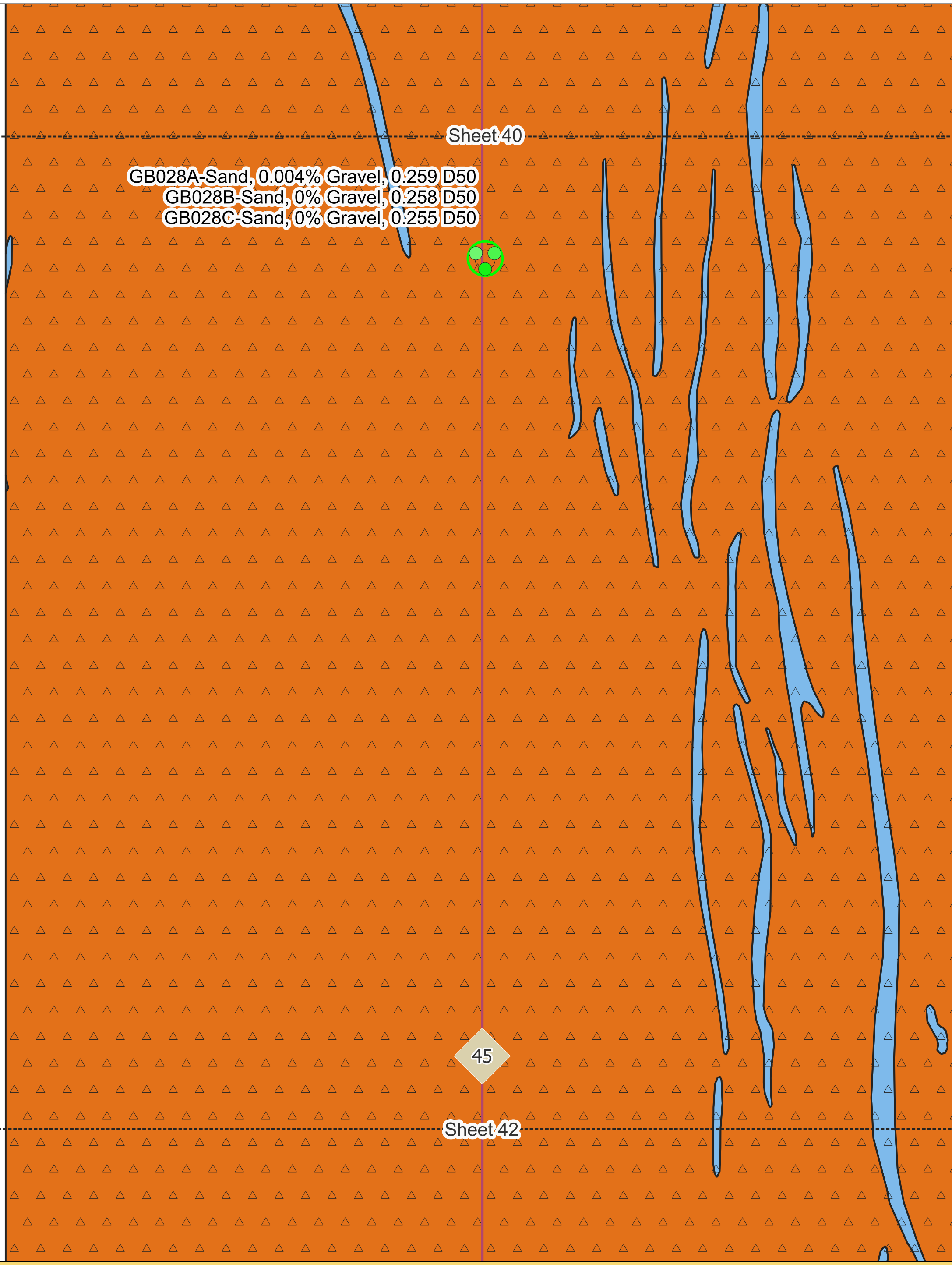

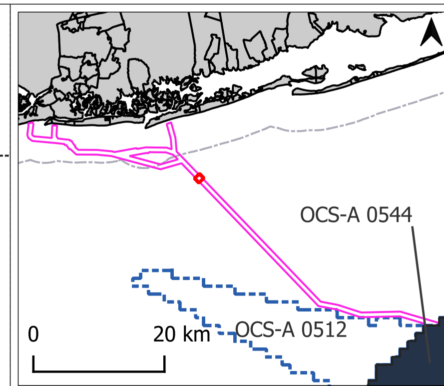

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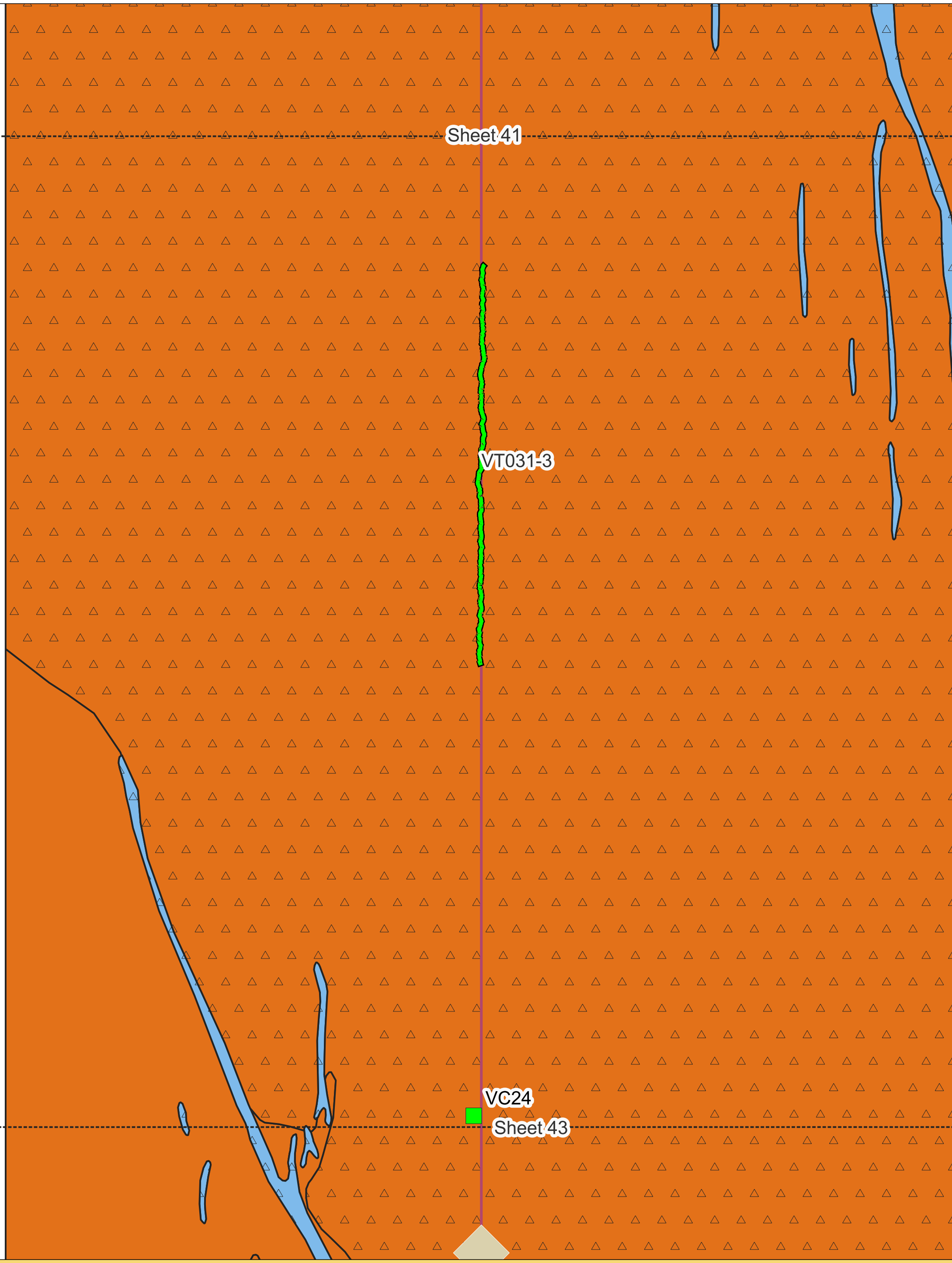

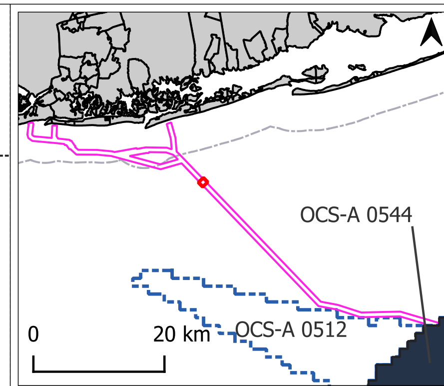

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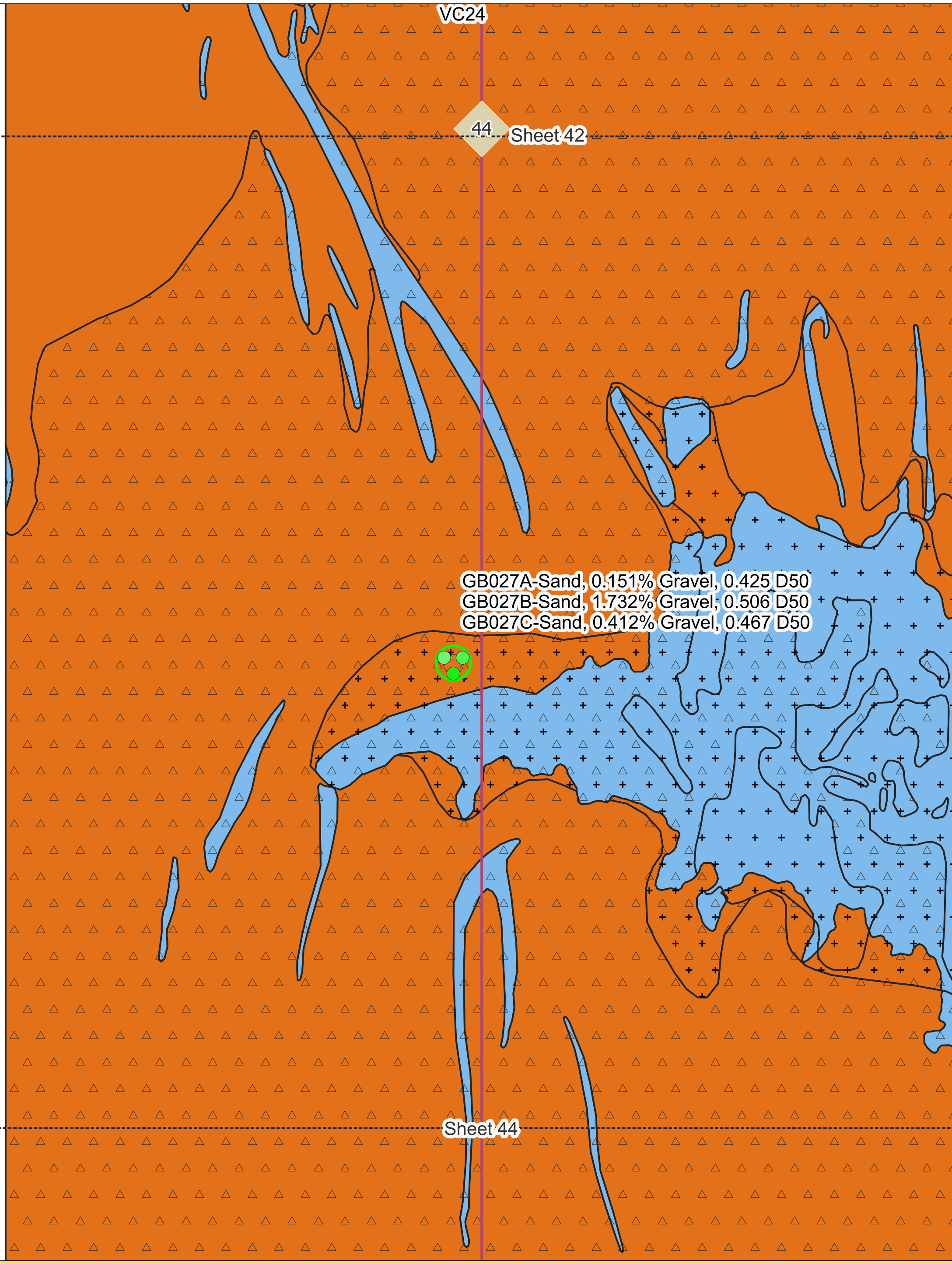

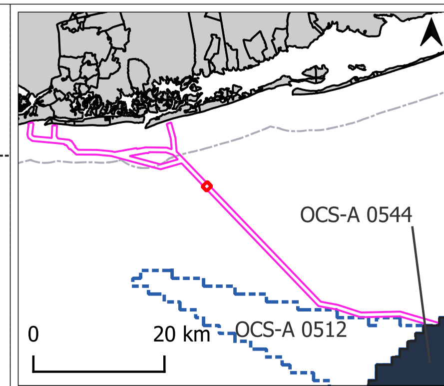

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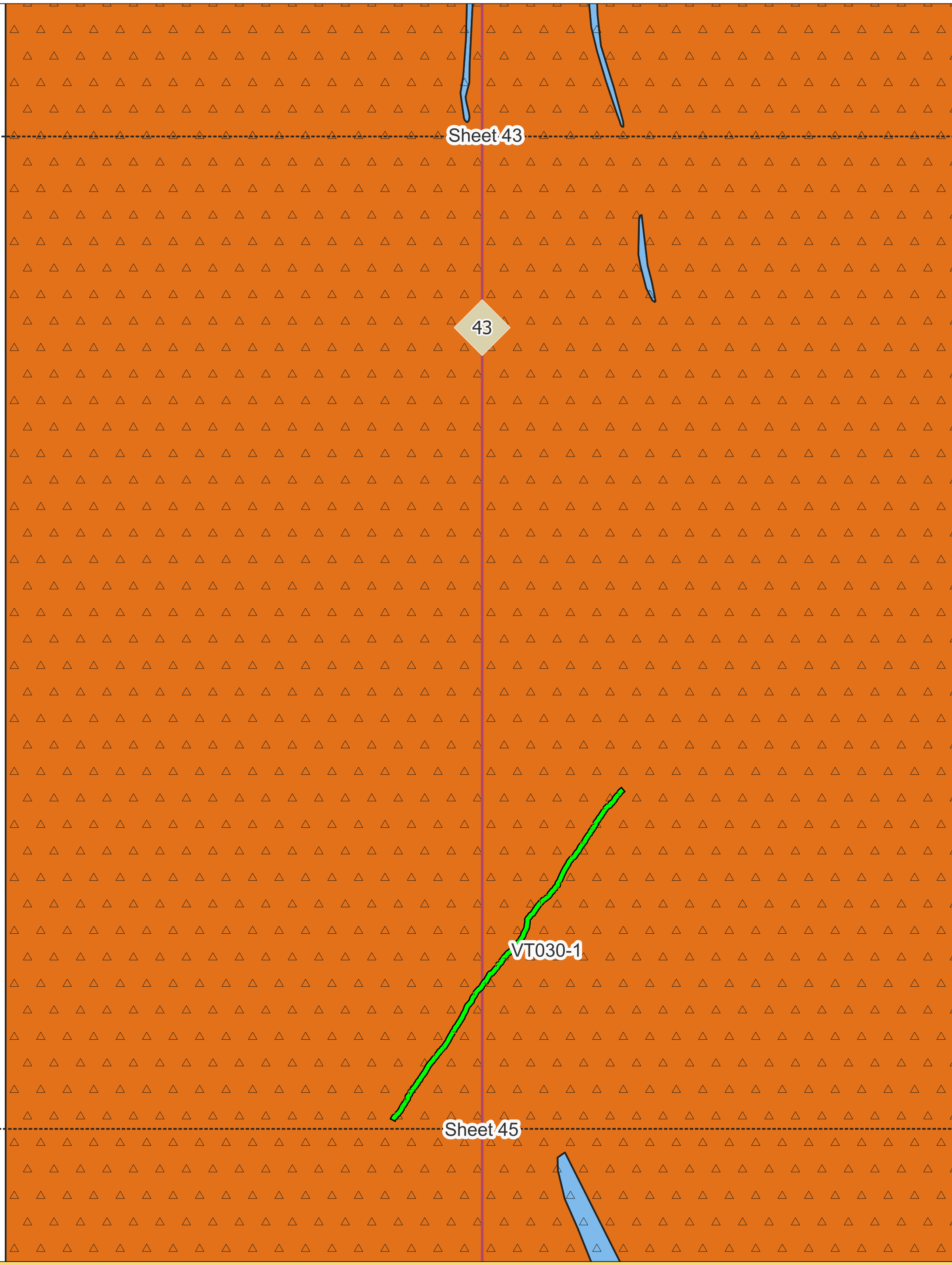
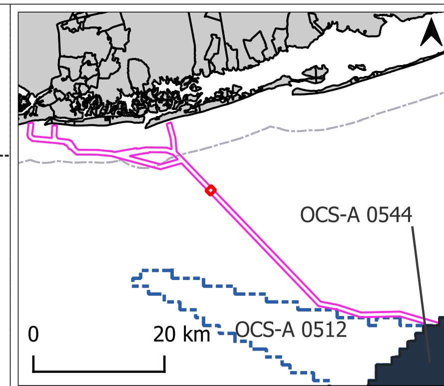
0 50 100 150 200 m

Large Scale Maps of Bottom Habitats and Benthic Features Located in the OECC

VINEYARD MID-ATLANTIC

VINEYARD OFFSHORE





LEGEND
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- BOEM Wind Lease Areas
- Offshore Export Cable Corridor
- Chart Extents
- State/Federal Waters Boundary
- Reference Line
- Kilometer Post
- Representative HDD Location

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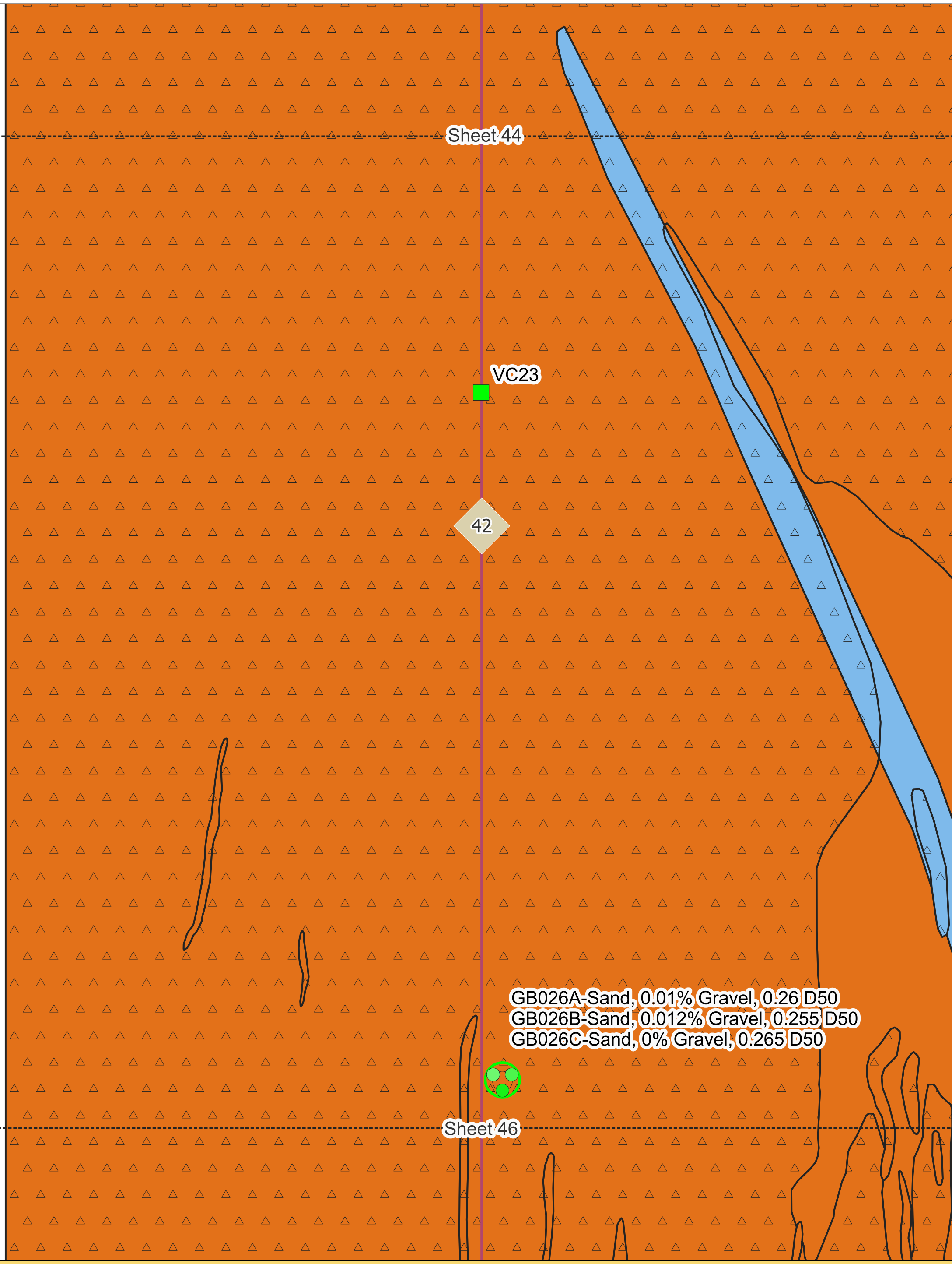

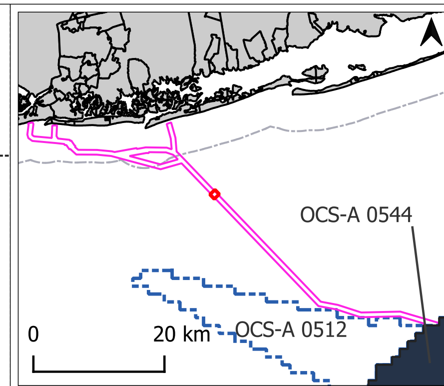

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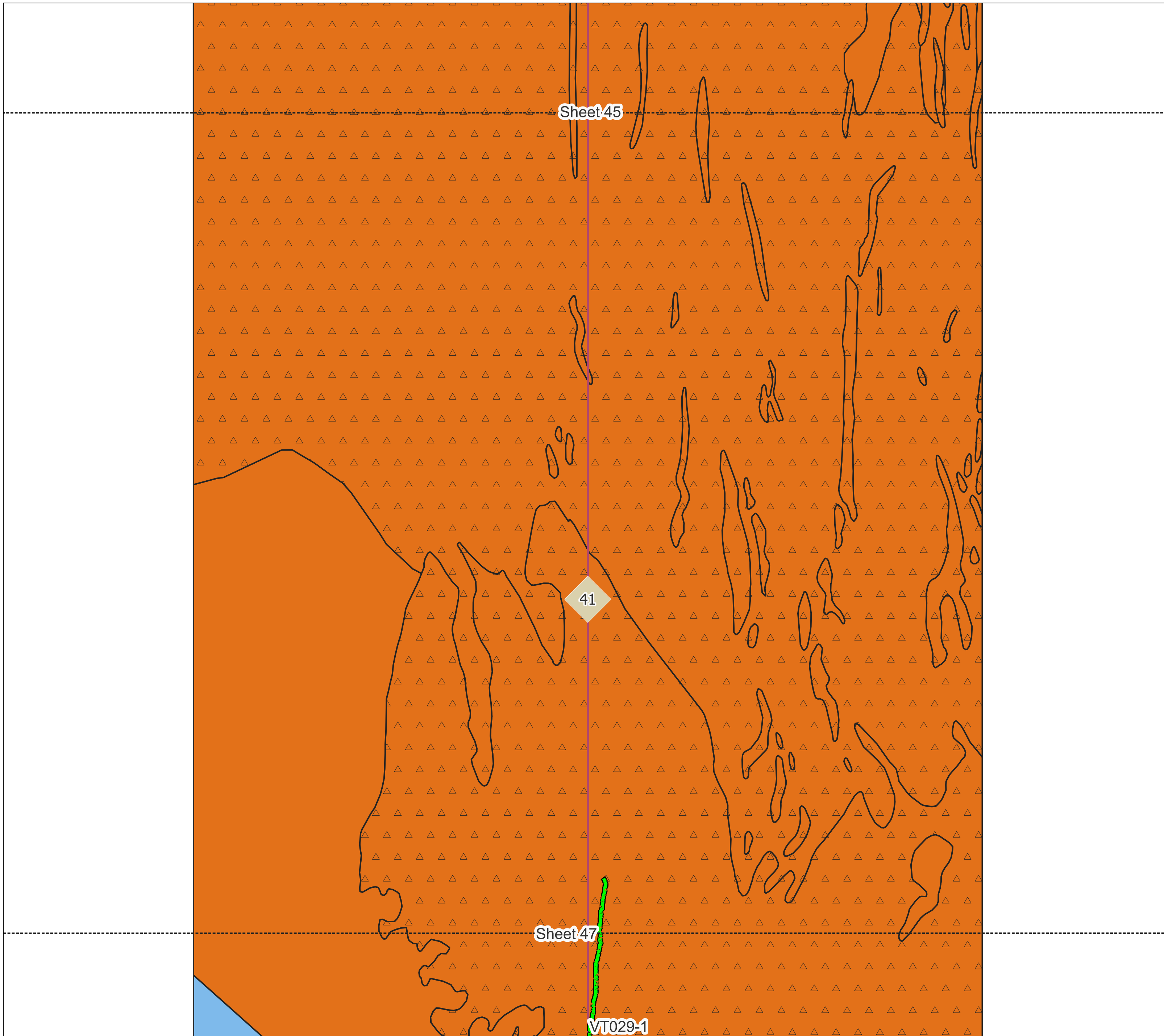

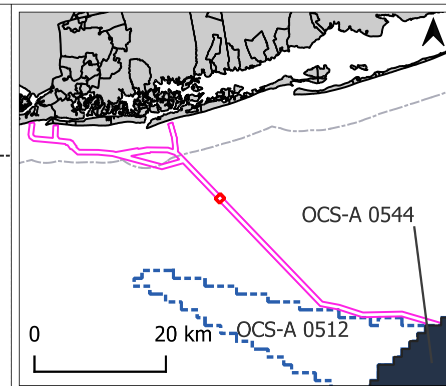

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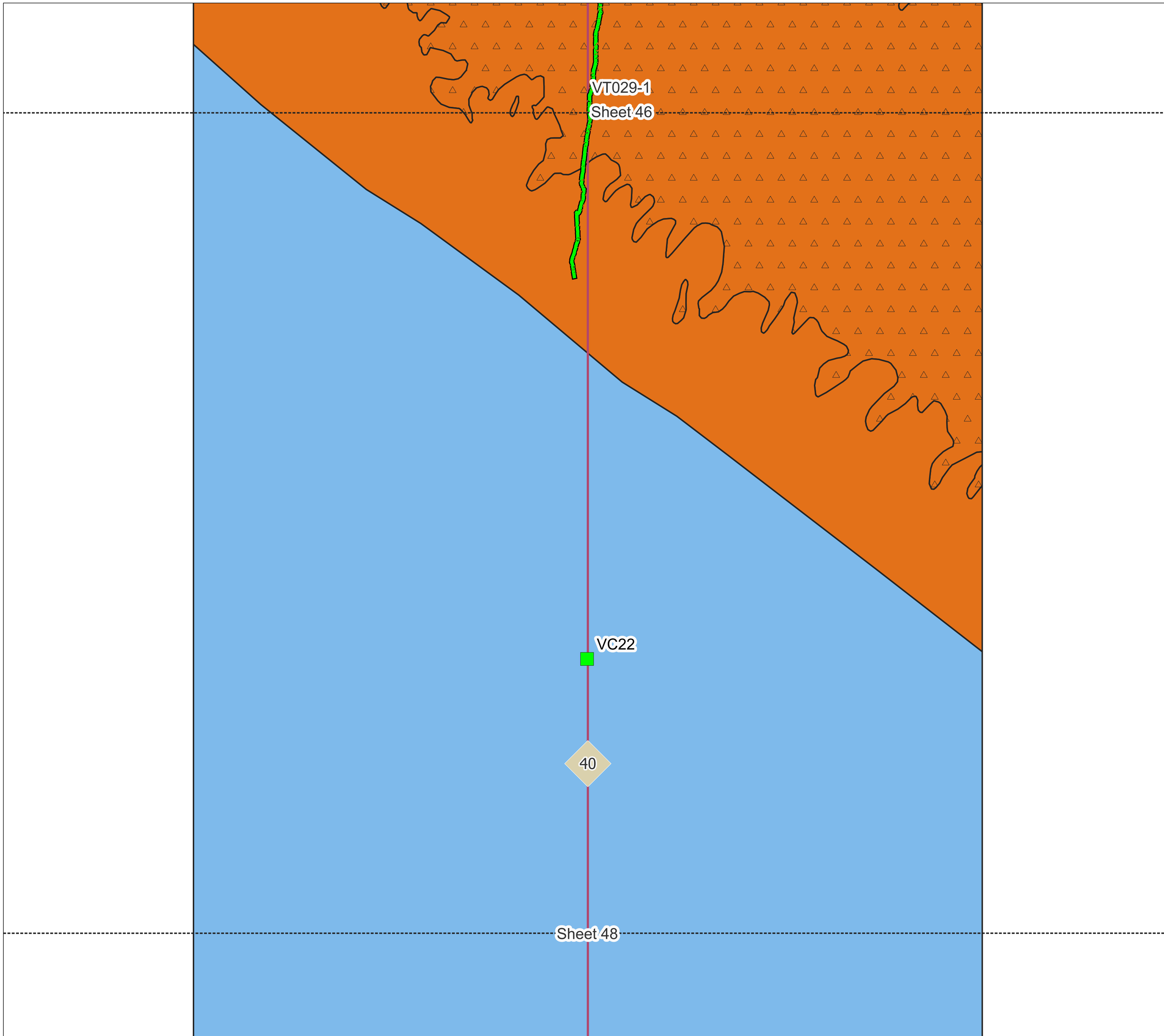

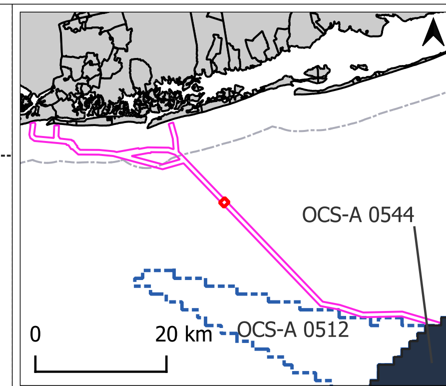

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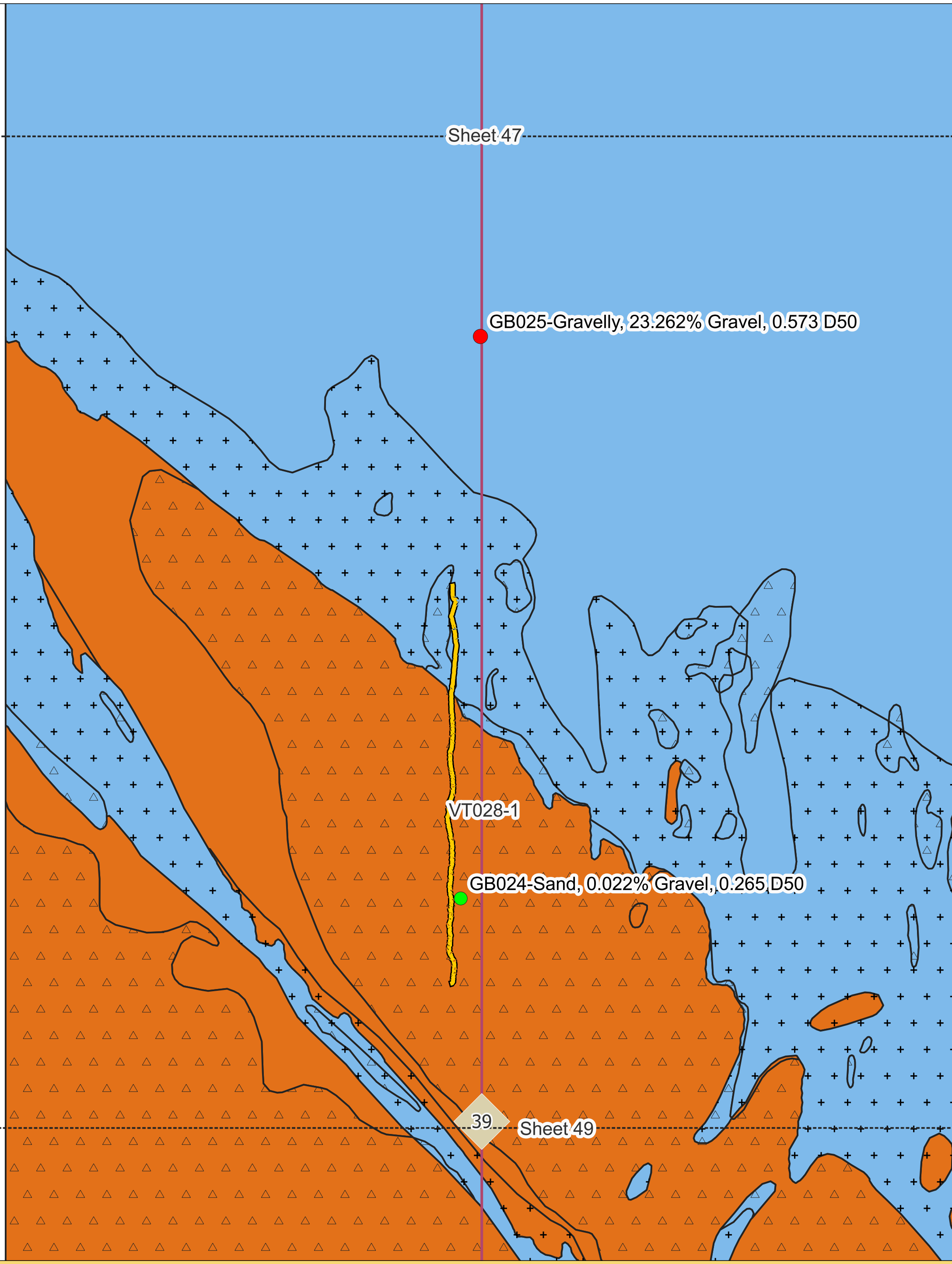

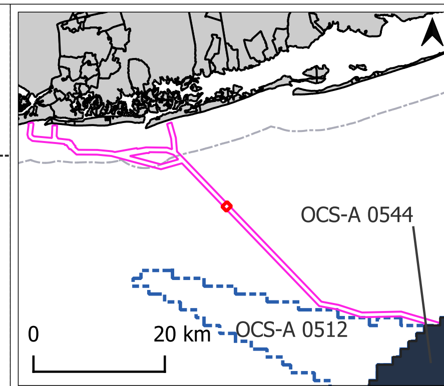

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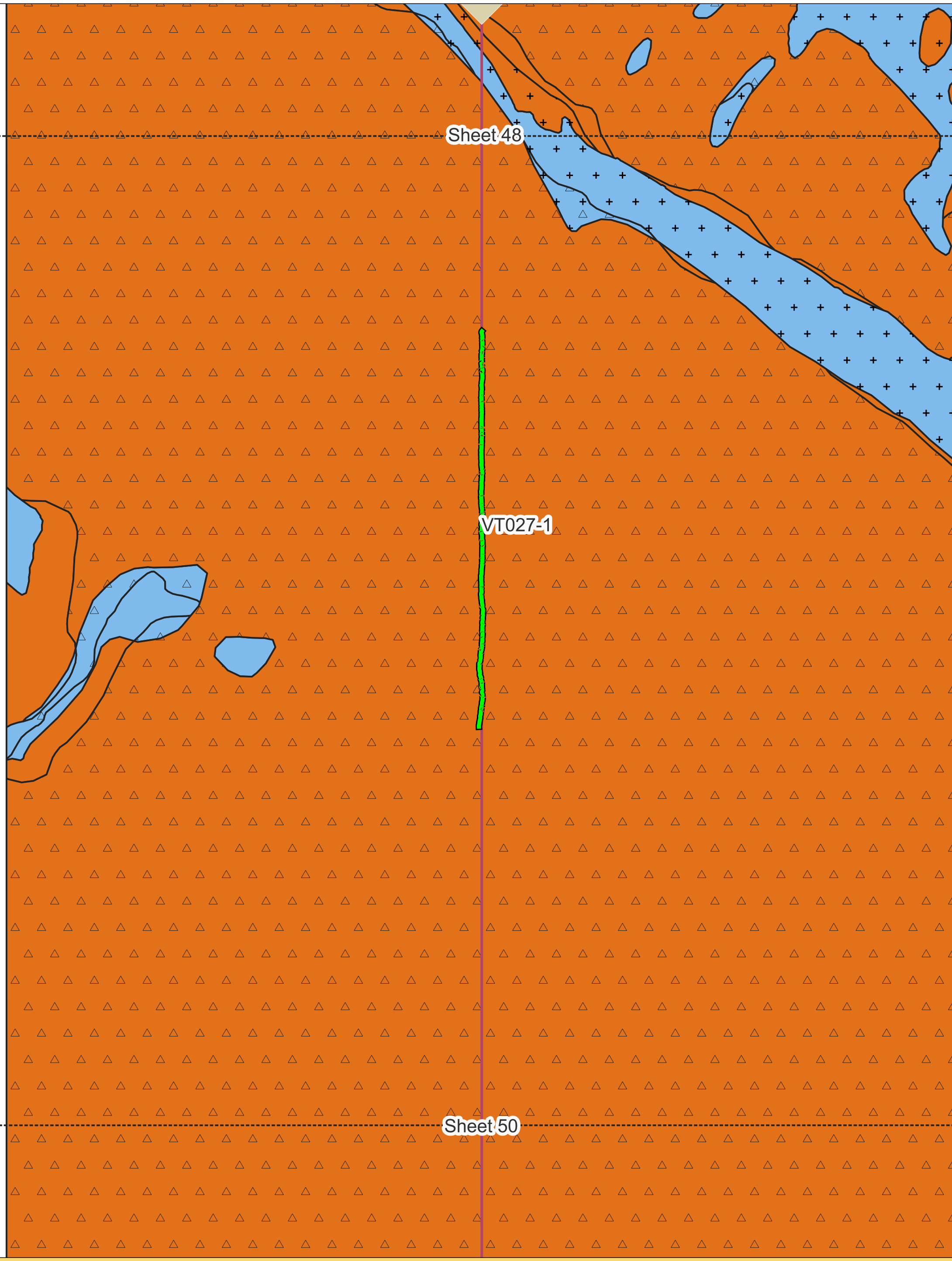

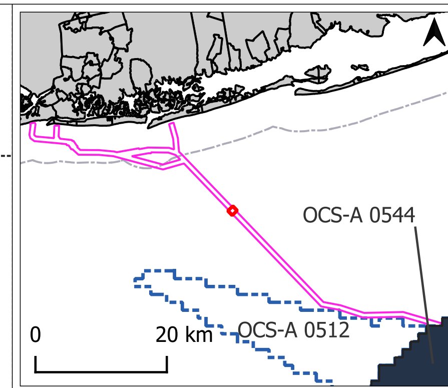

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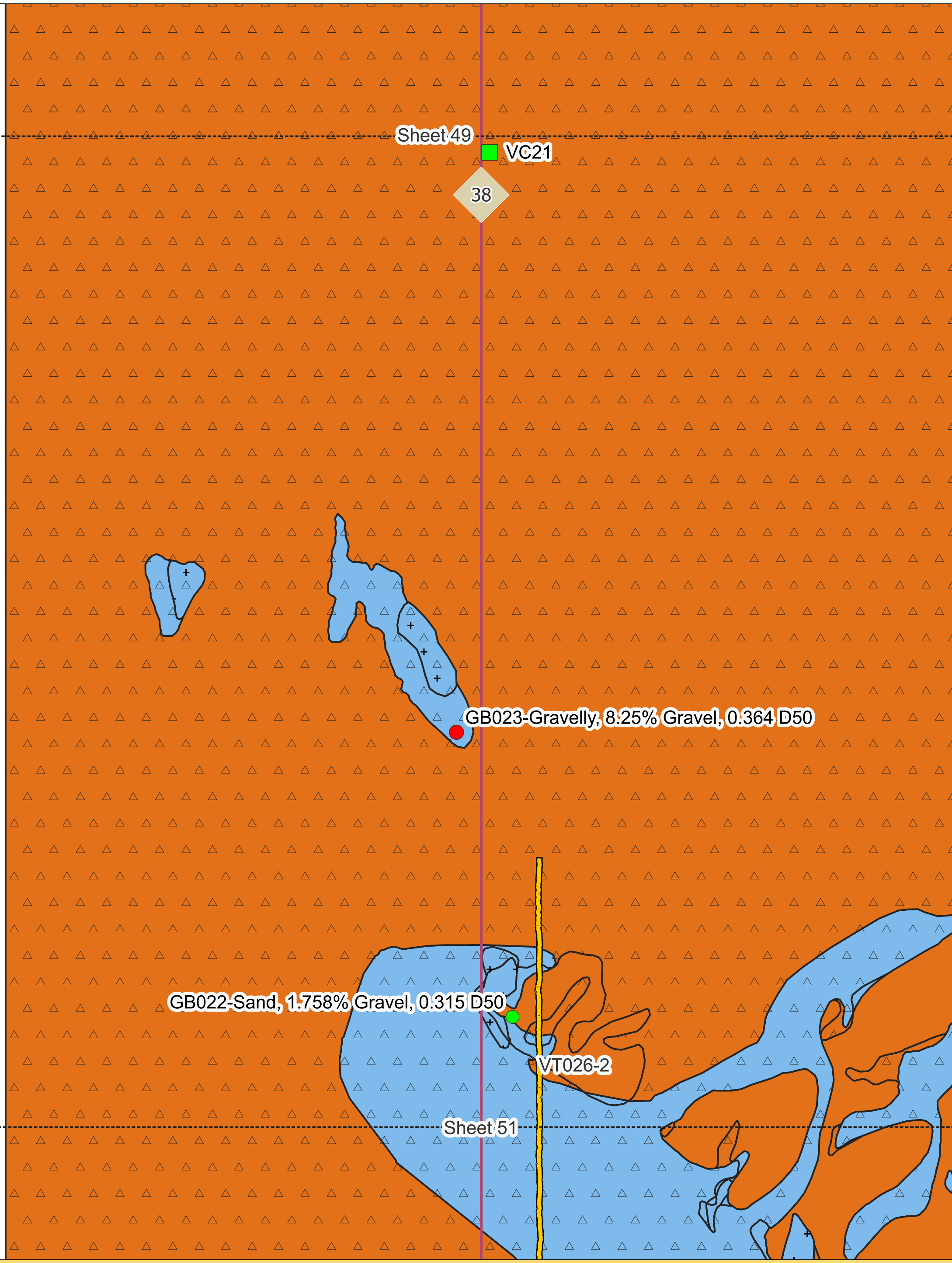

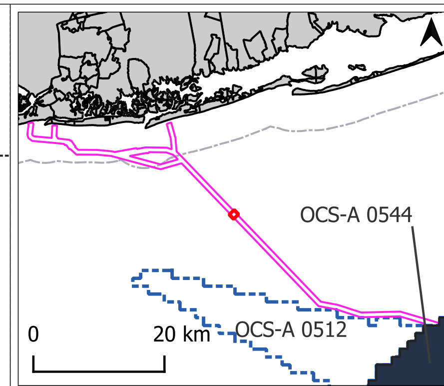

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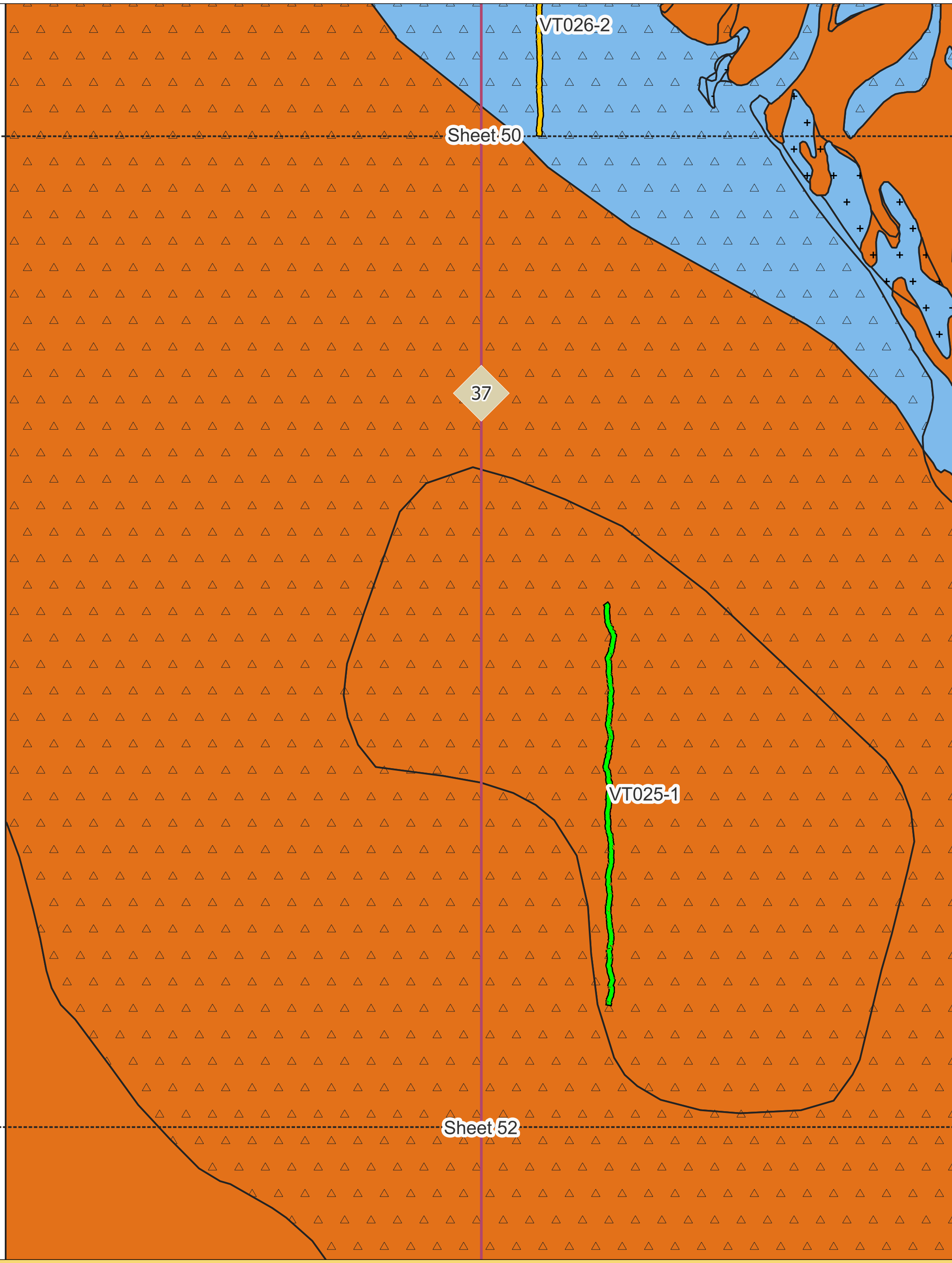

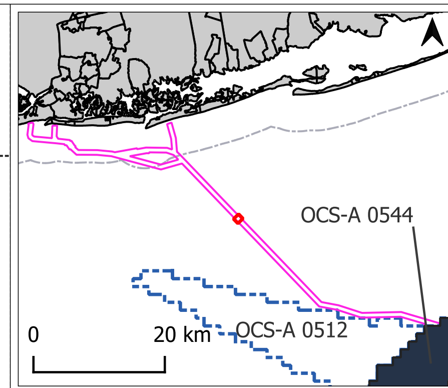

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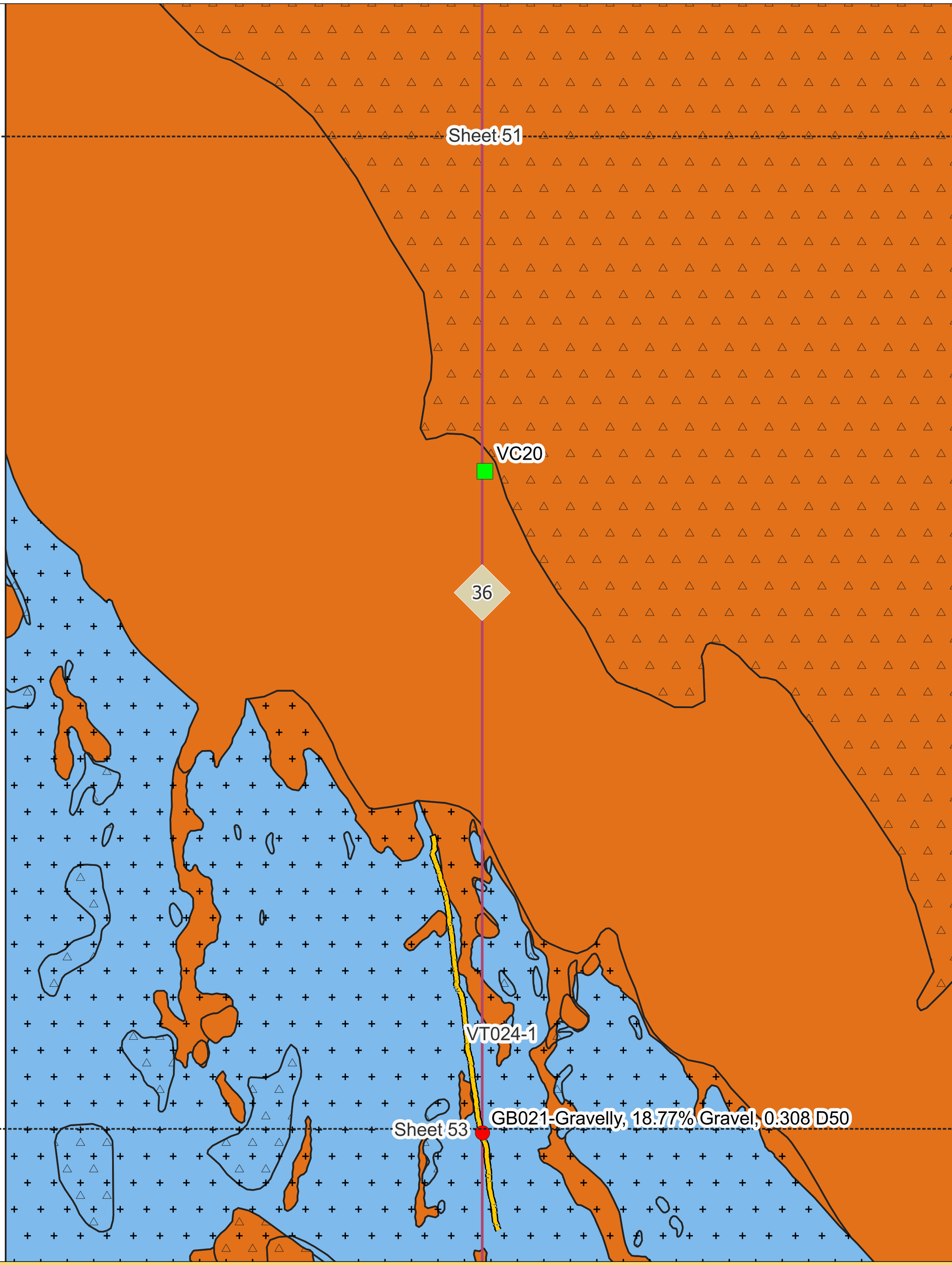

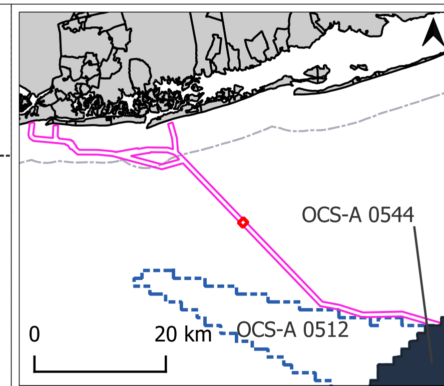

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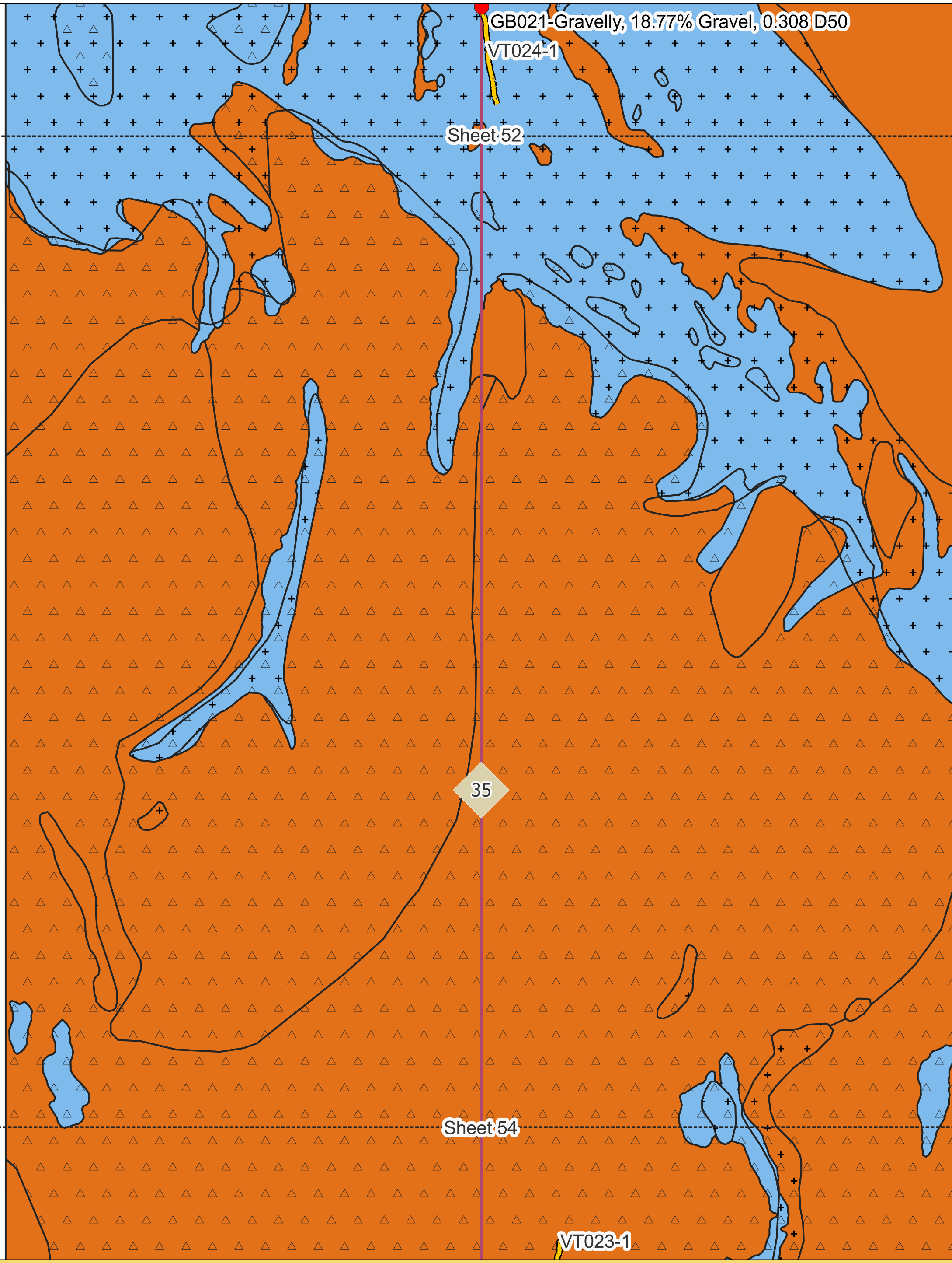

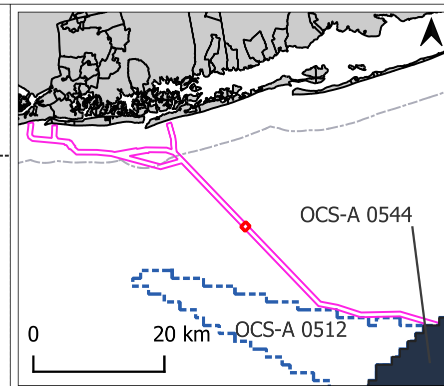

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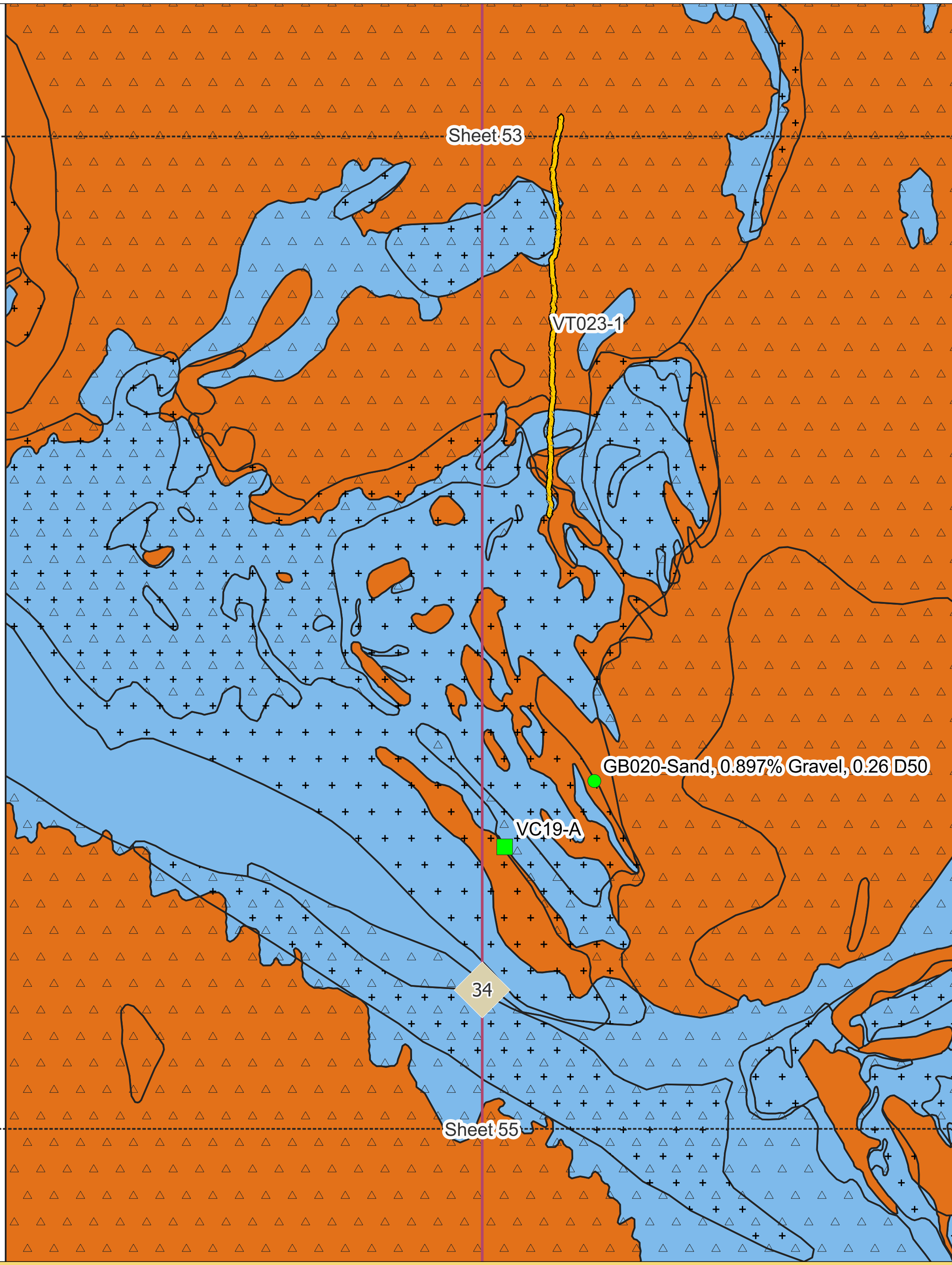

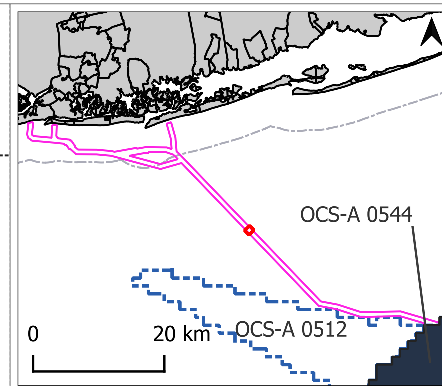

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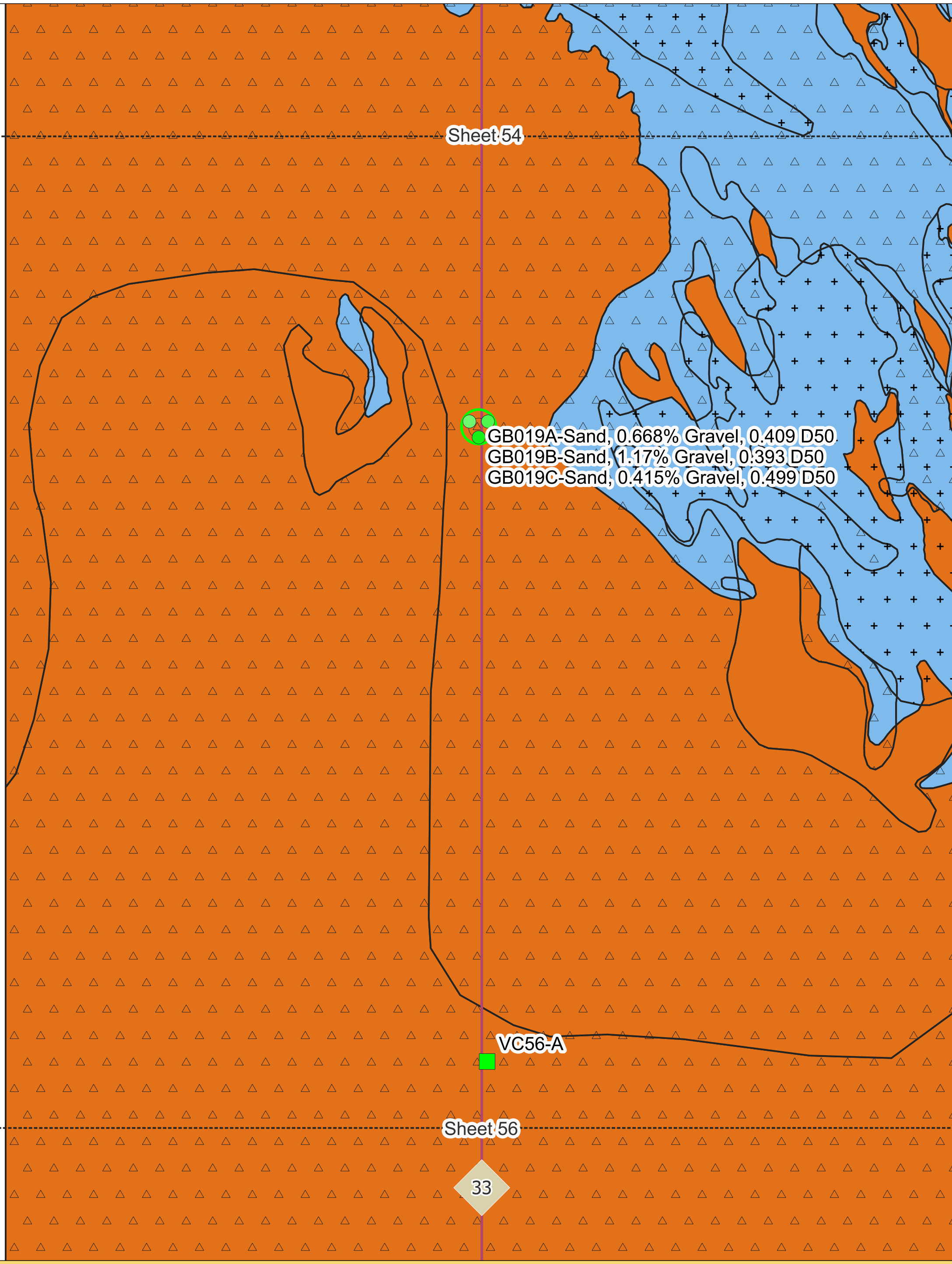

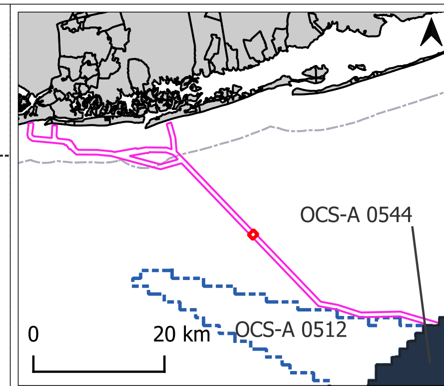

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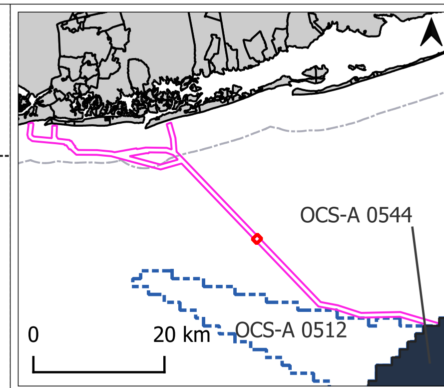

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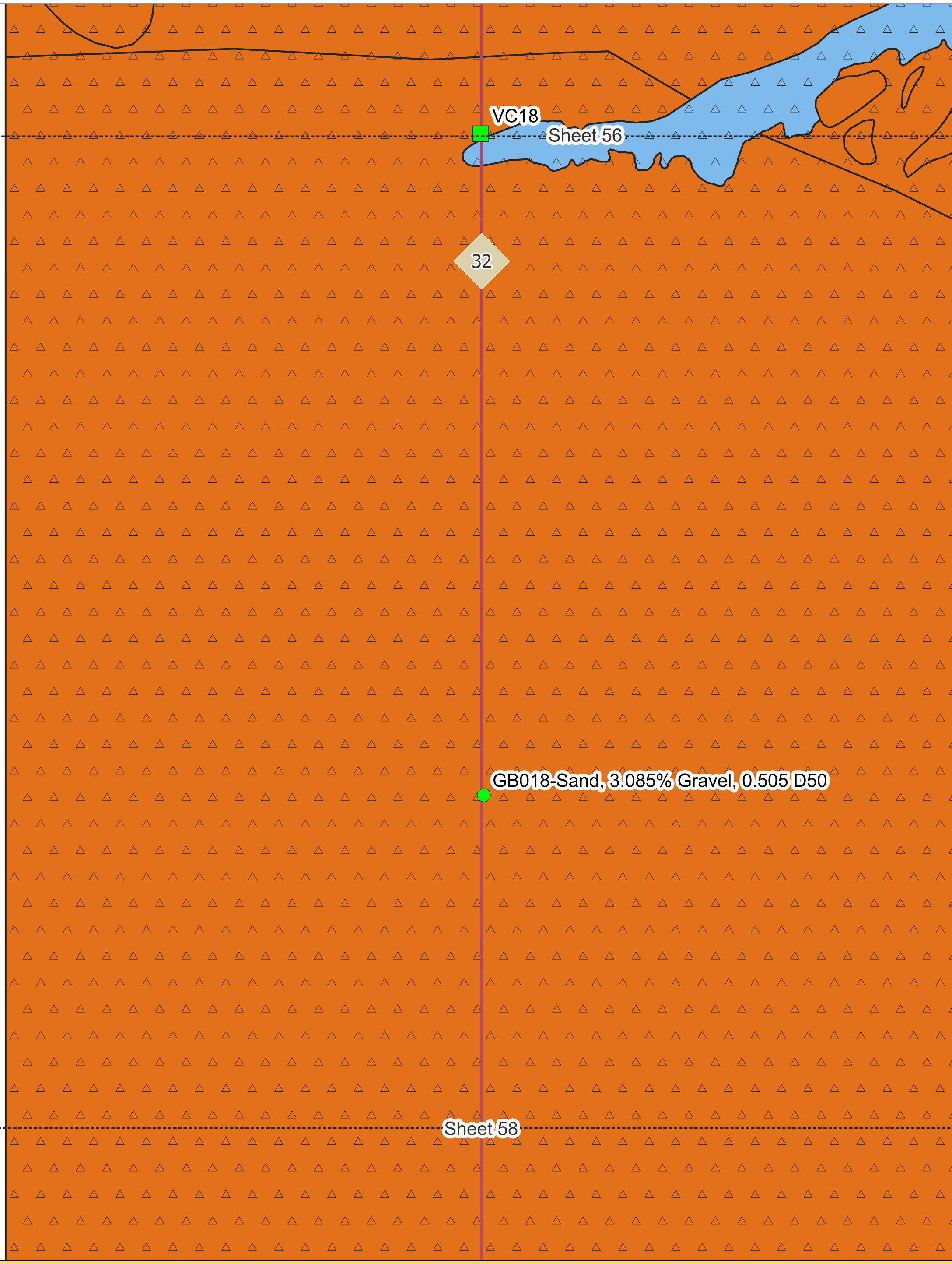

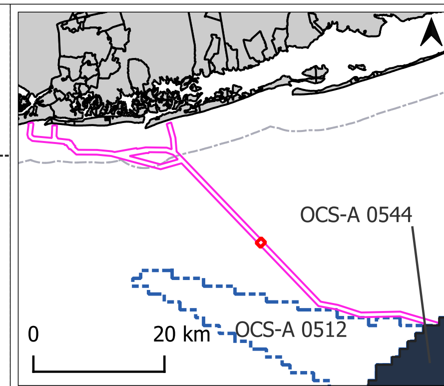

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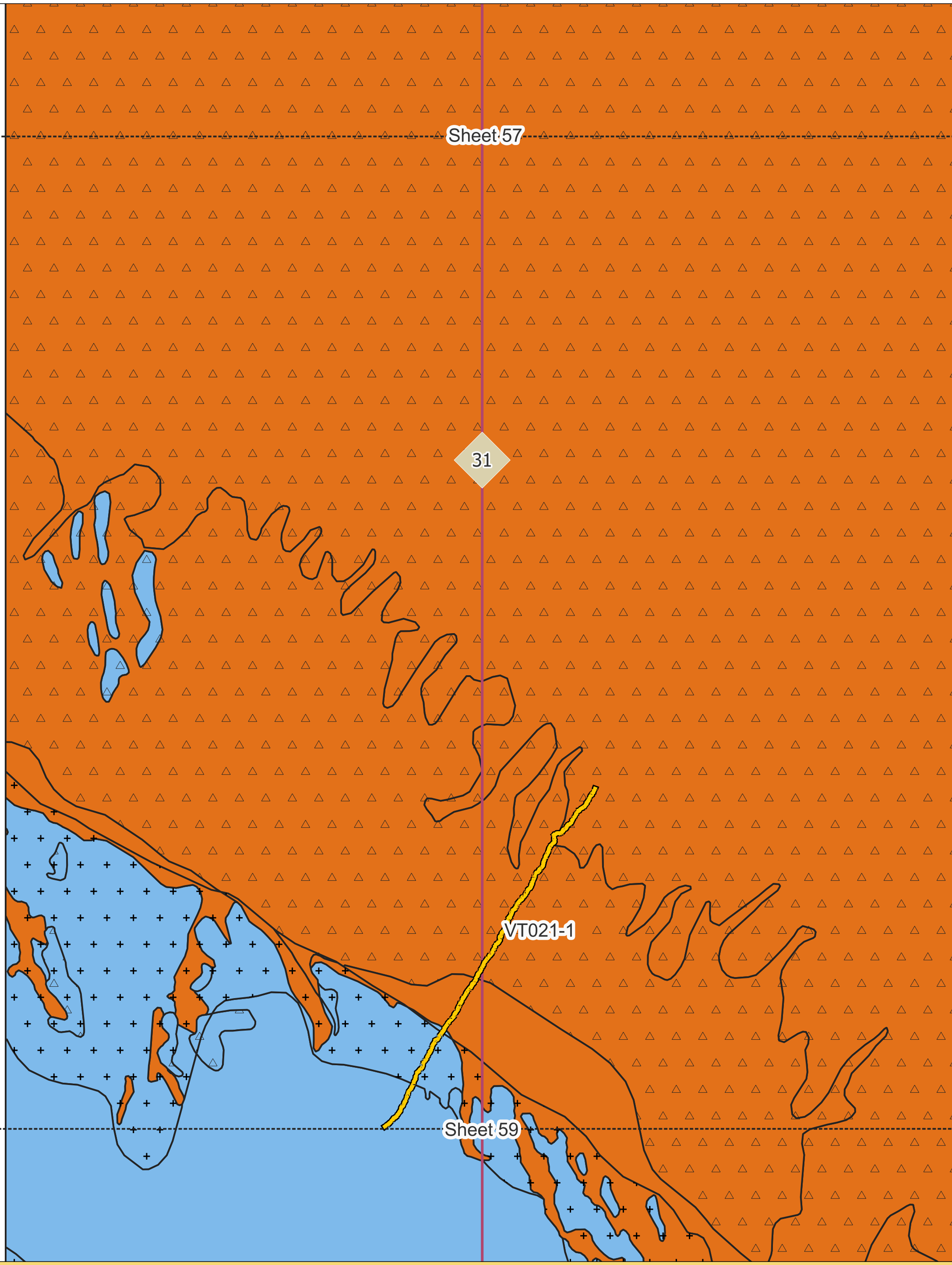

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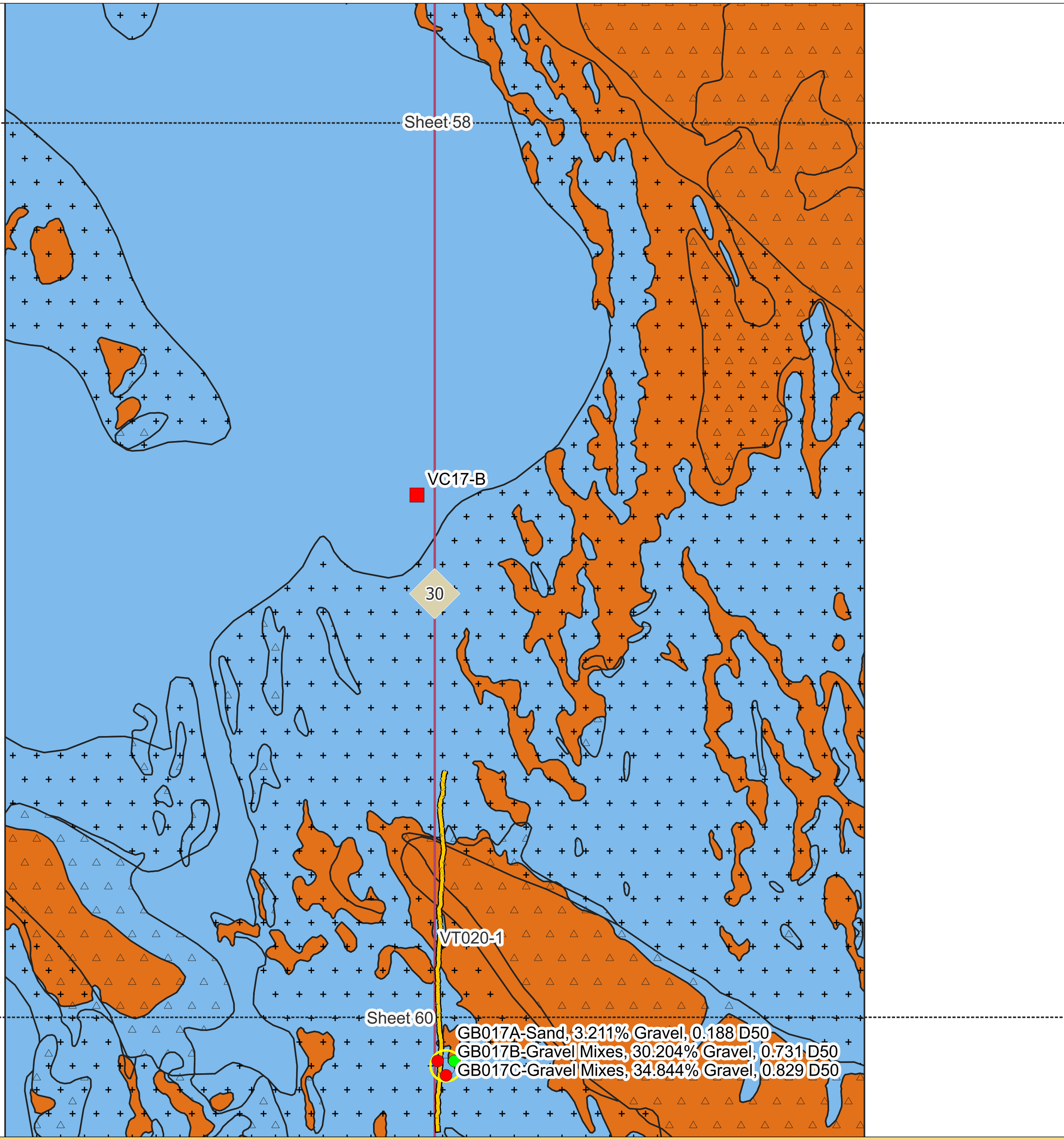

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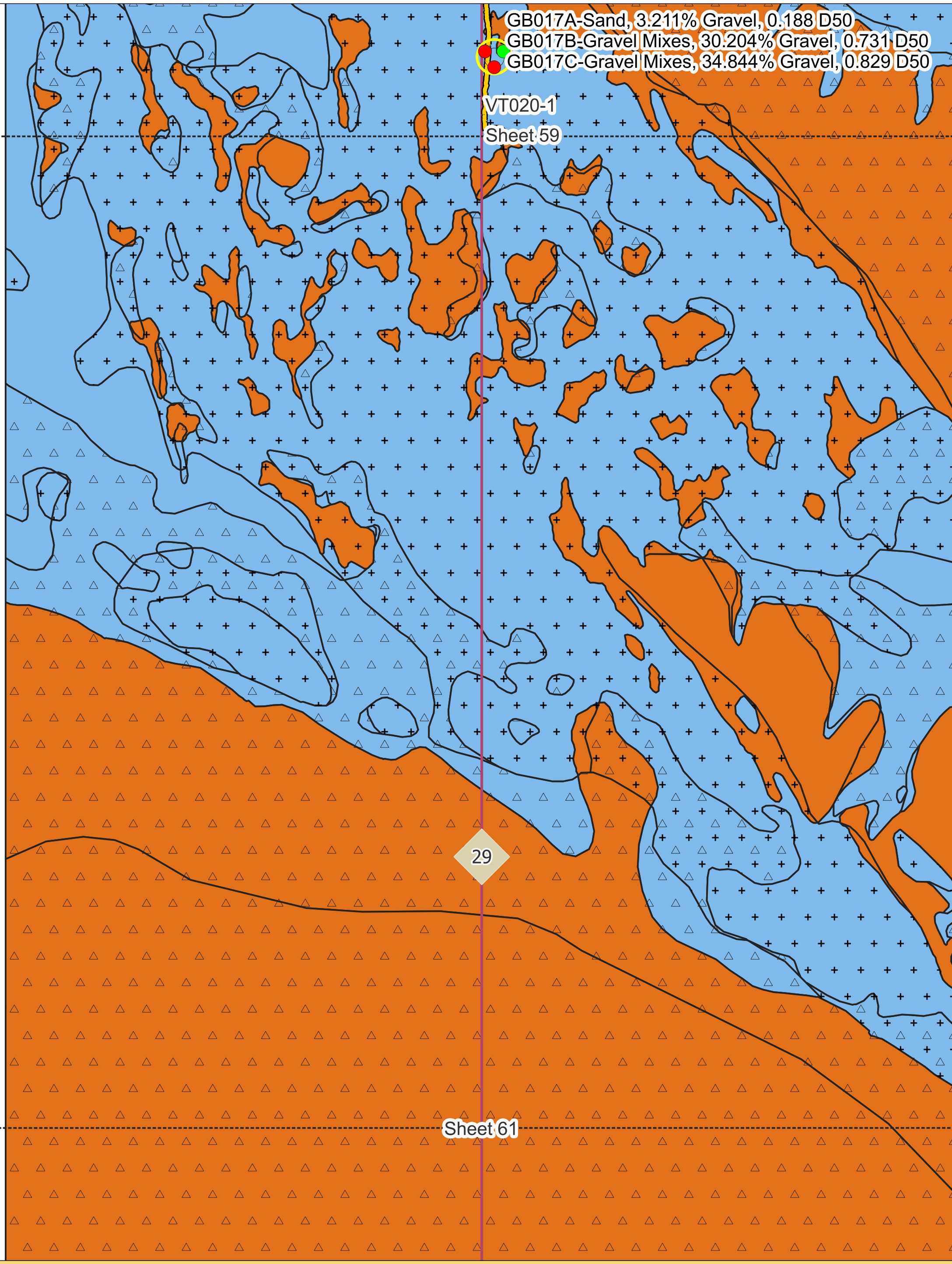

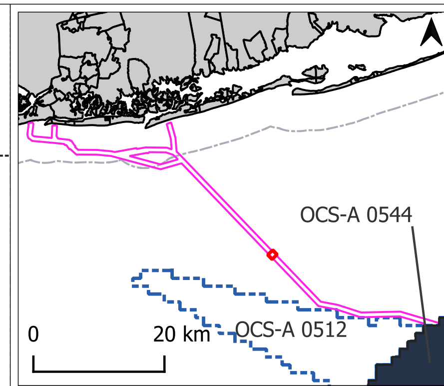

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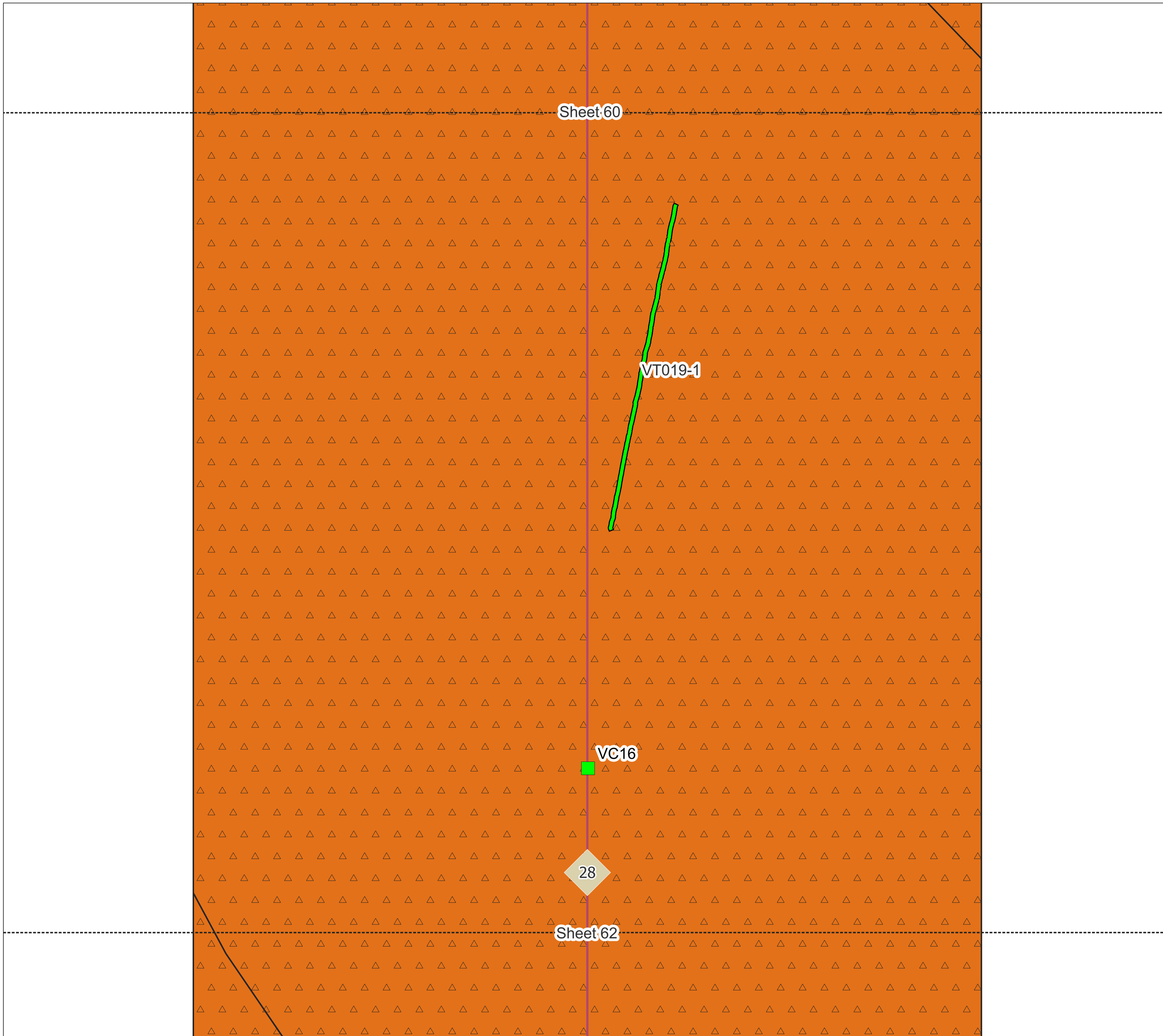

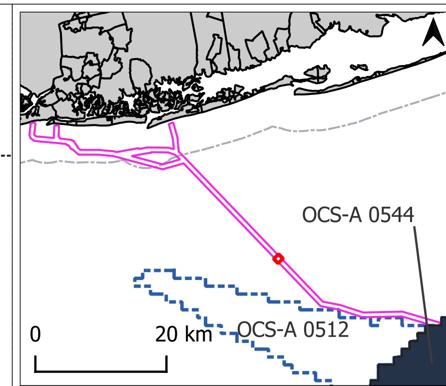

LEGEND

- OCS-A 0544
- BOEM Wind Lease Areas
- Offshore Export Cable Corridor
- Chart Extents
- State/Federal Waters Boundary
- Reference Line
- Kilometer Post
- Representative HDD Location

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- Ripples
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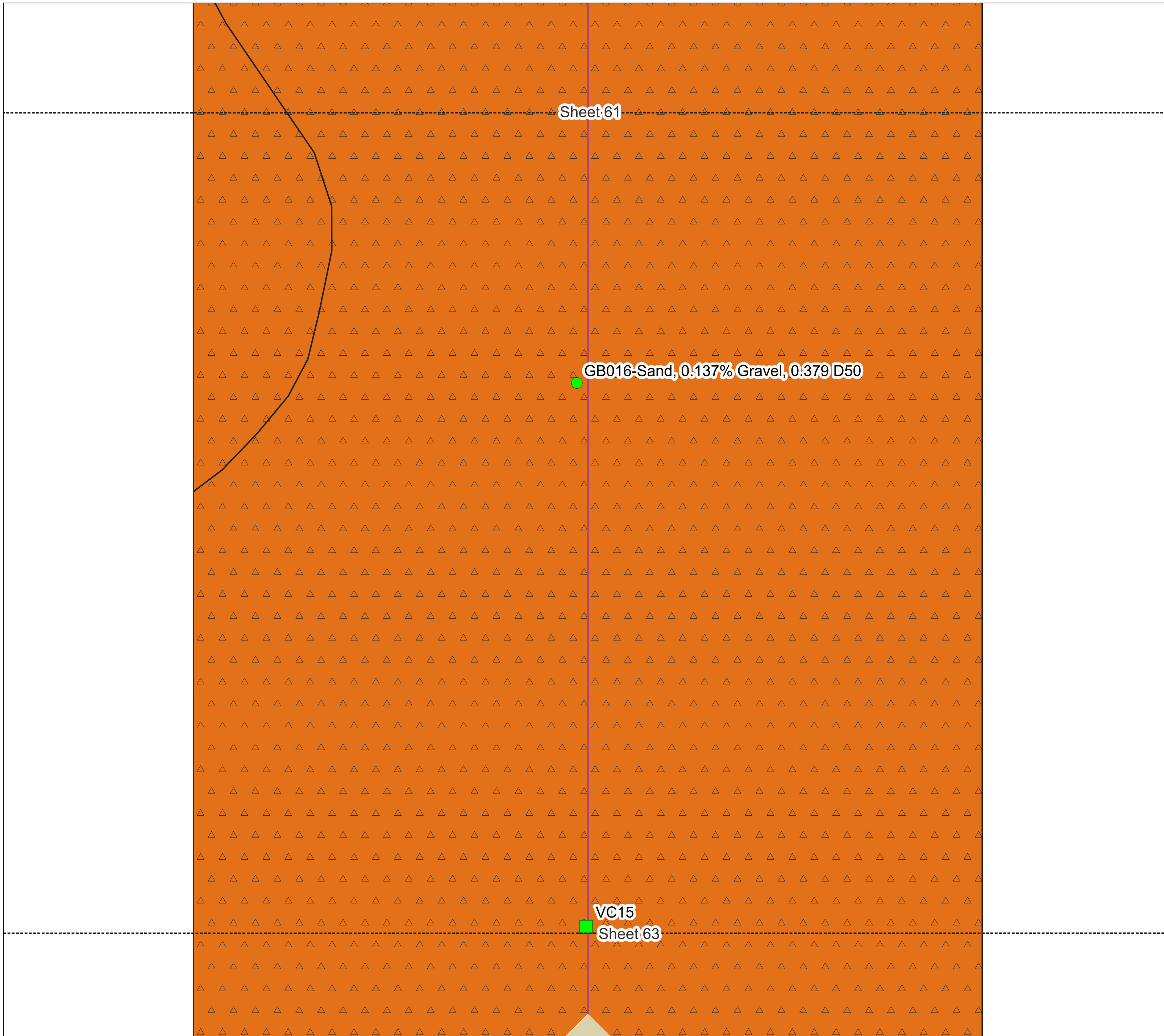
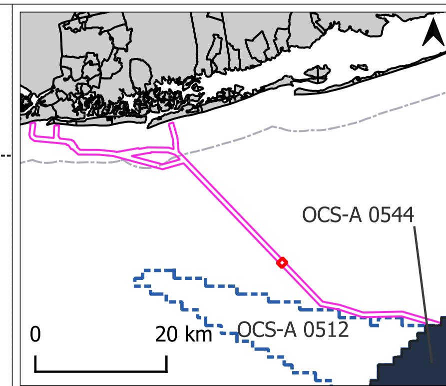
(1 inch = 127 meters @ 11" x 8.5" paper size)

0 50 100 150 200 m

Large Scale Maps of Bottom Habitats and Benthic Features Located in the OECC

VINEYARD MID-ATLANTIC
VINEYARD OFFSHORE





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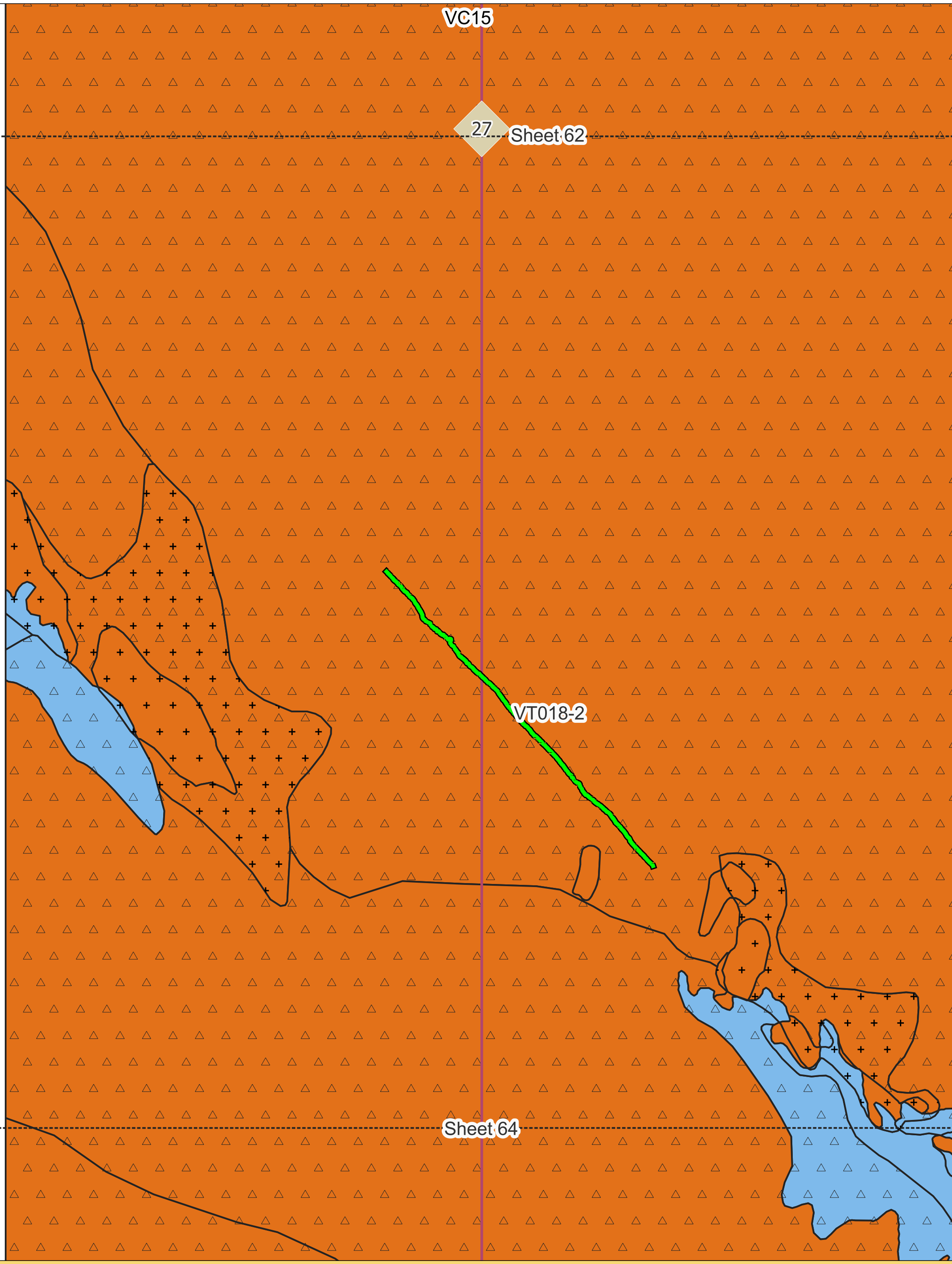

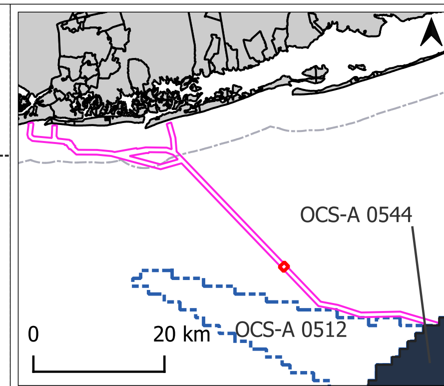

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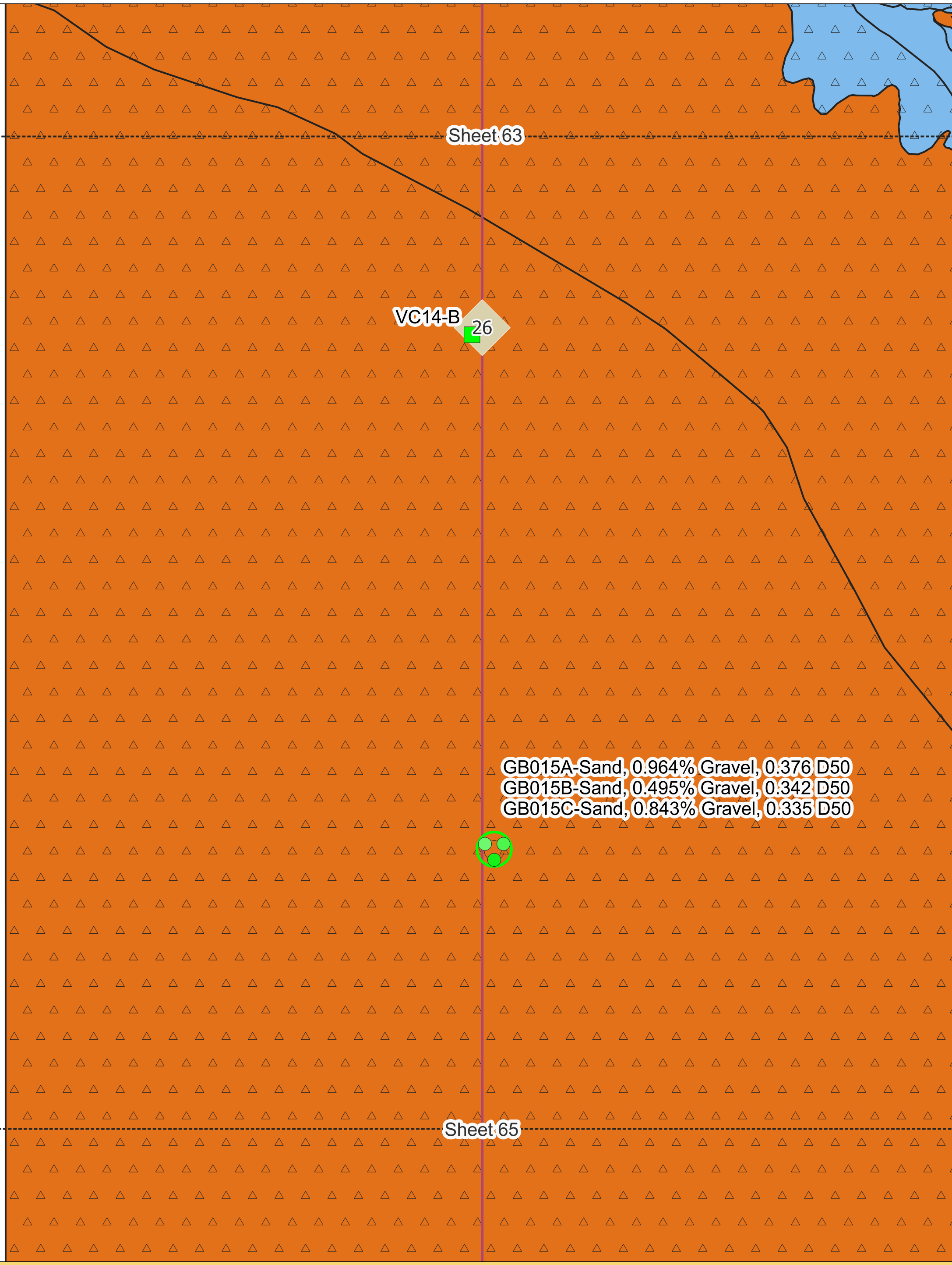

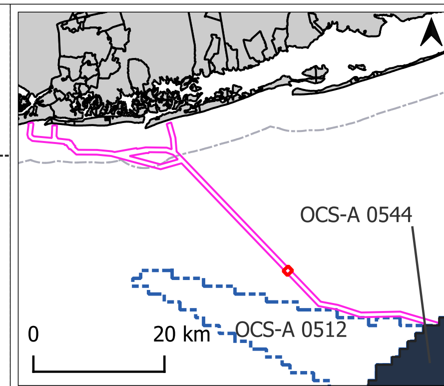

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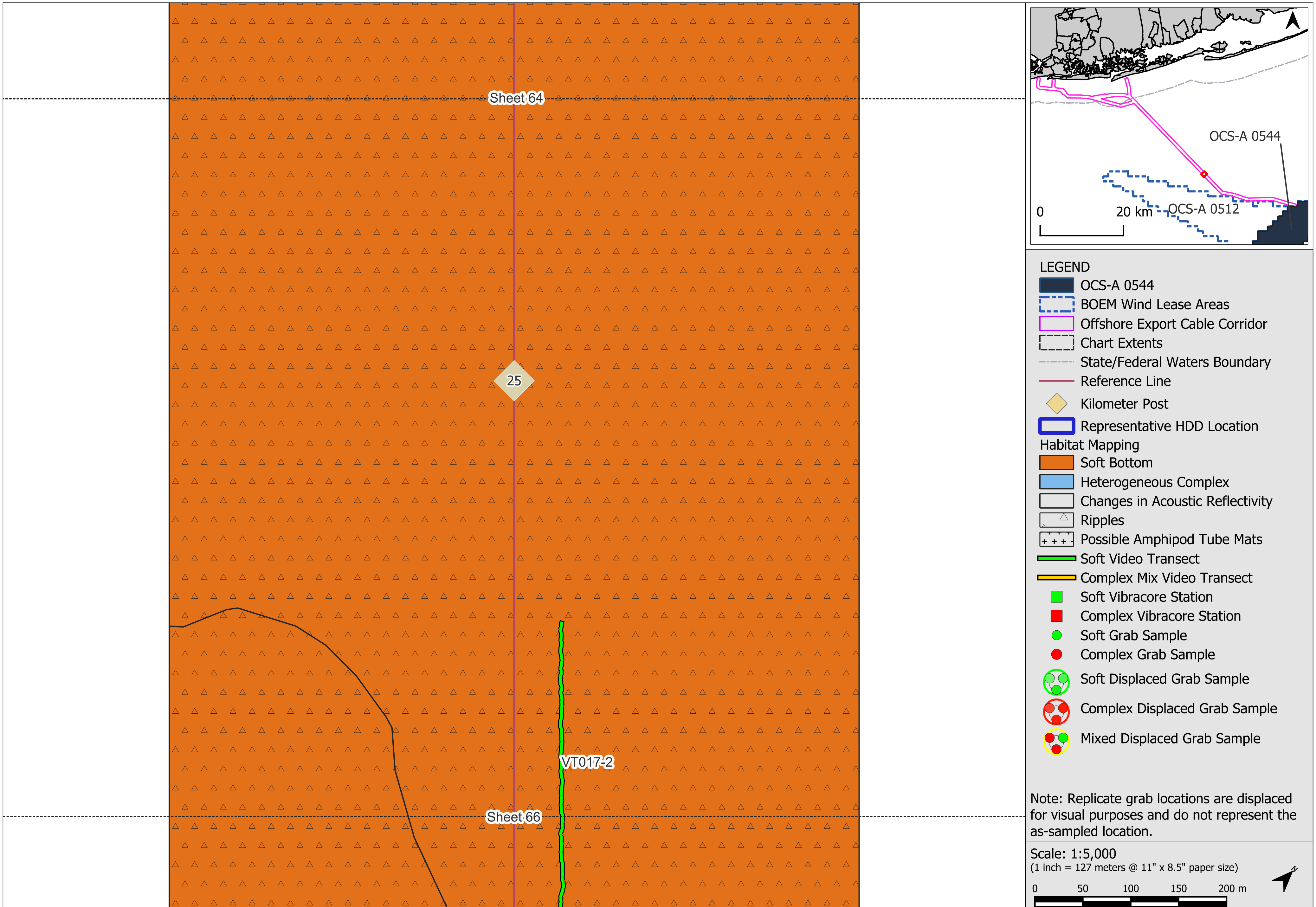

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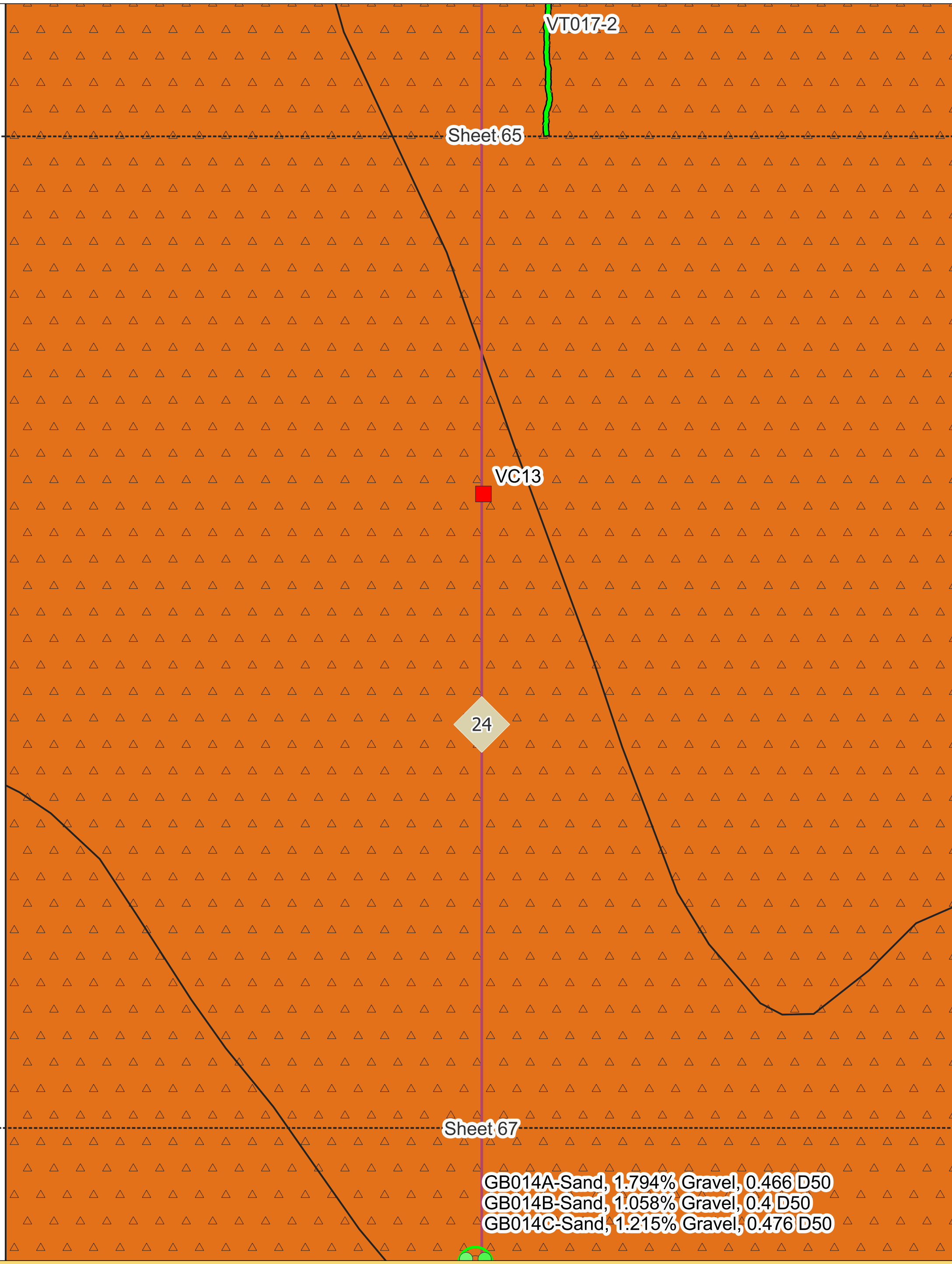

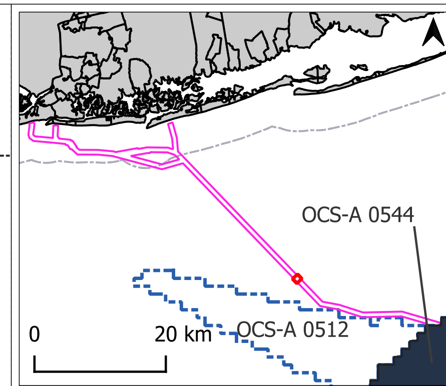

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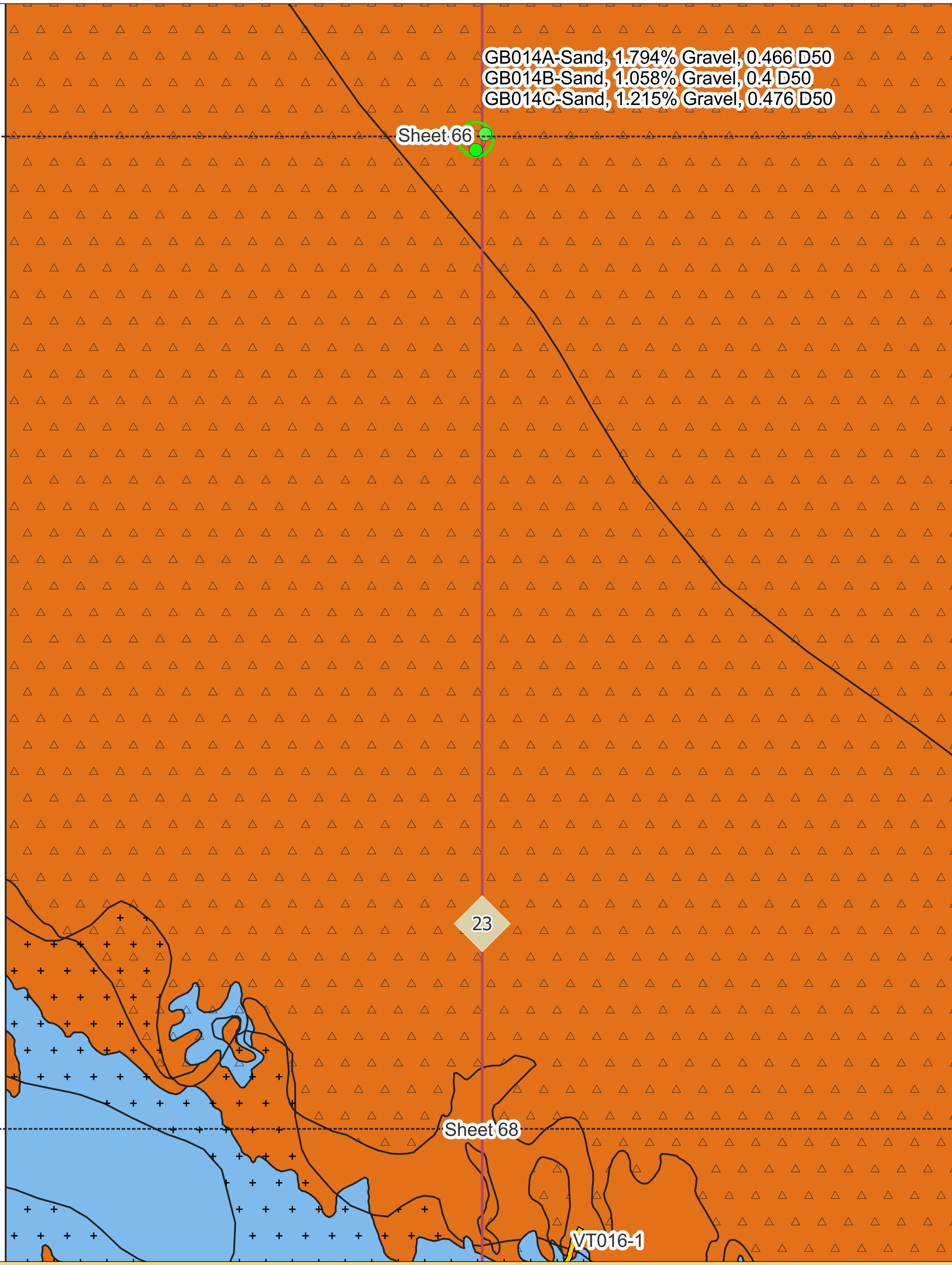

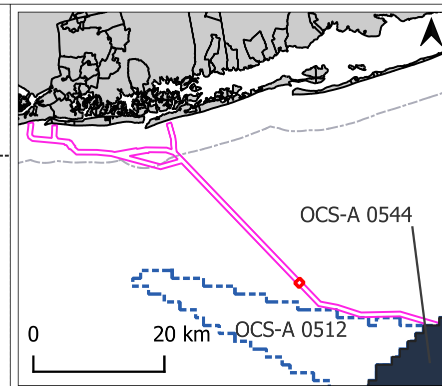

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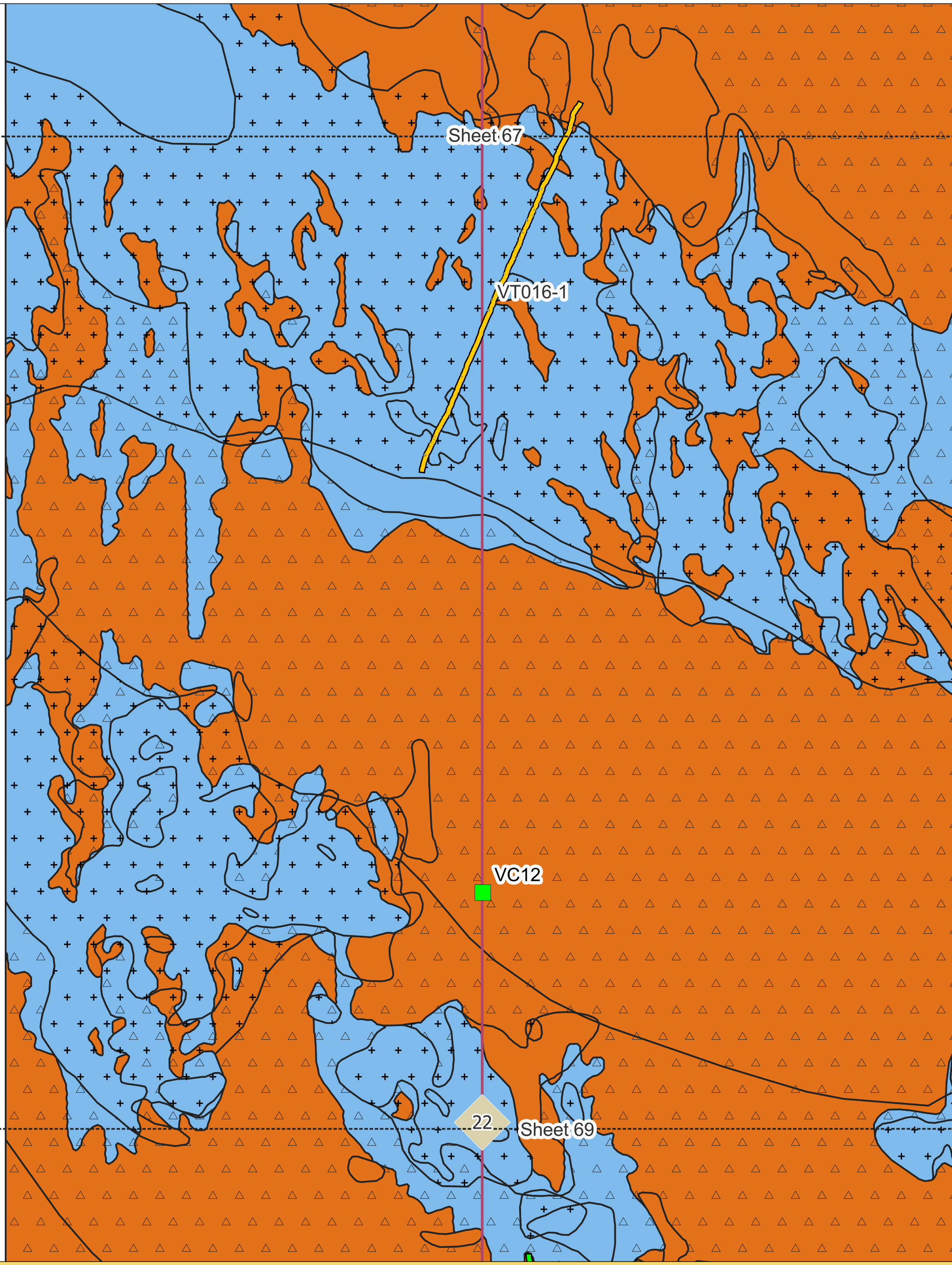

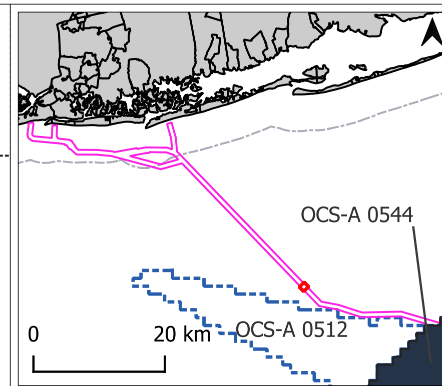

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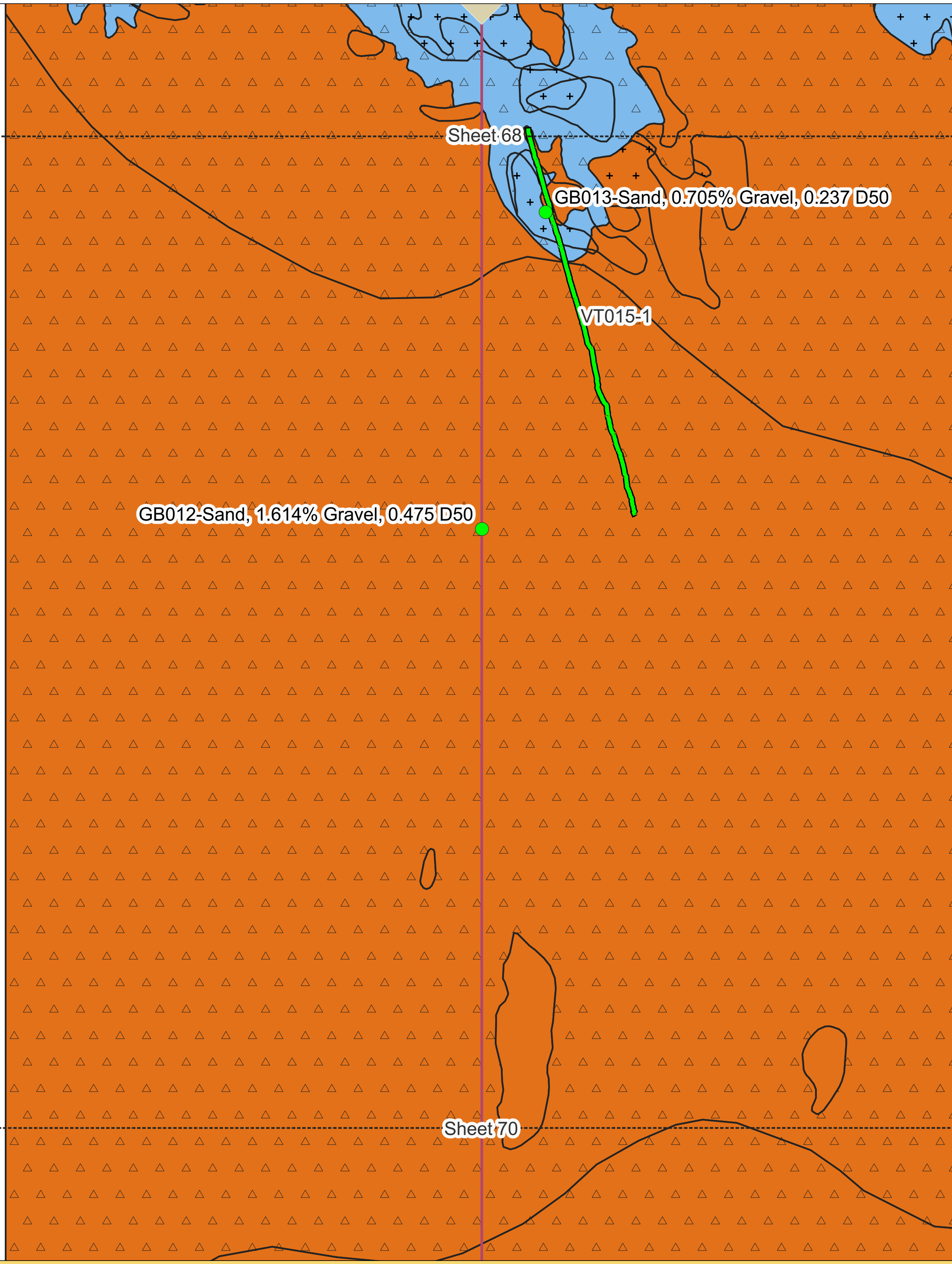

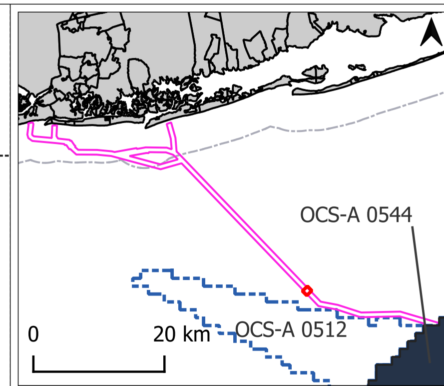

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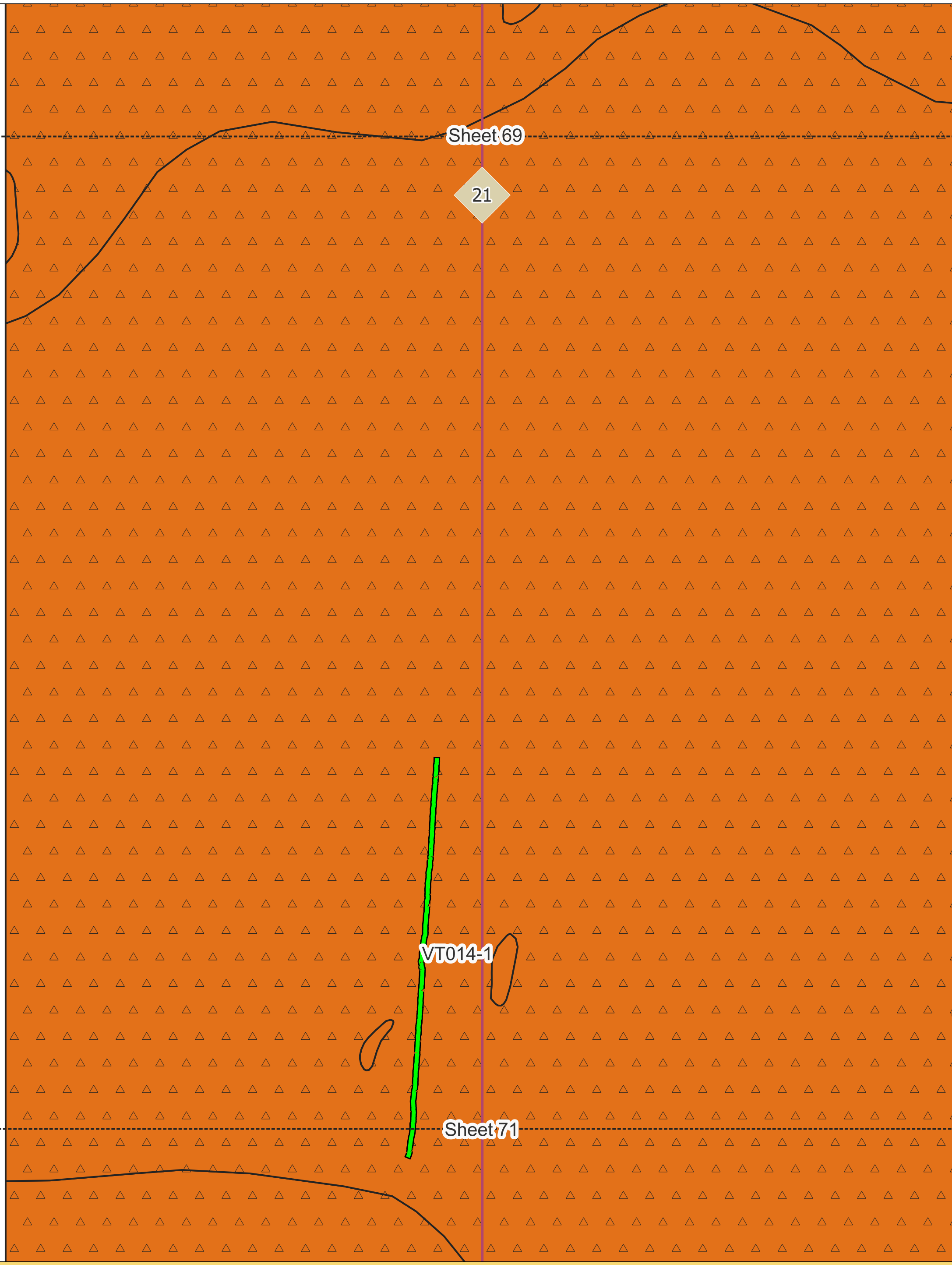

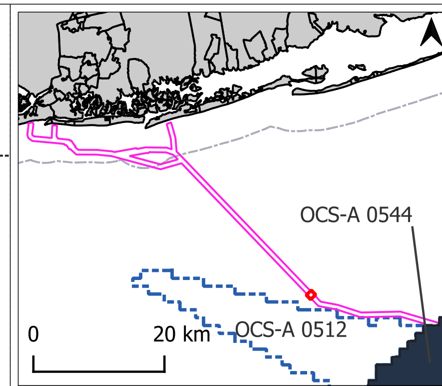

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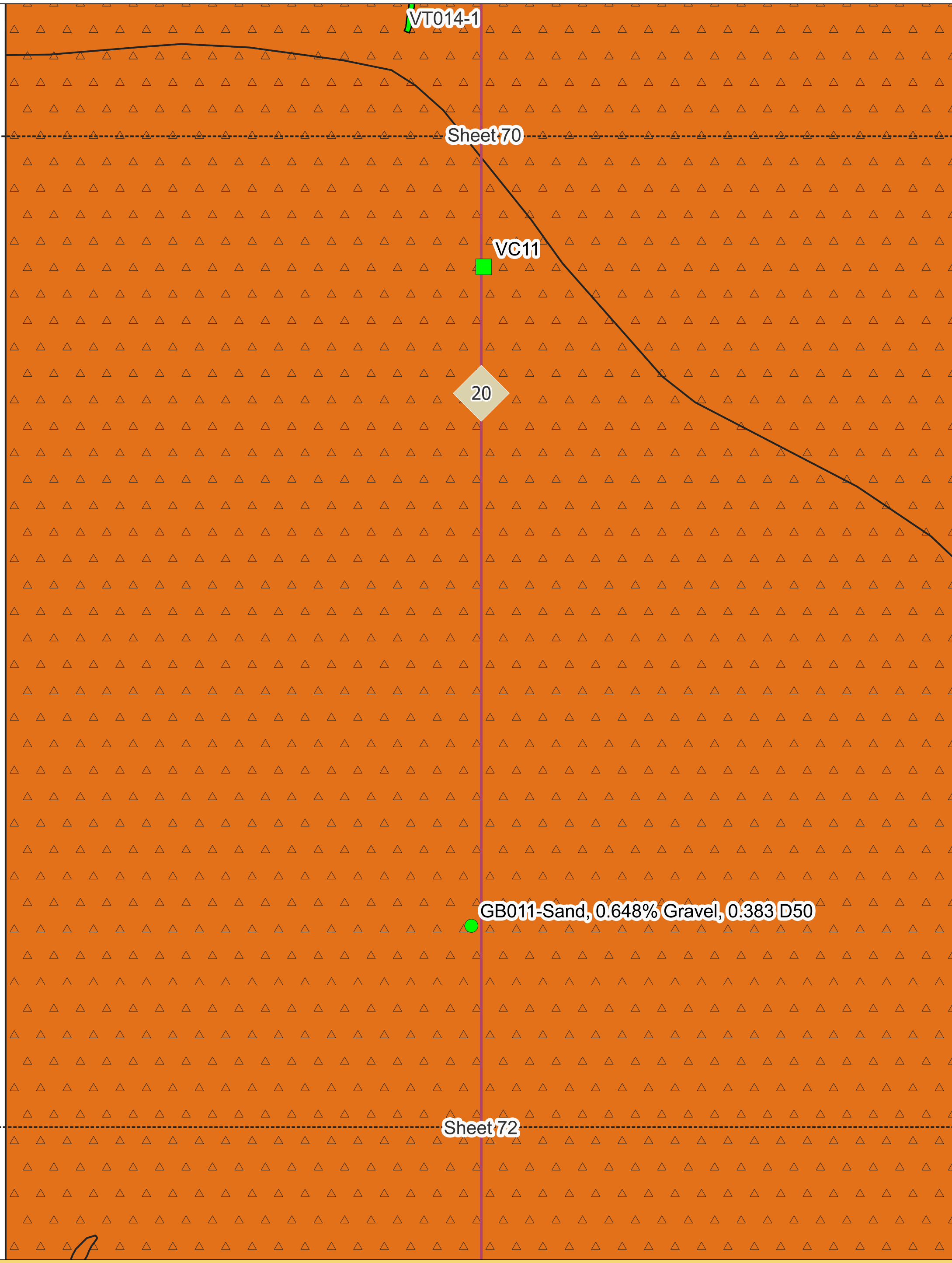

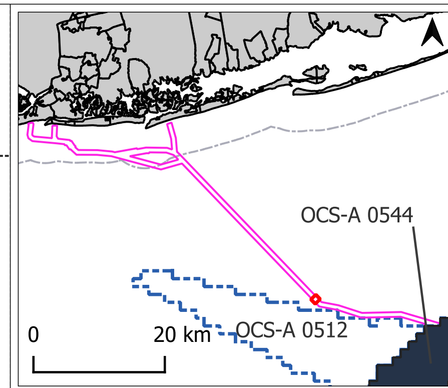

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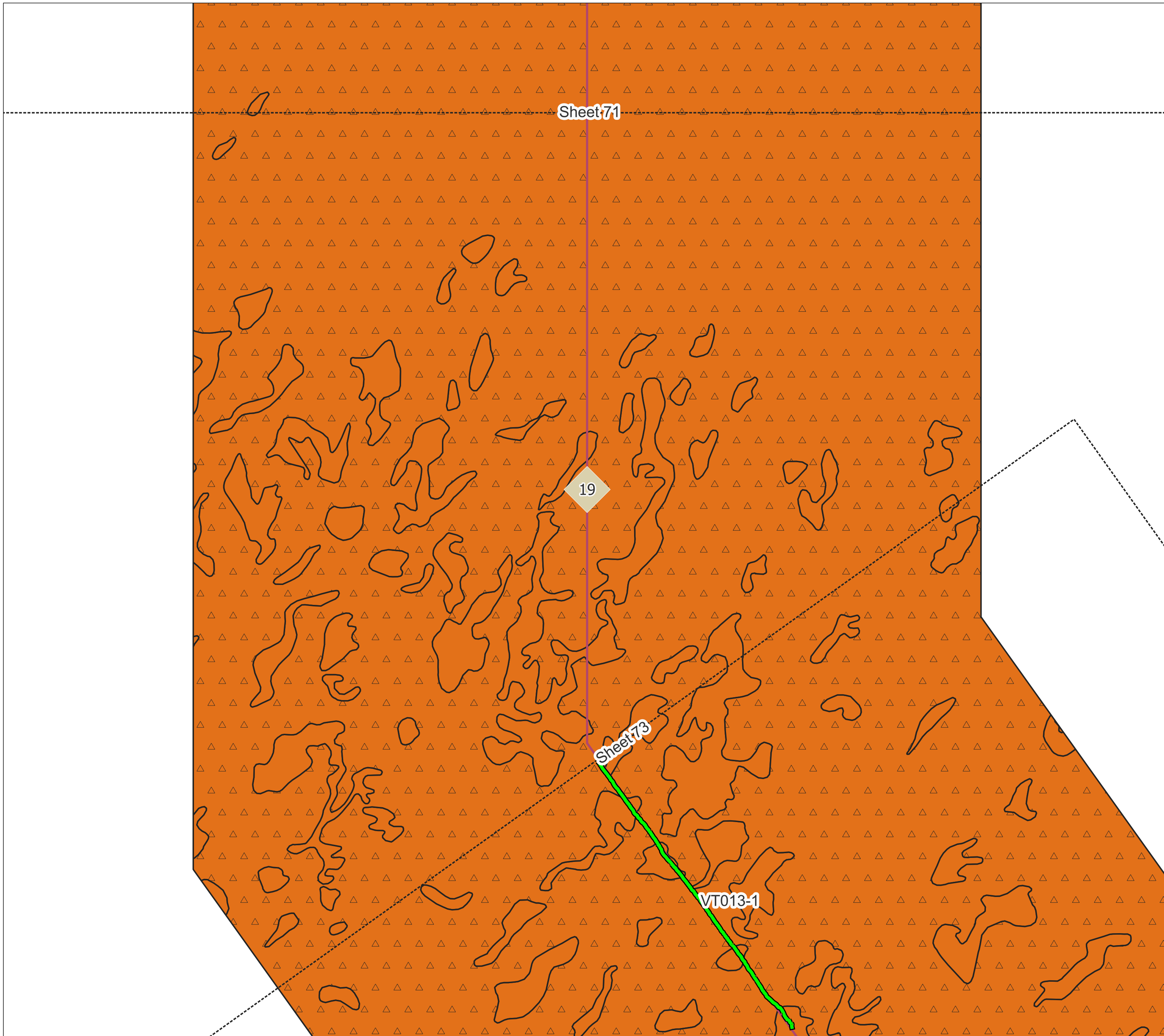

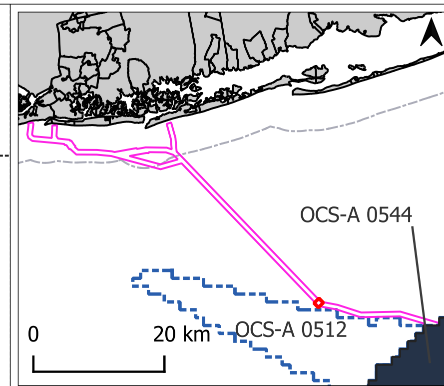

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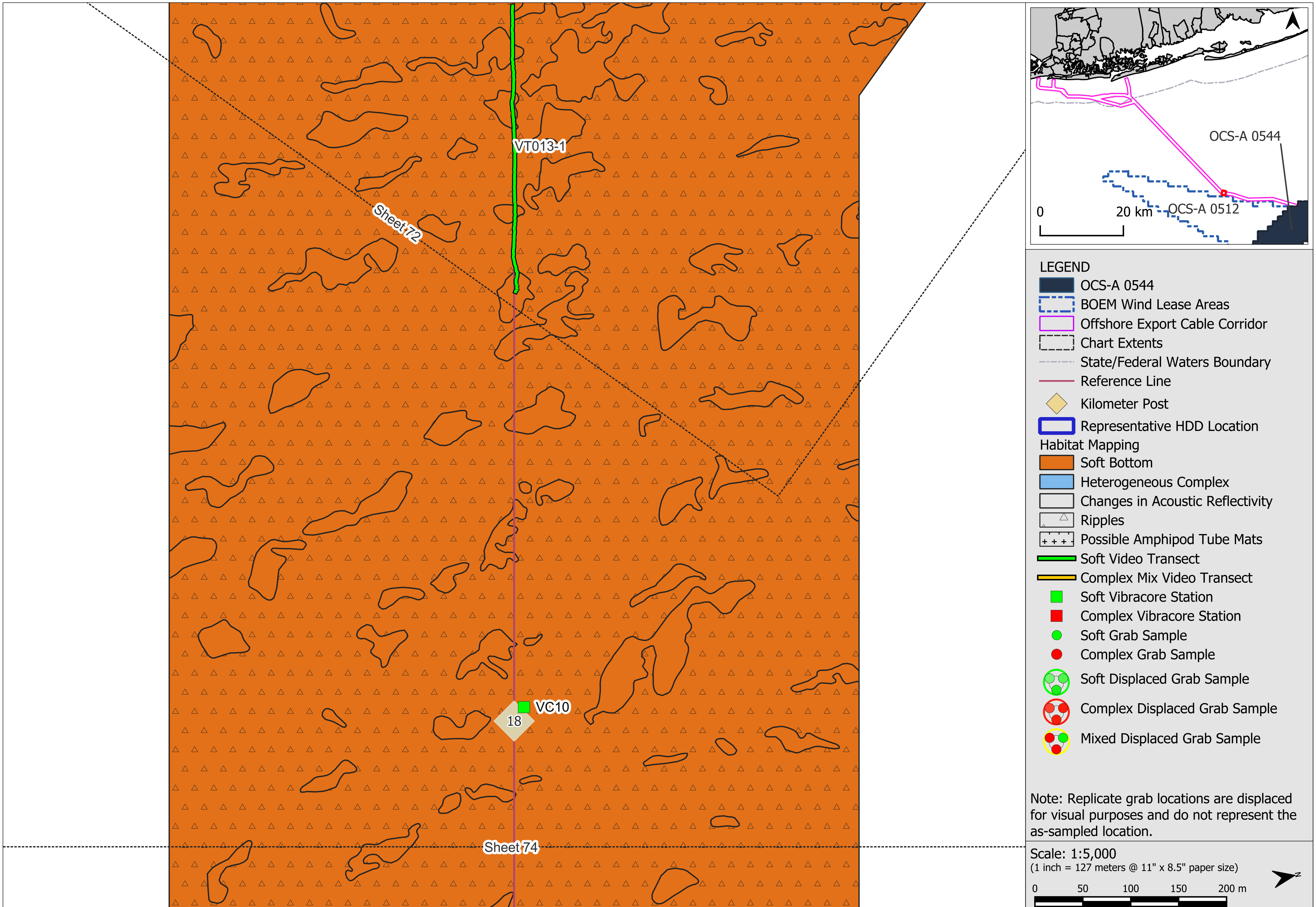
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OCS-A 0544
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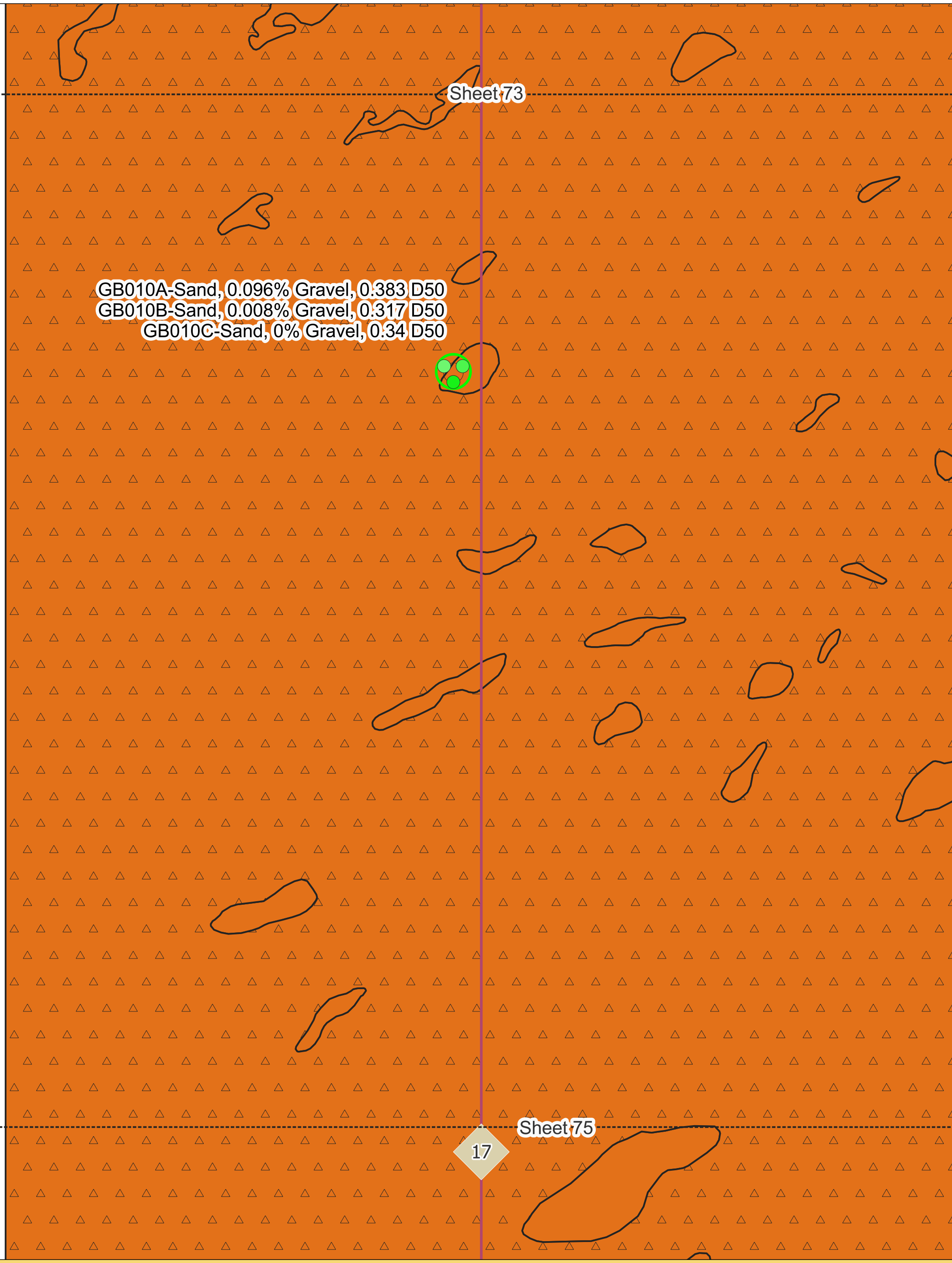

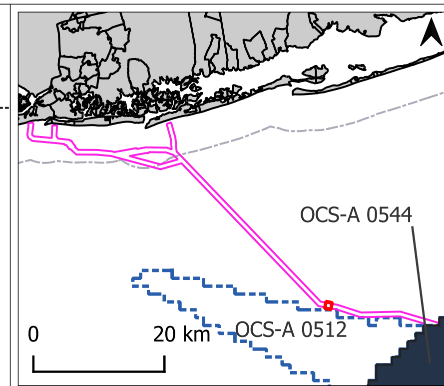

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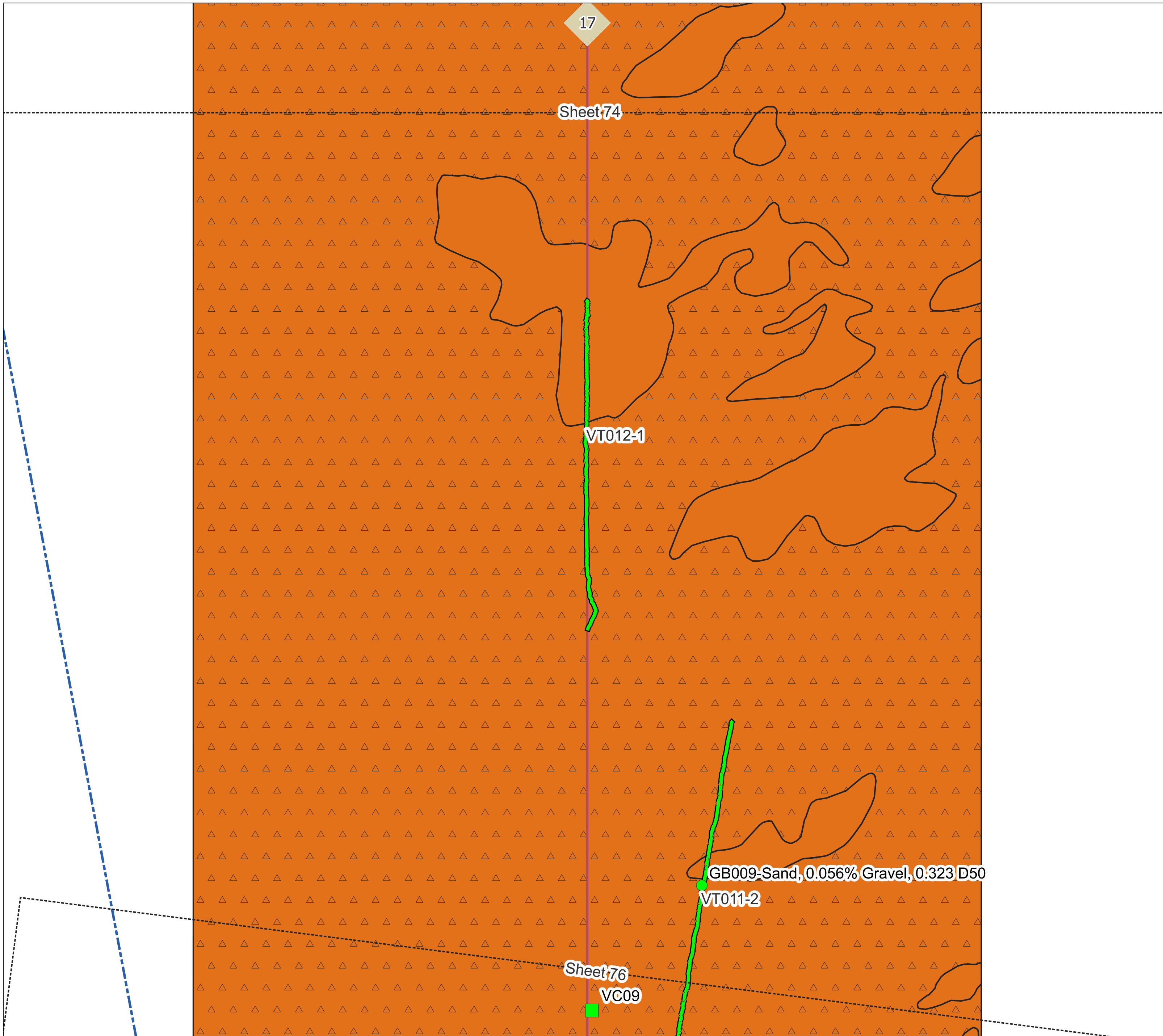

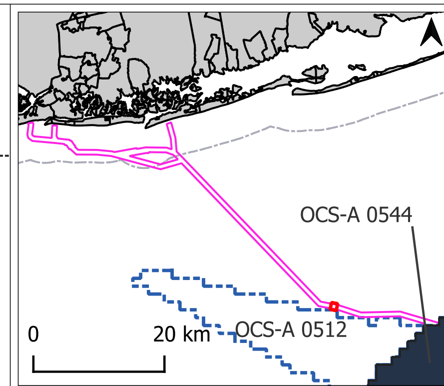

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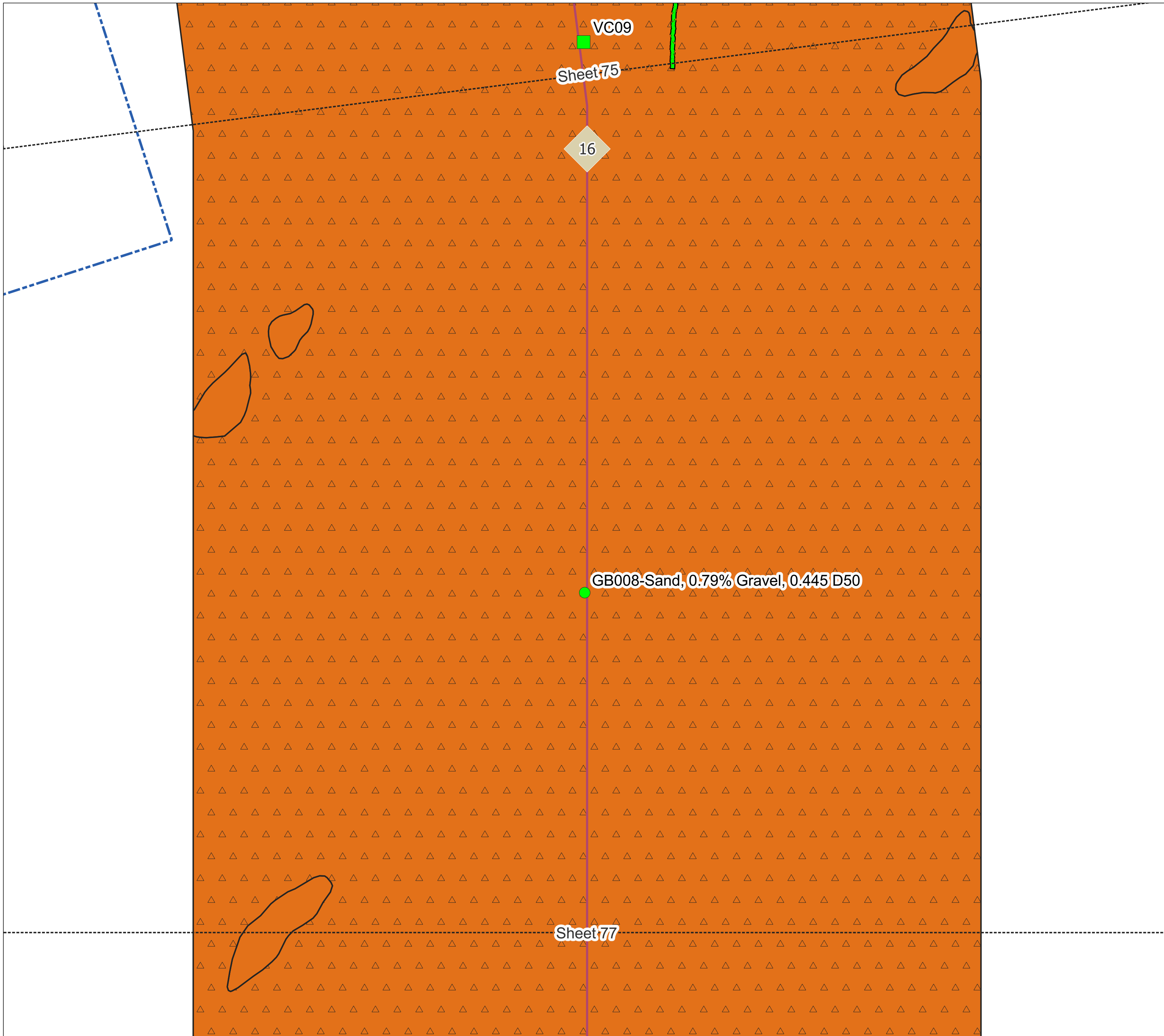

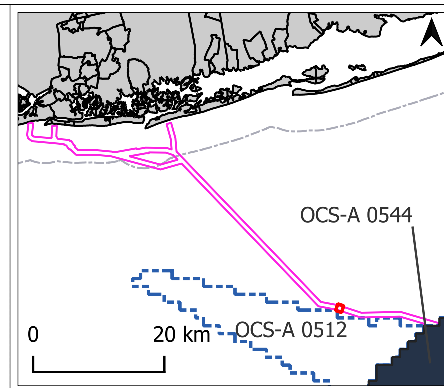

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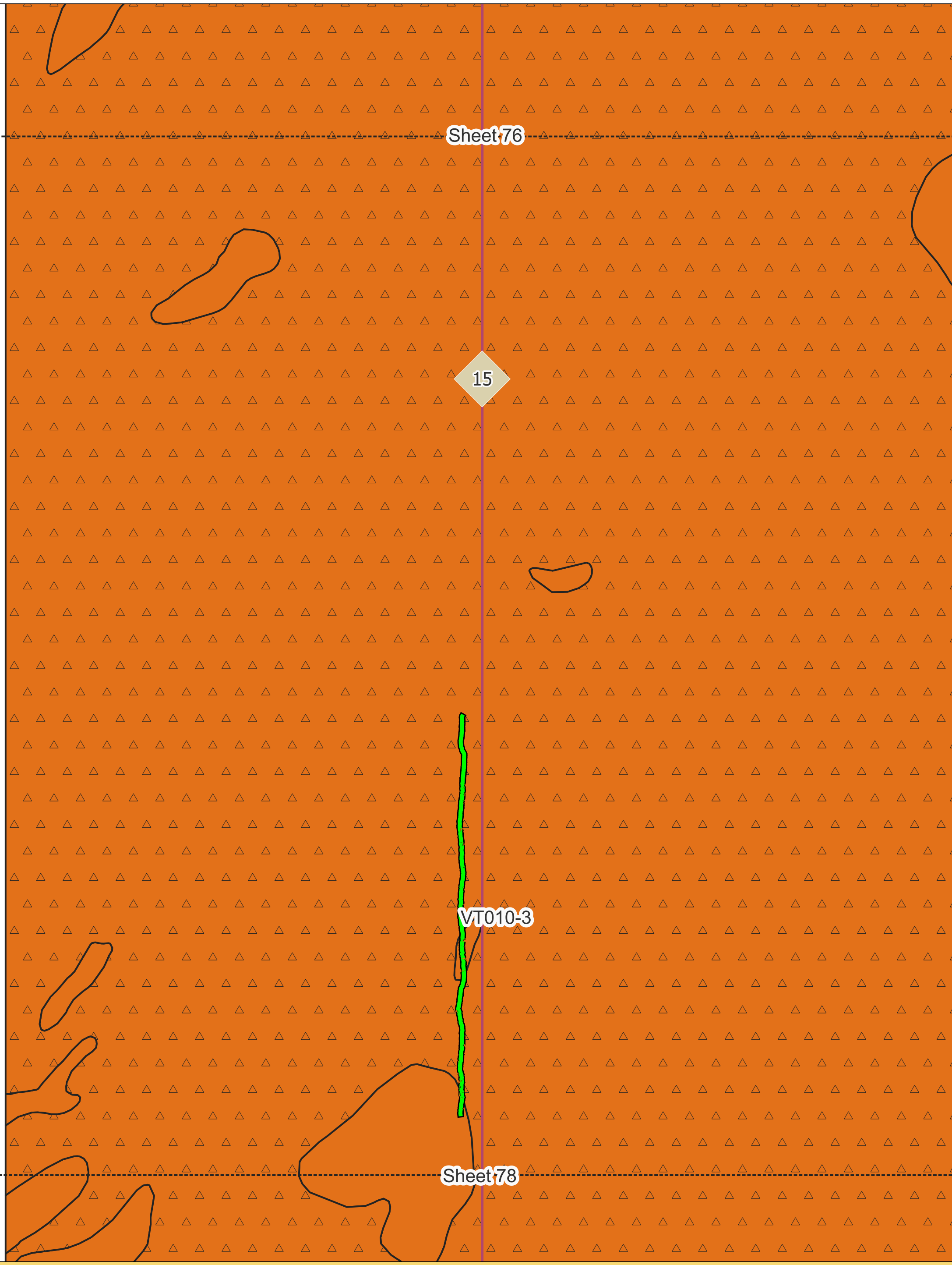

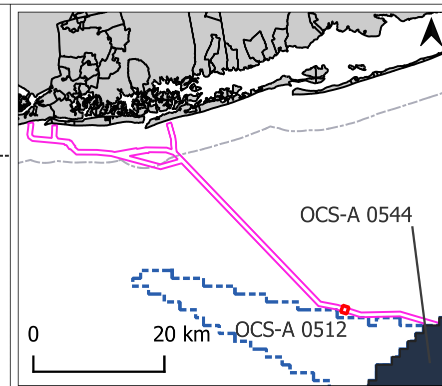

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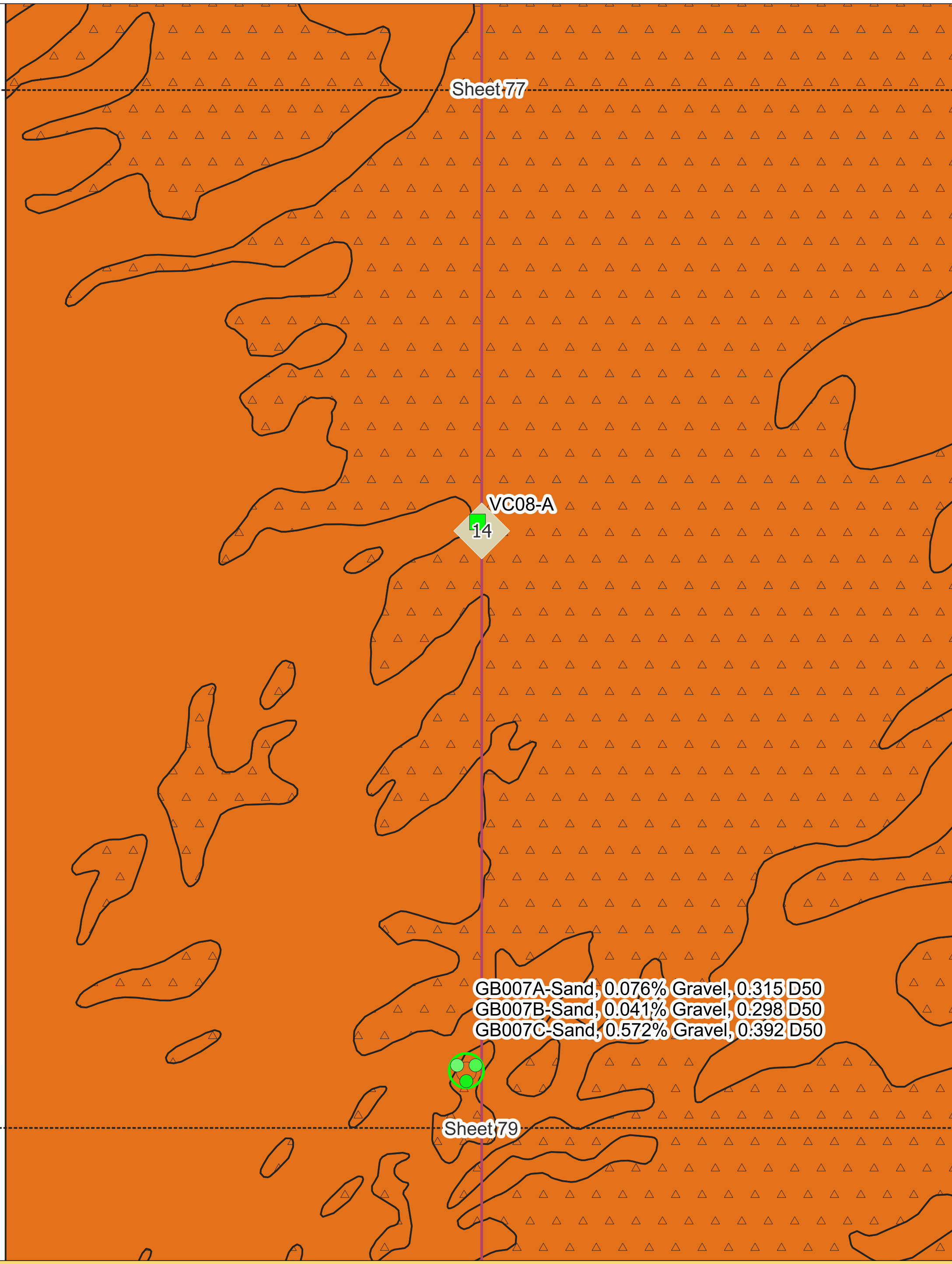

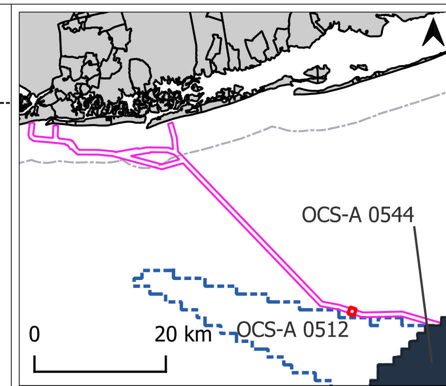

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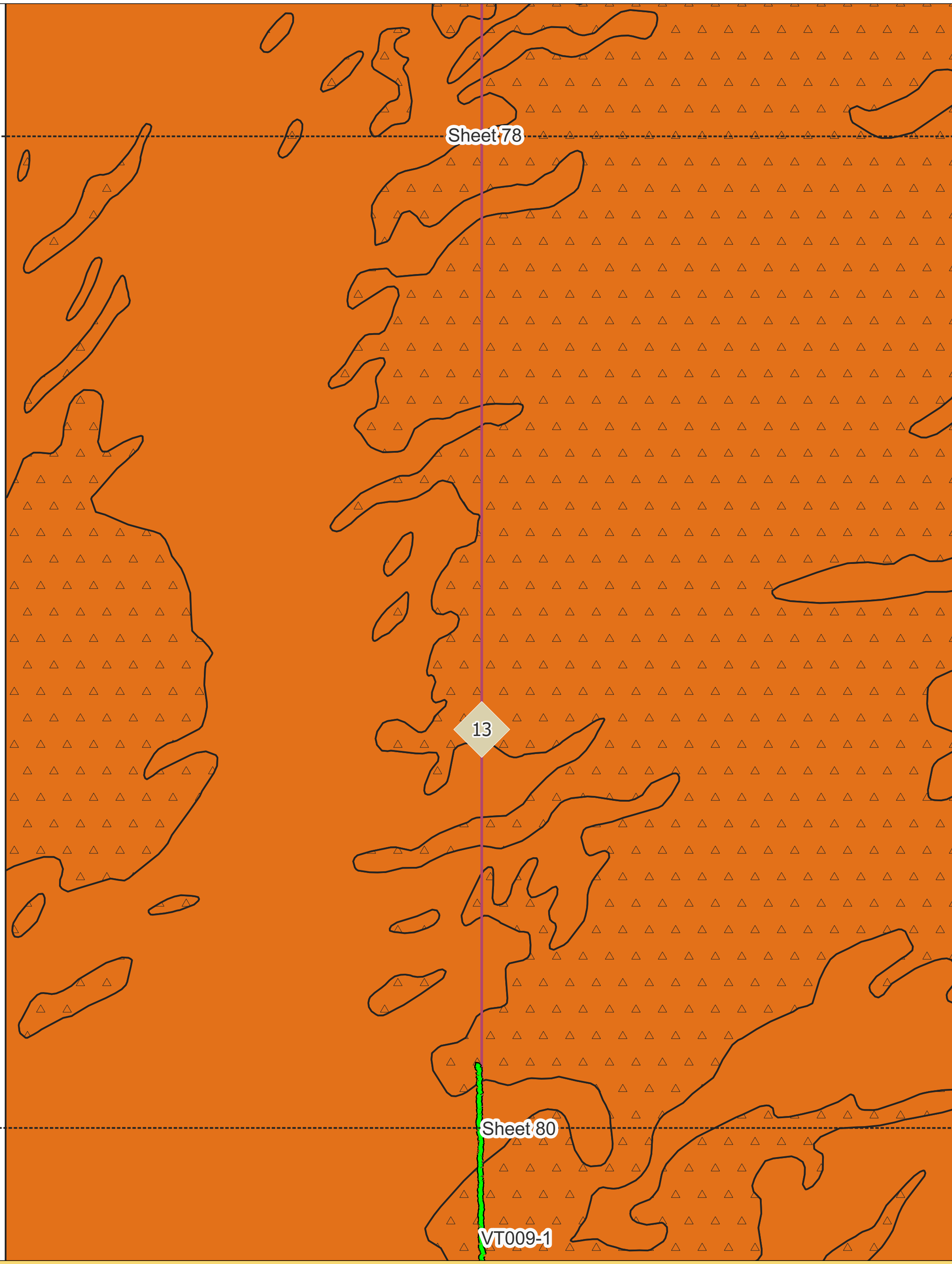
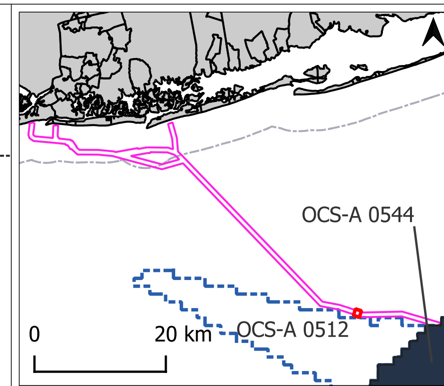
0 50 100 150 200 m

Large Scale Maps of Bottom Habitats and Benthic Features Located in the OECC

VINEYARD MID-ATLANTIC

VINEYARD OFFSHORE





LEGEND

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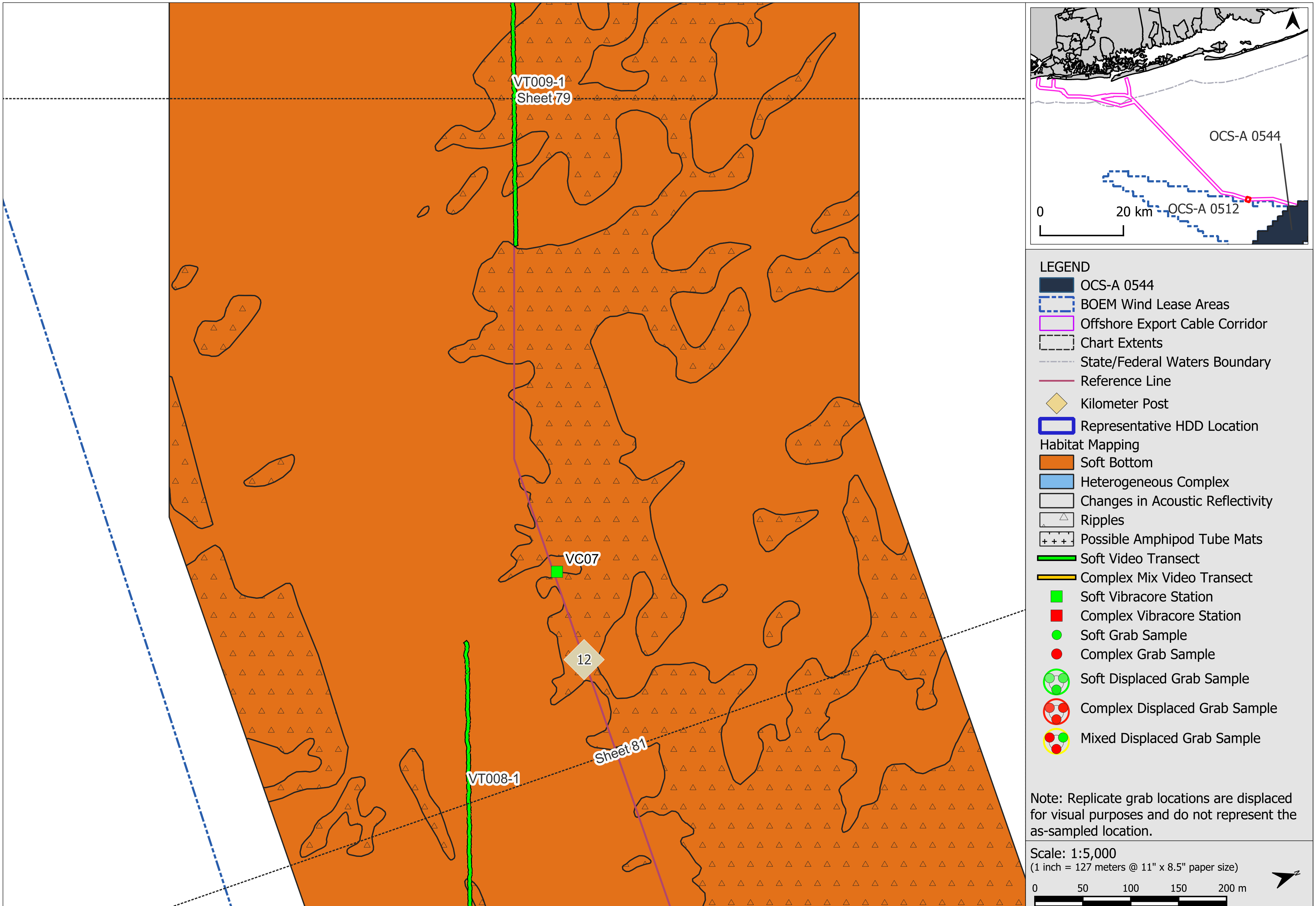

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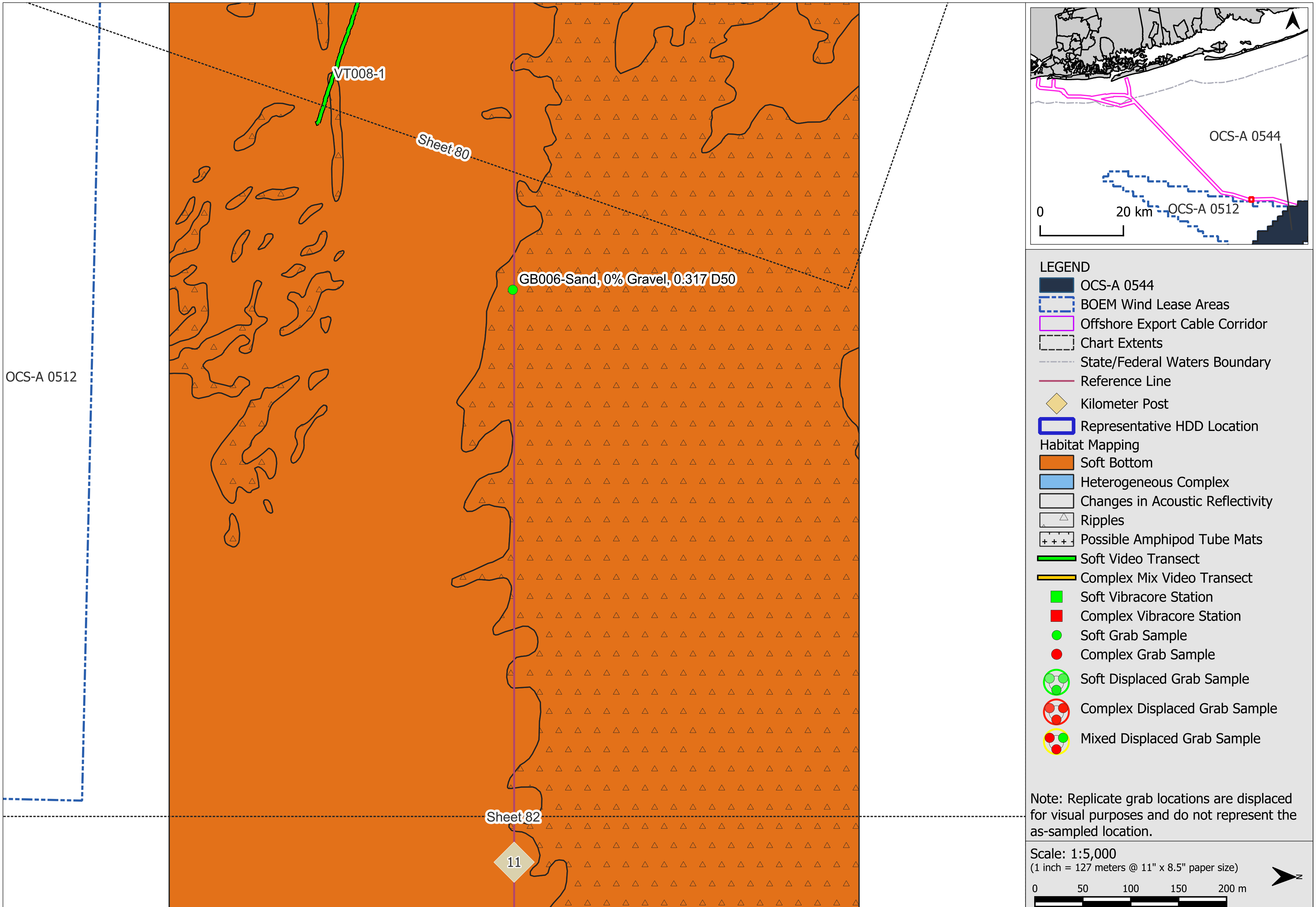

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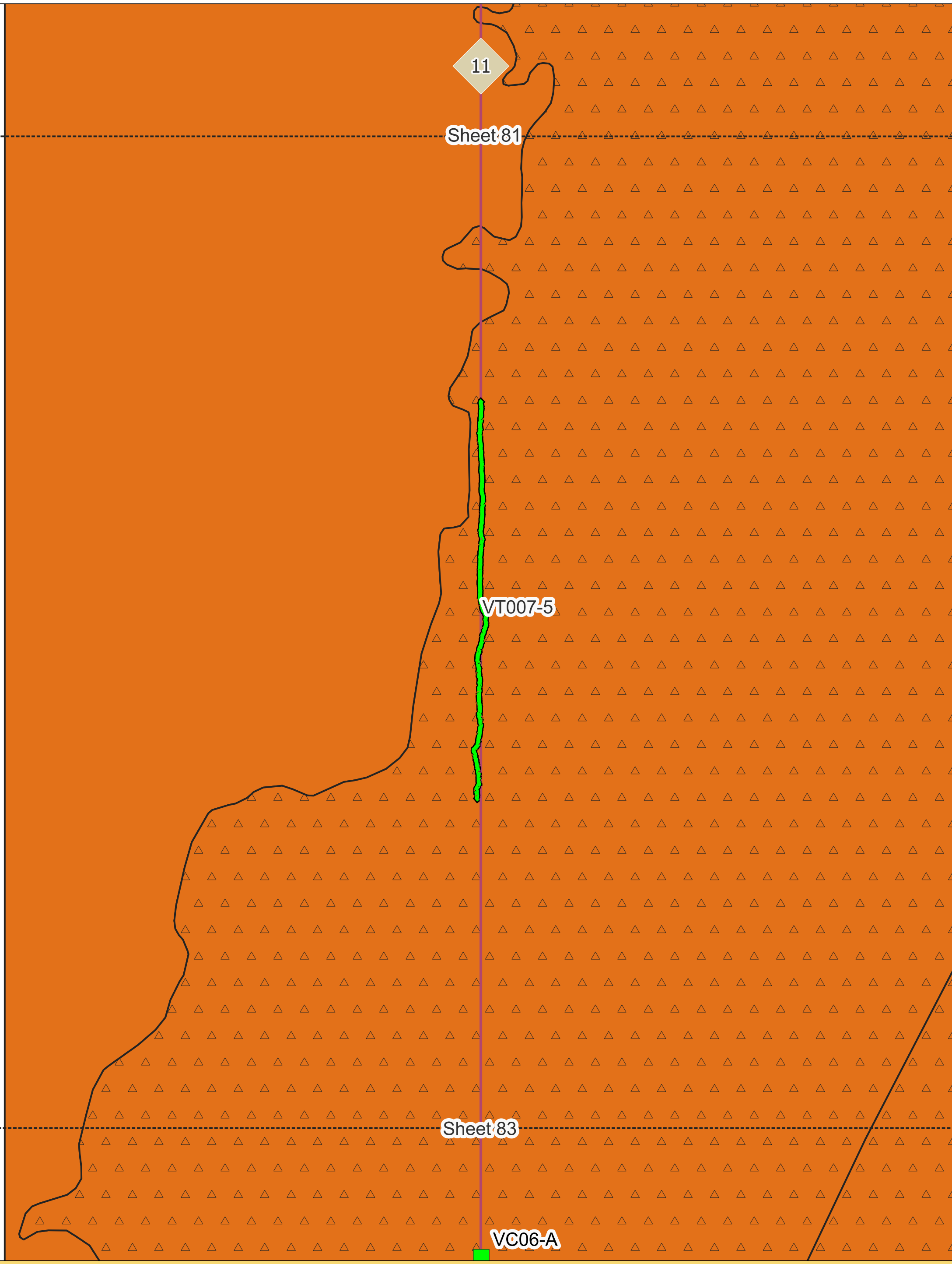

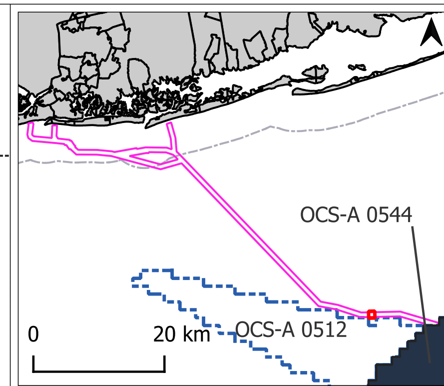

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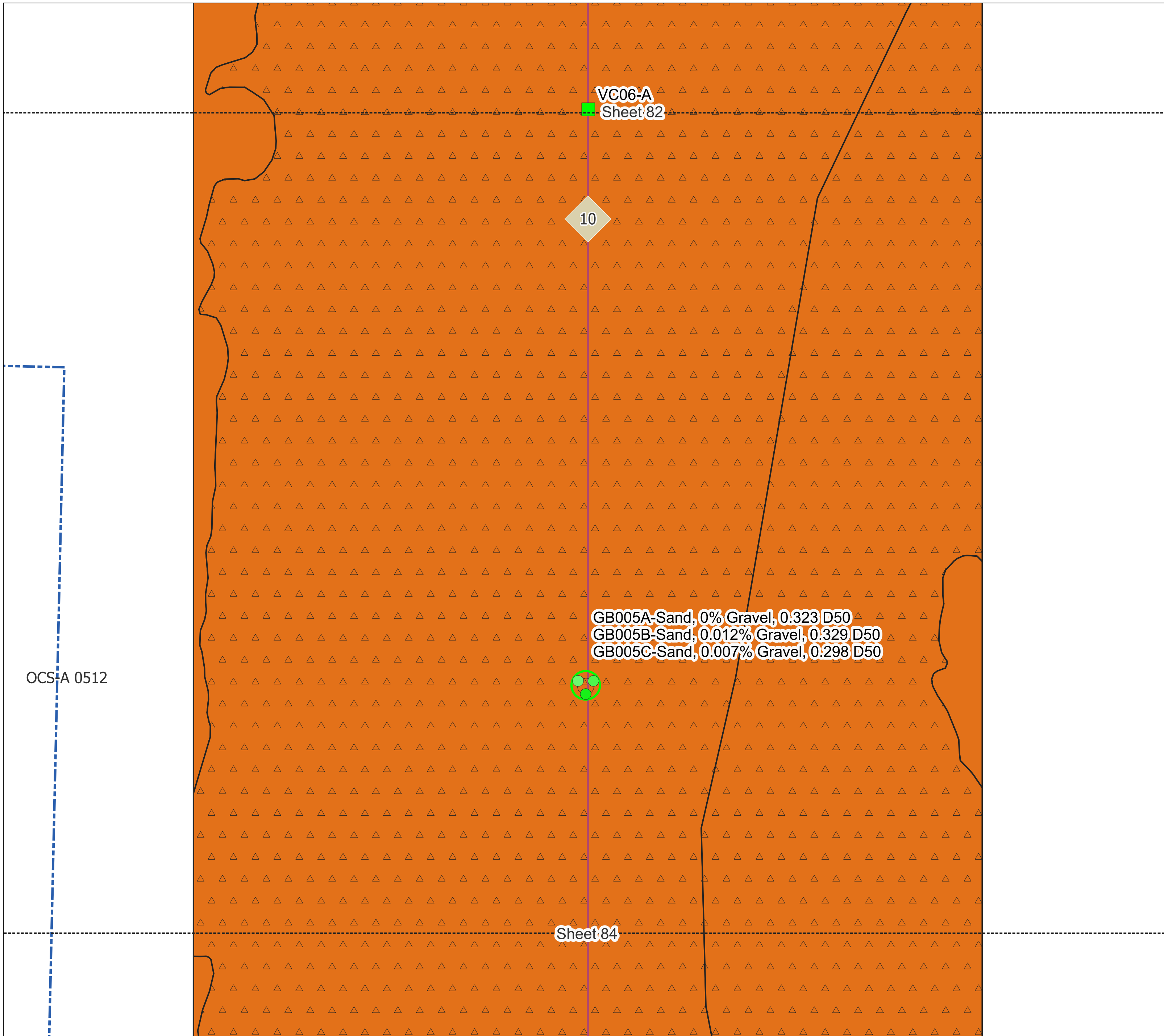

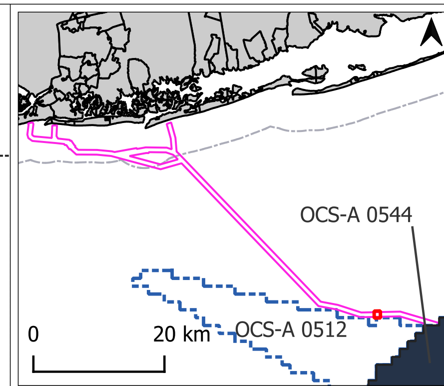

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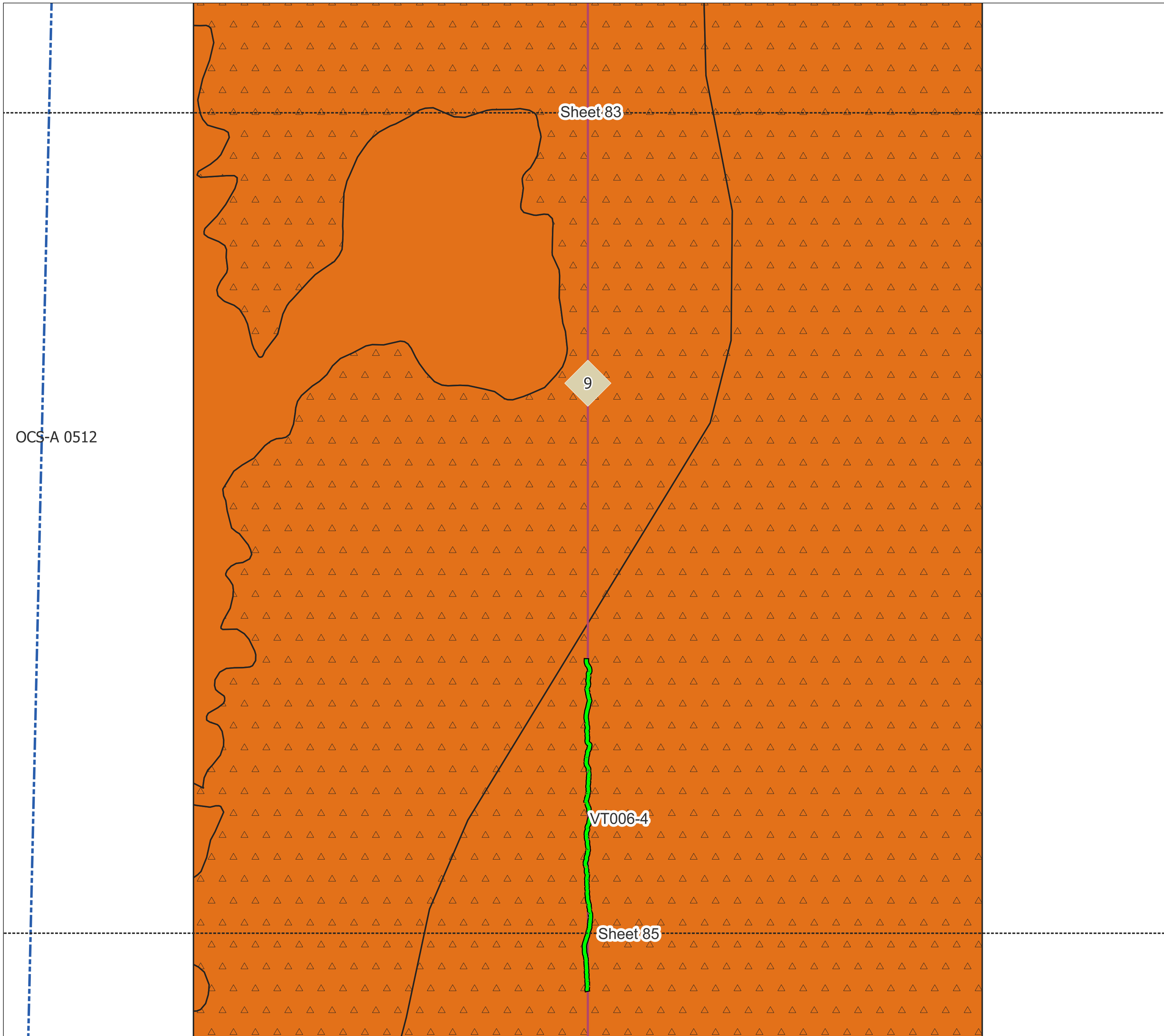

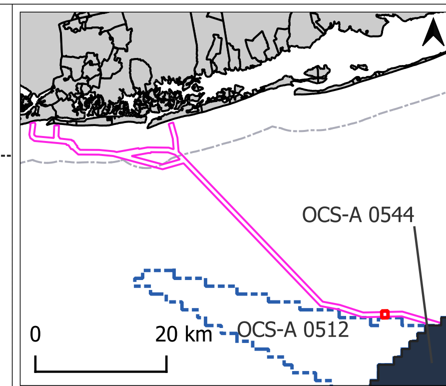

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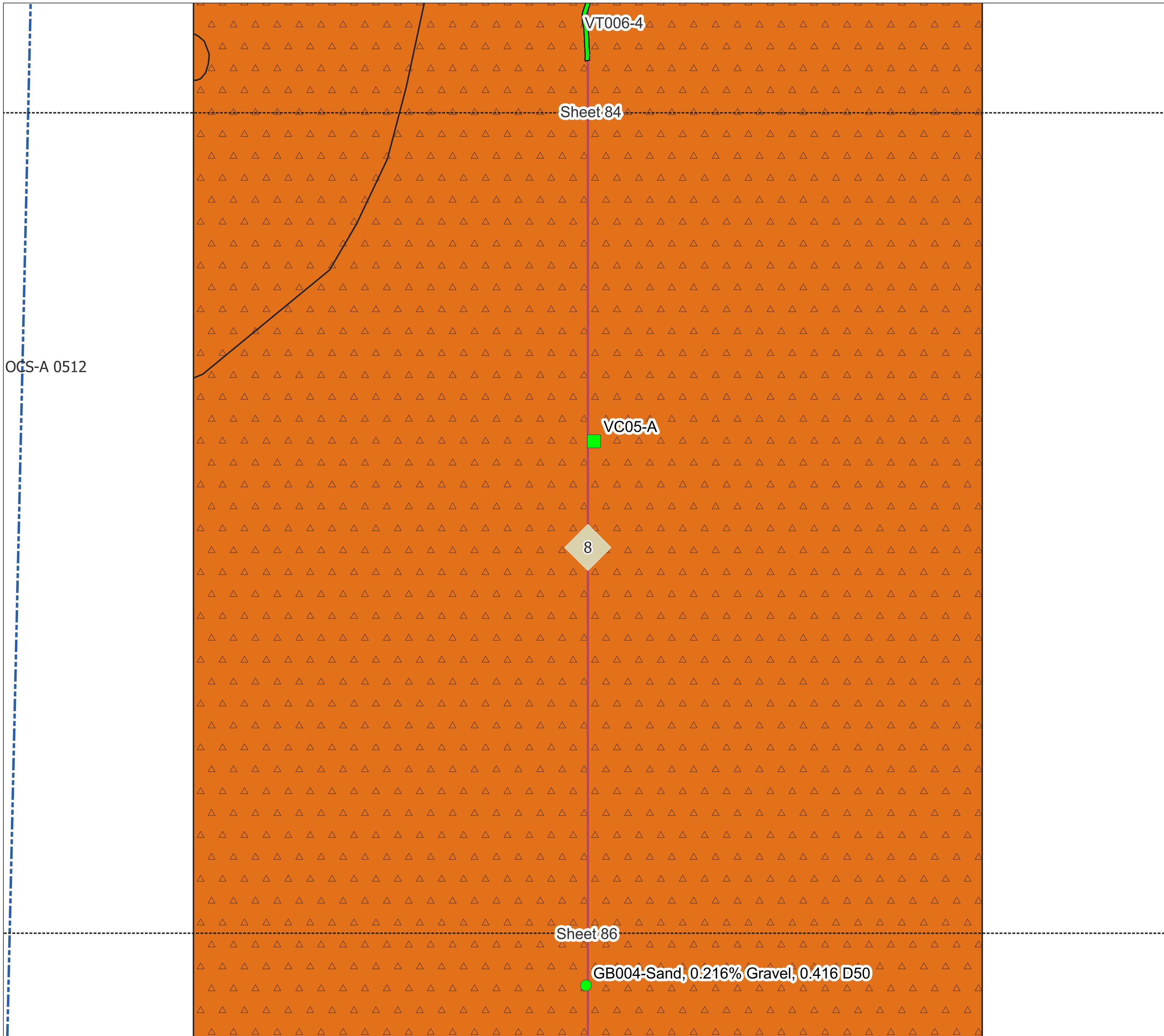

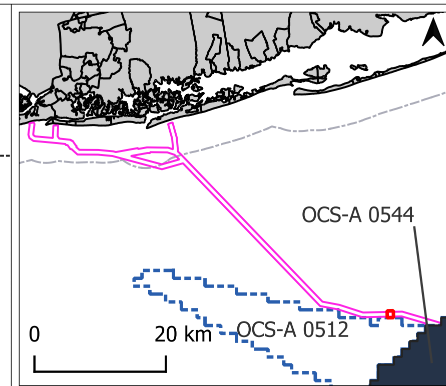

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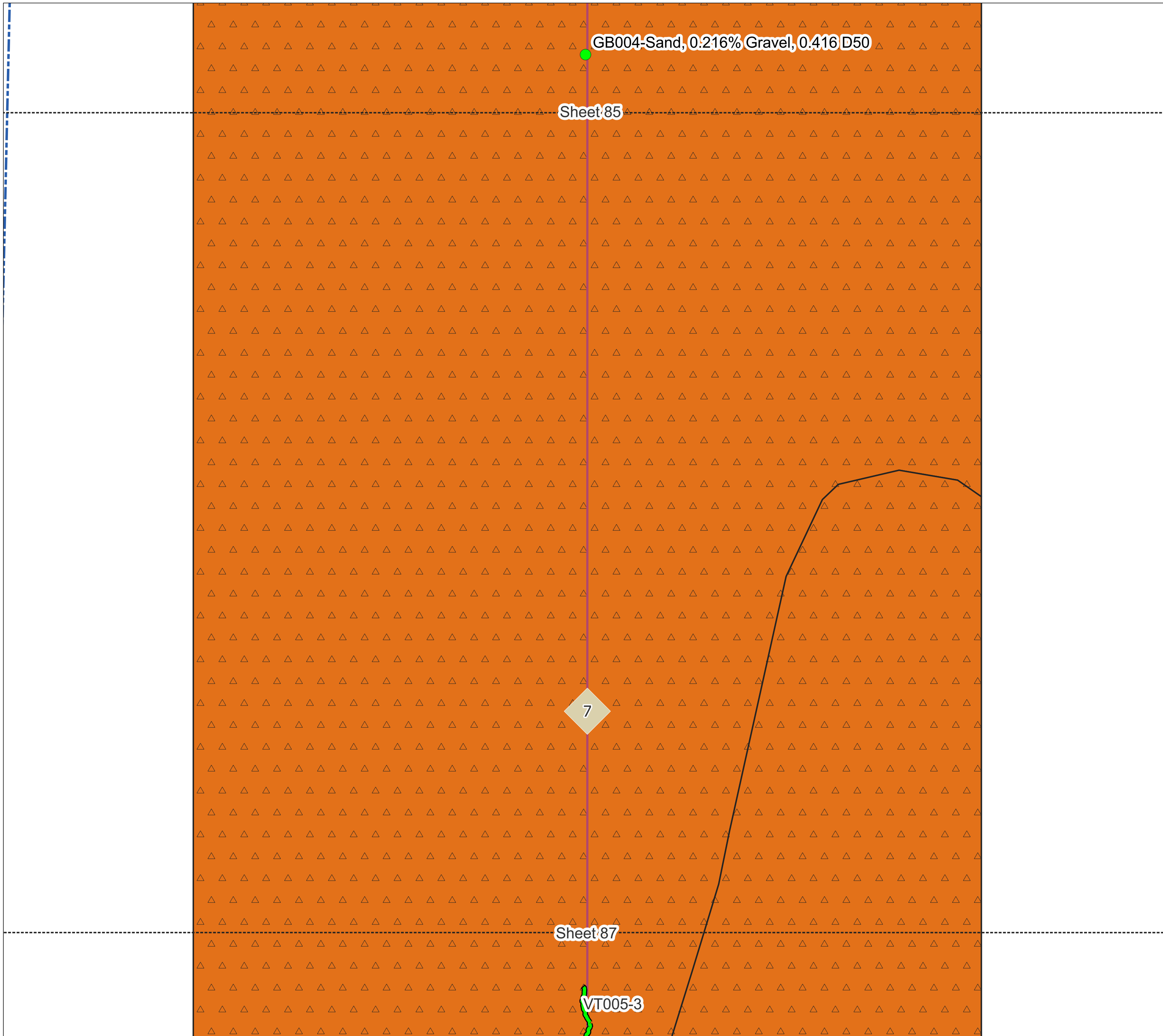

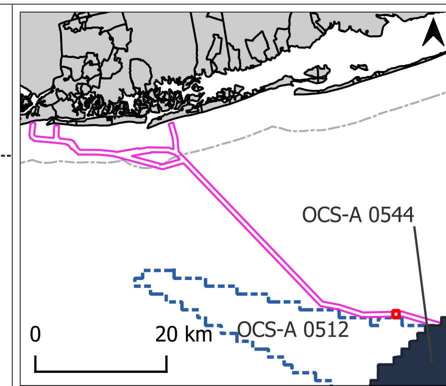

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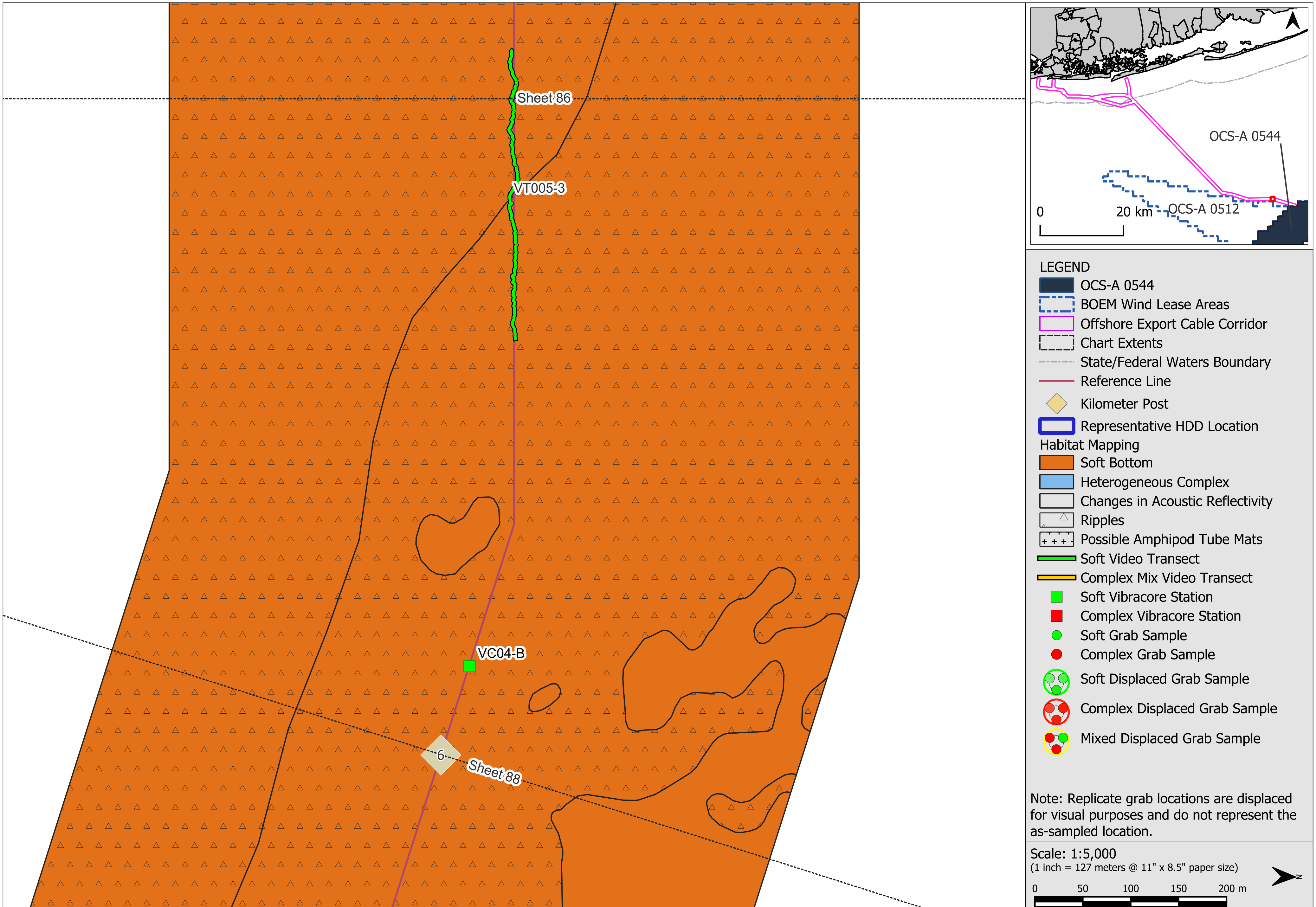

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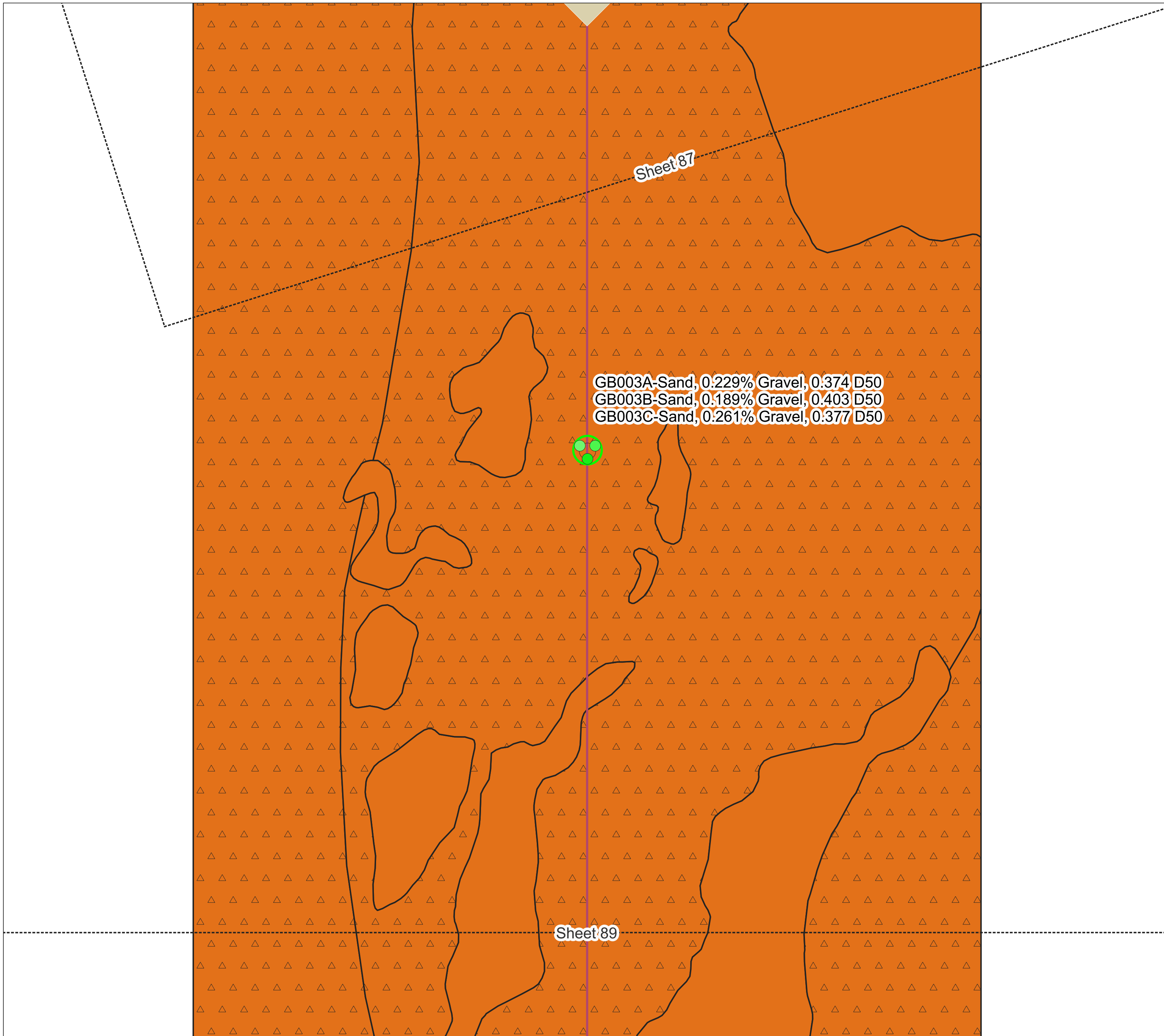

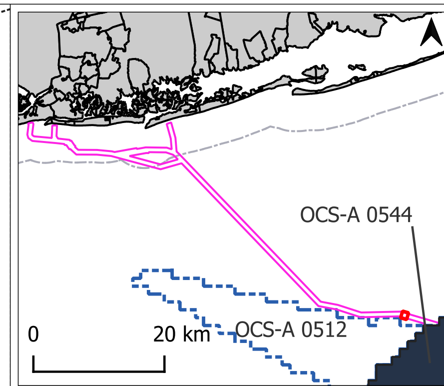

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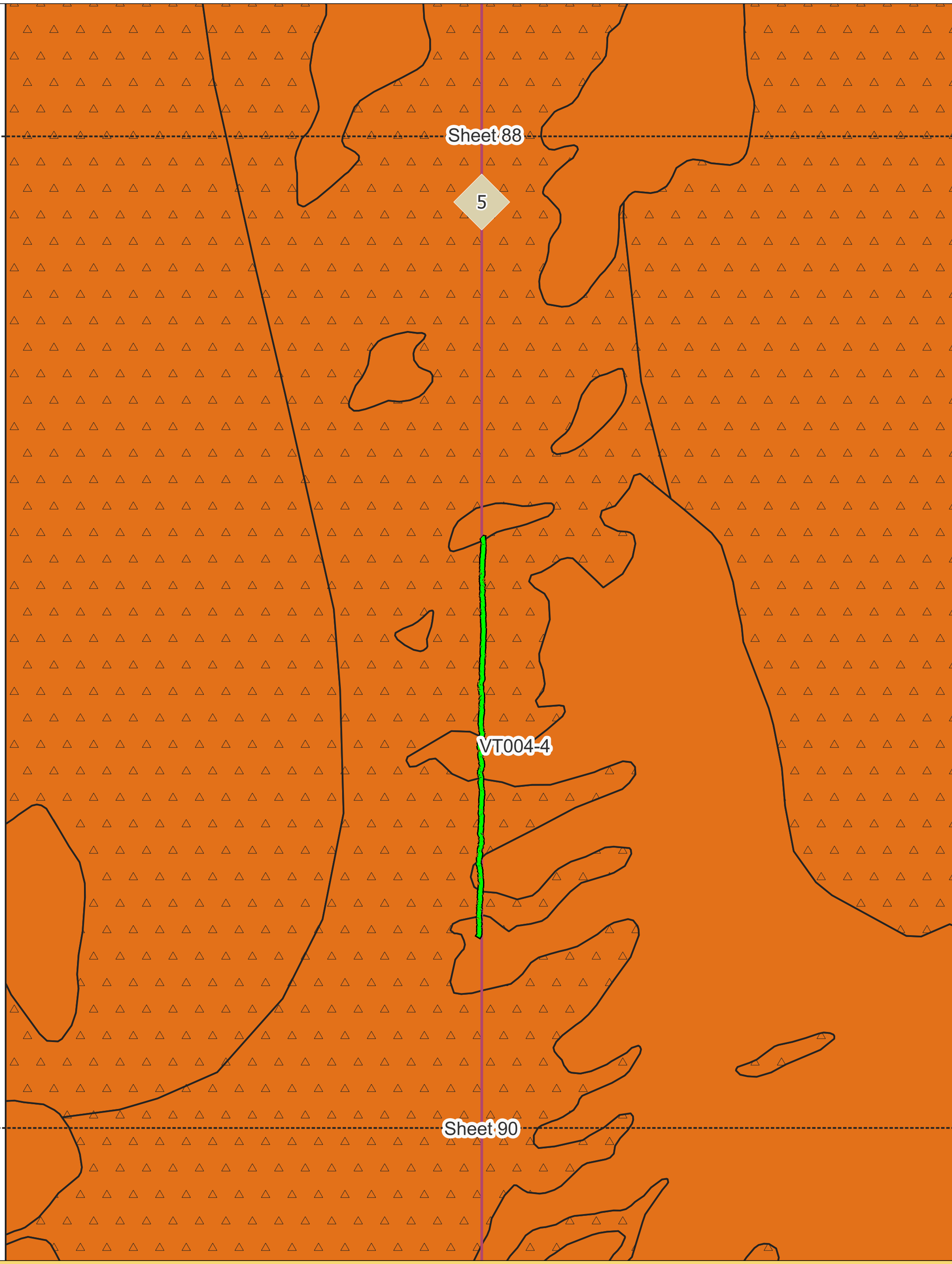

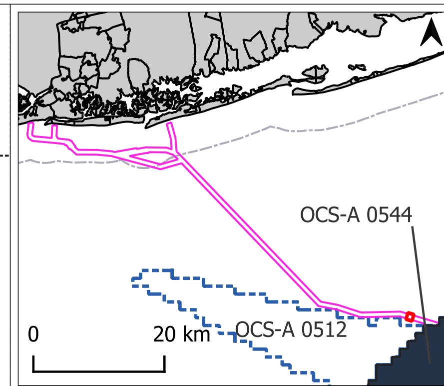

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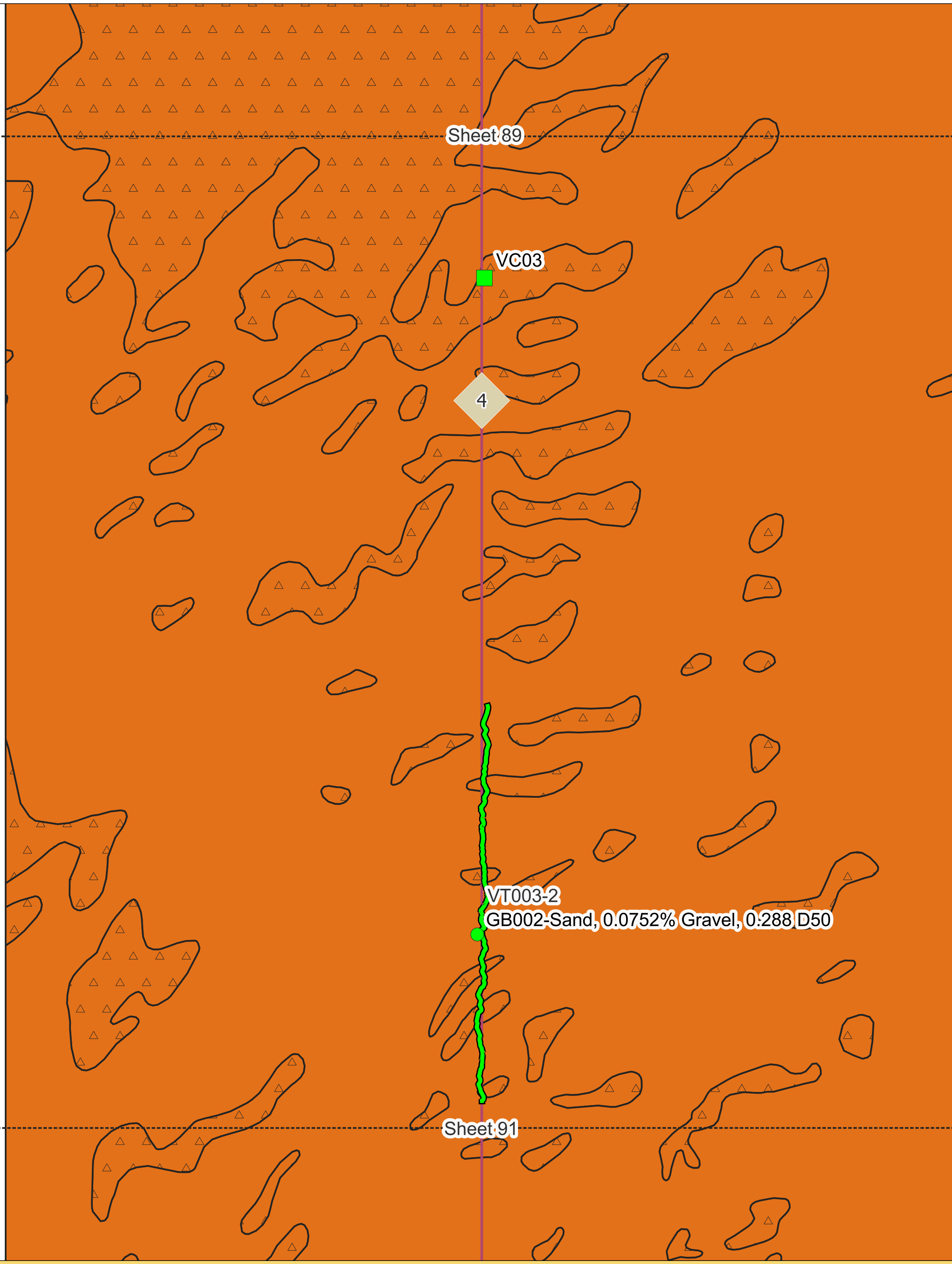

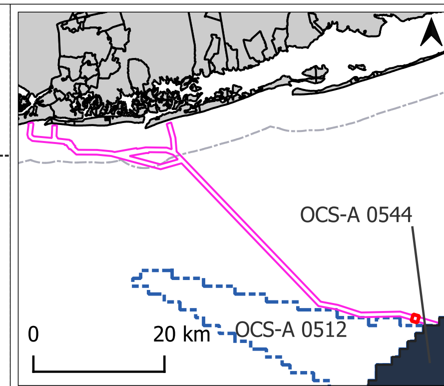

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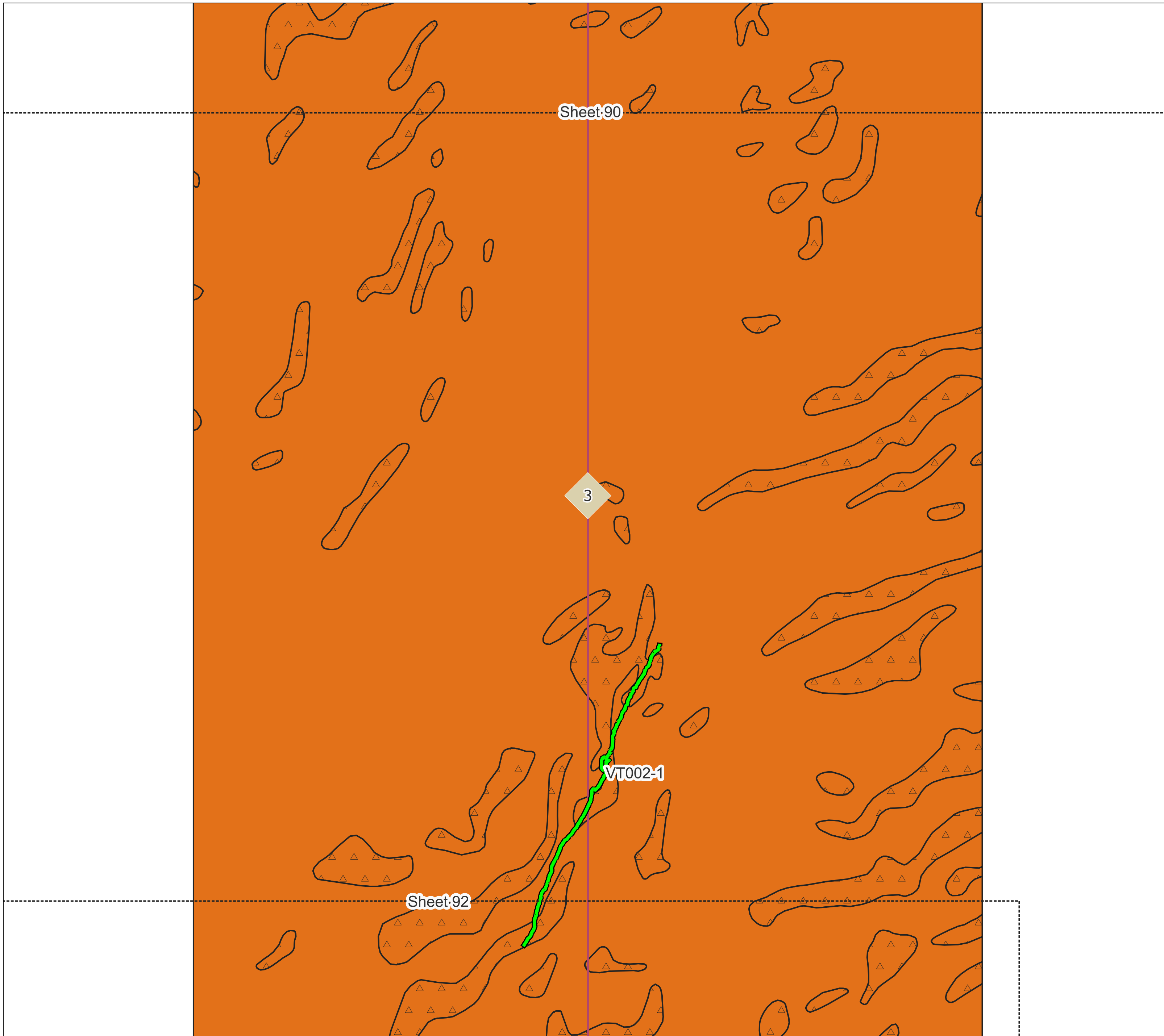

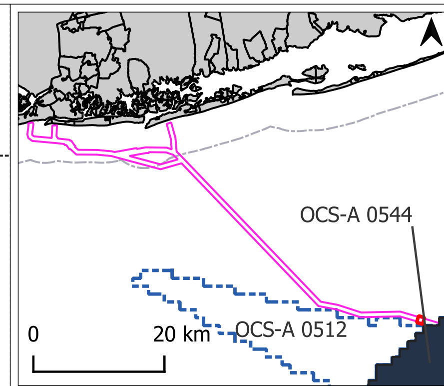

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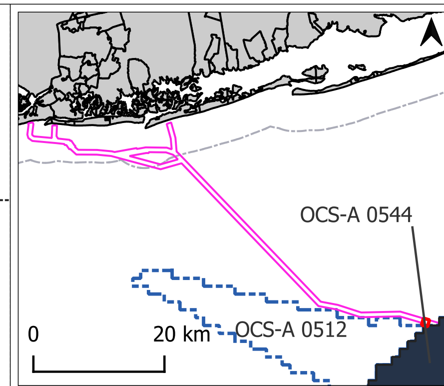

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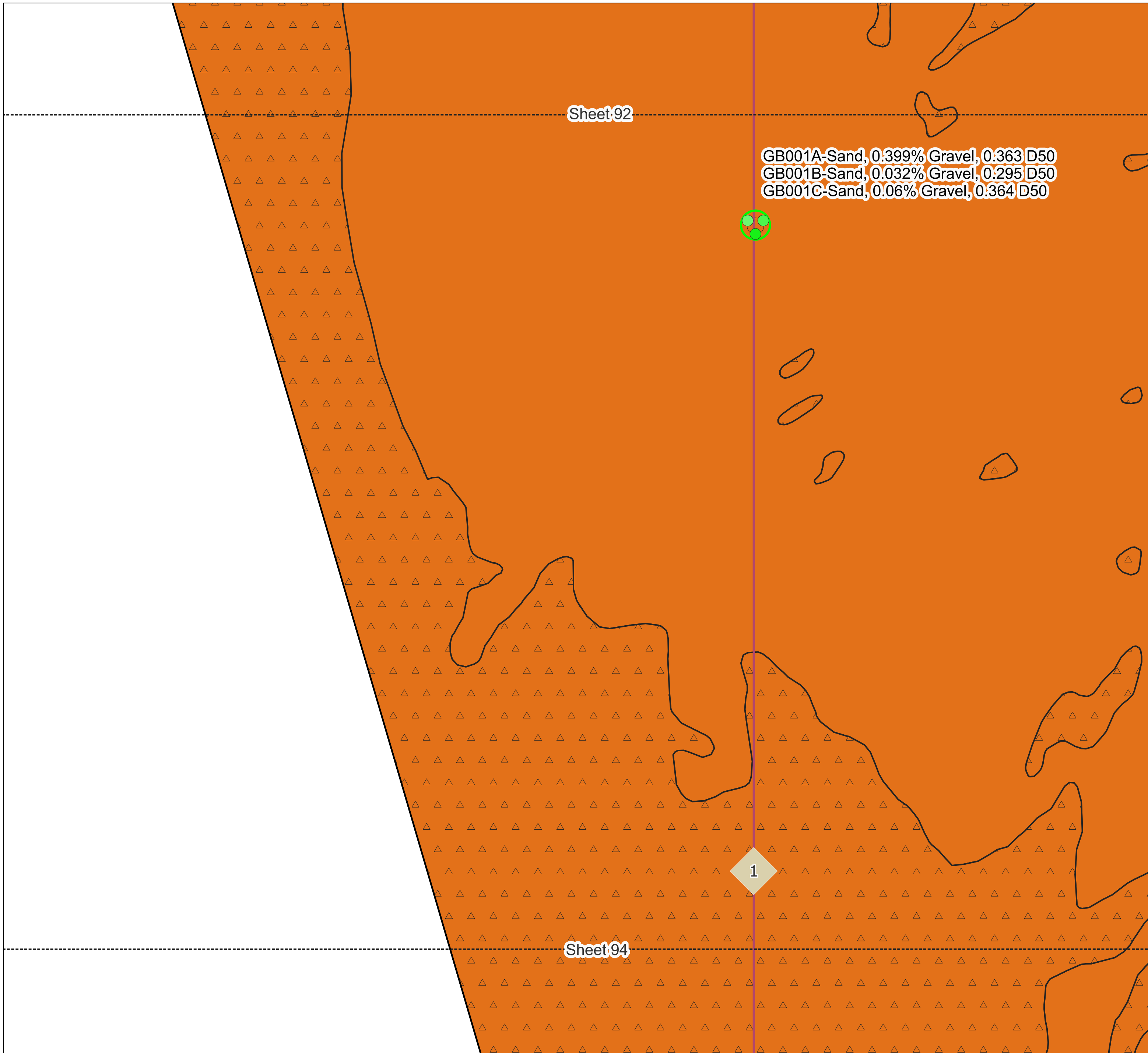

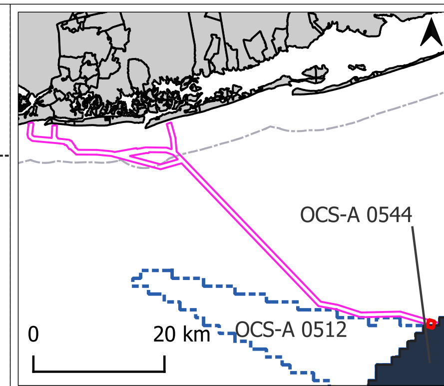

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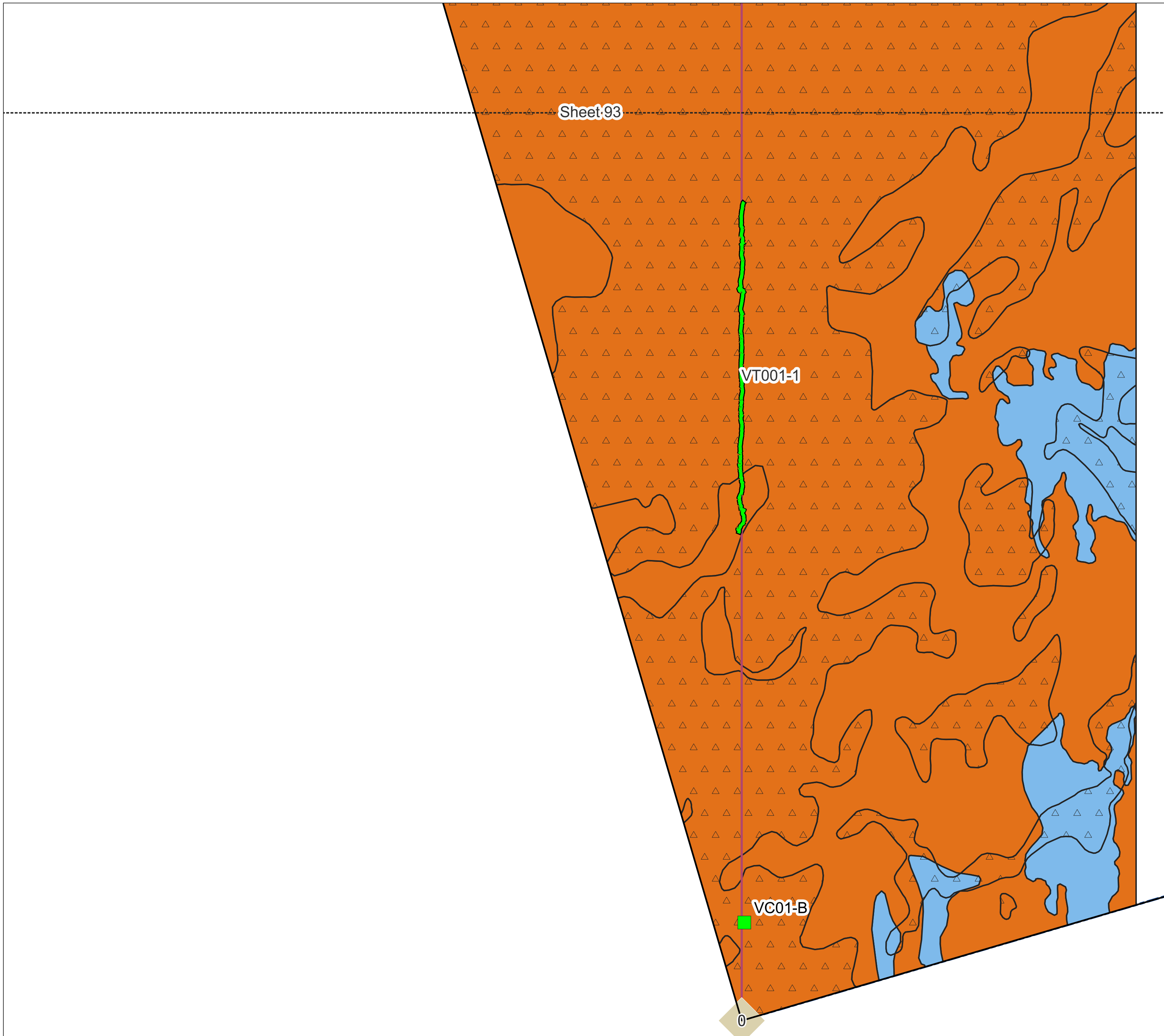

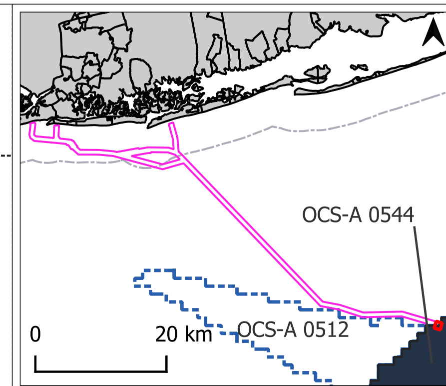

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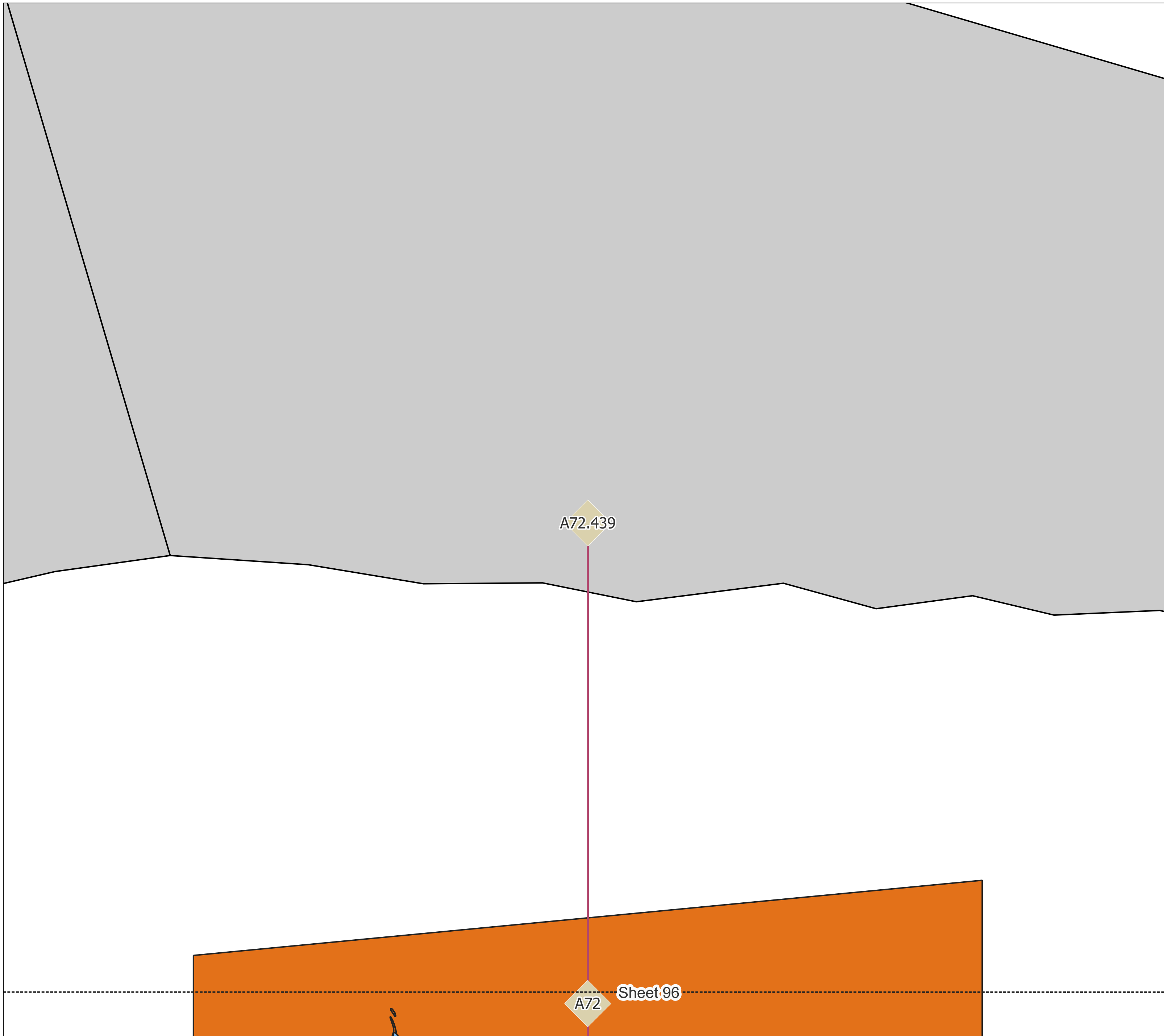

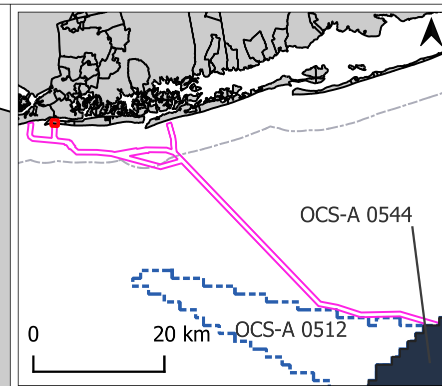

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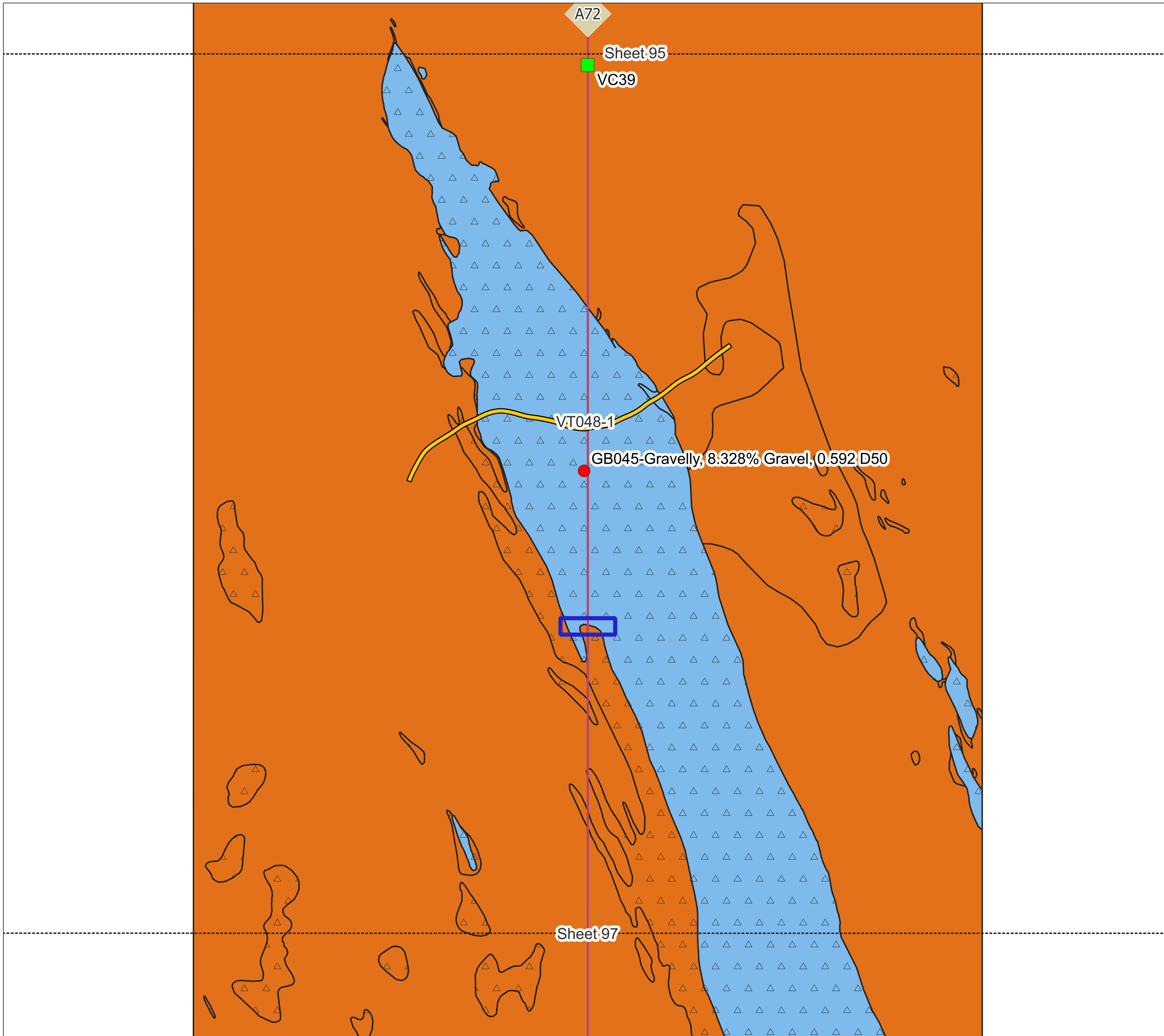

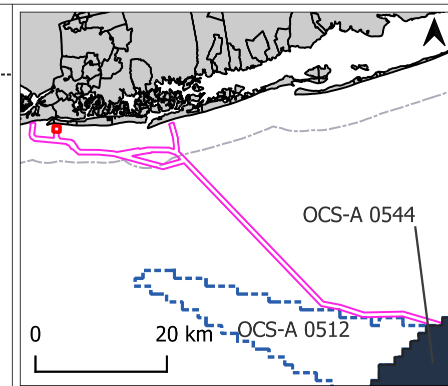

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- Representative HDD Location

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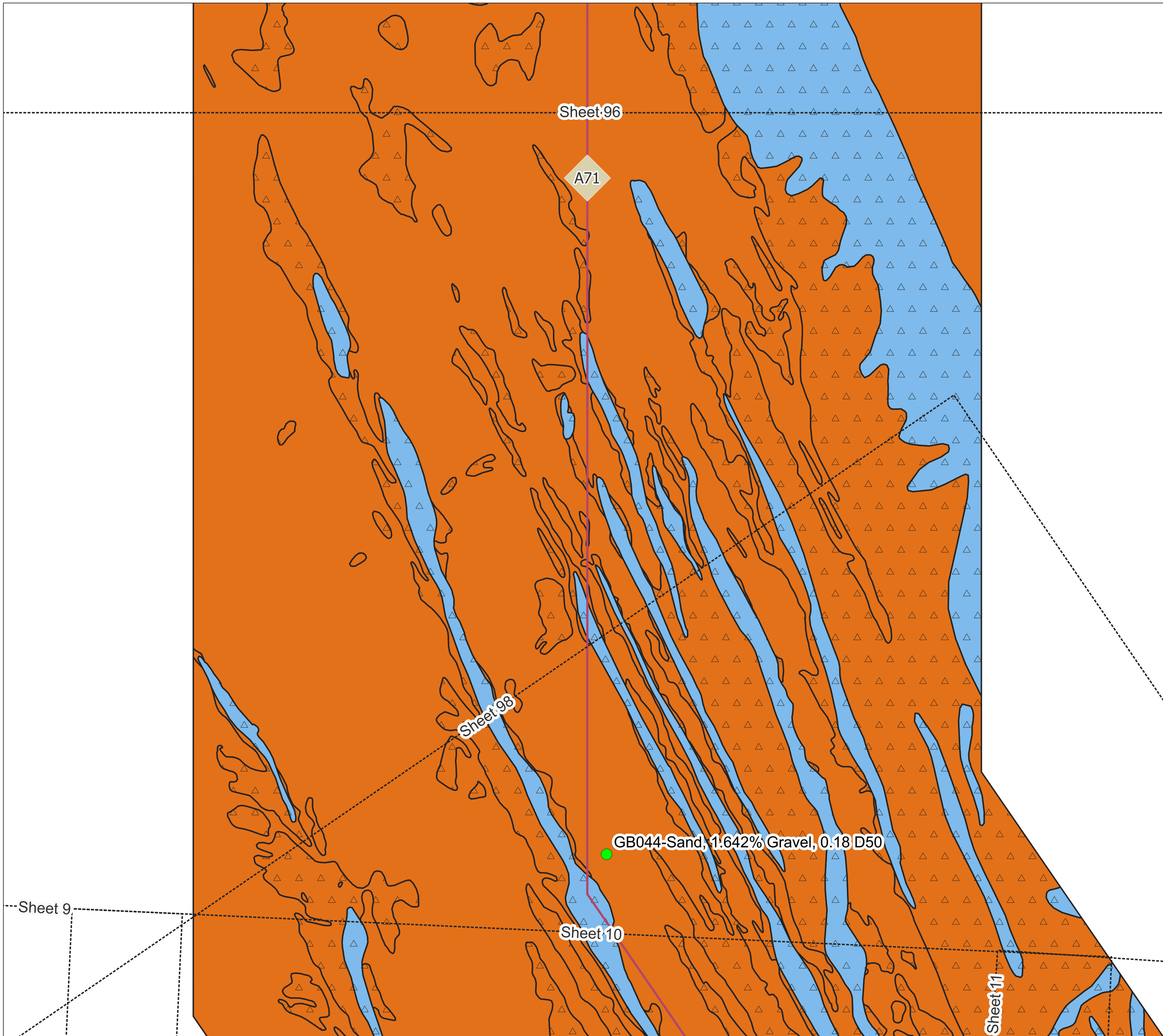
0 50 100 150 200 m

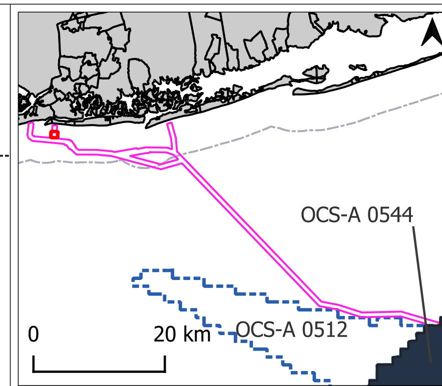
N

Large Scale Maps of Bottom Habitats and Benthic Features Located in the OECC

VINEYARD MID-ATLANTIC

VINEYARD OFFSHORE





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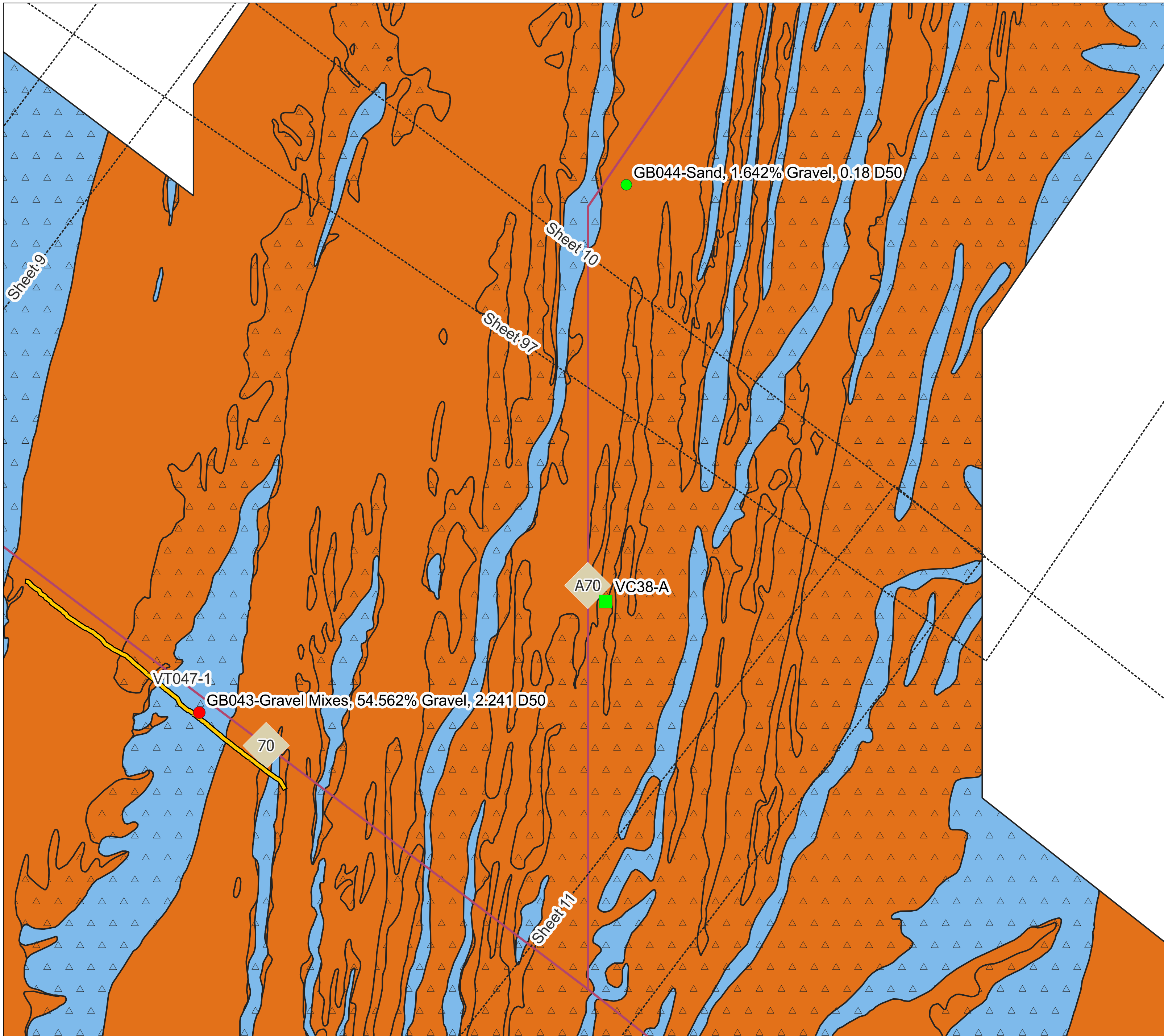

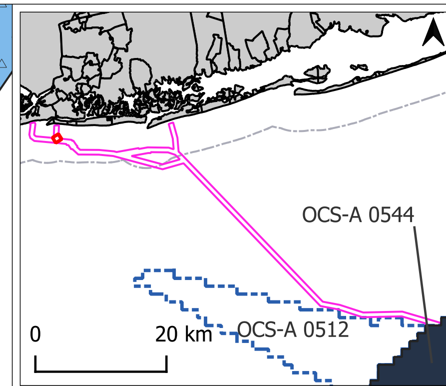

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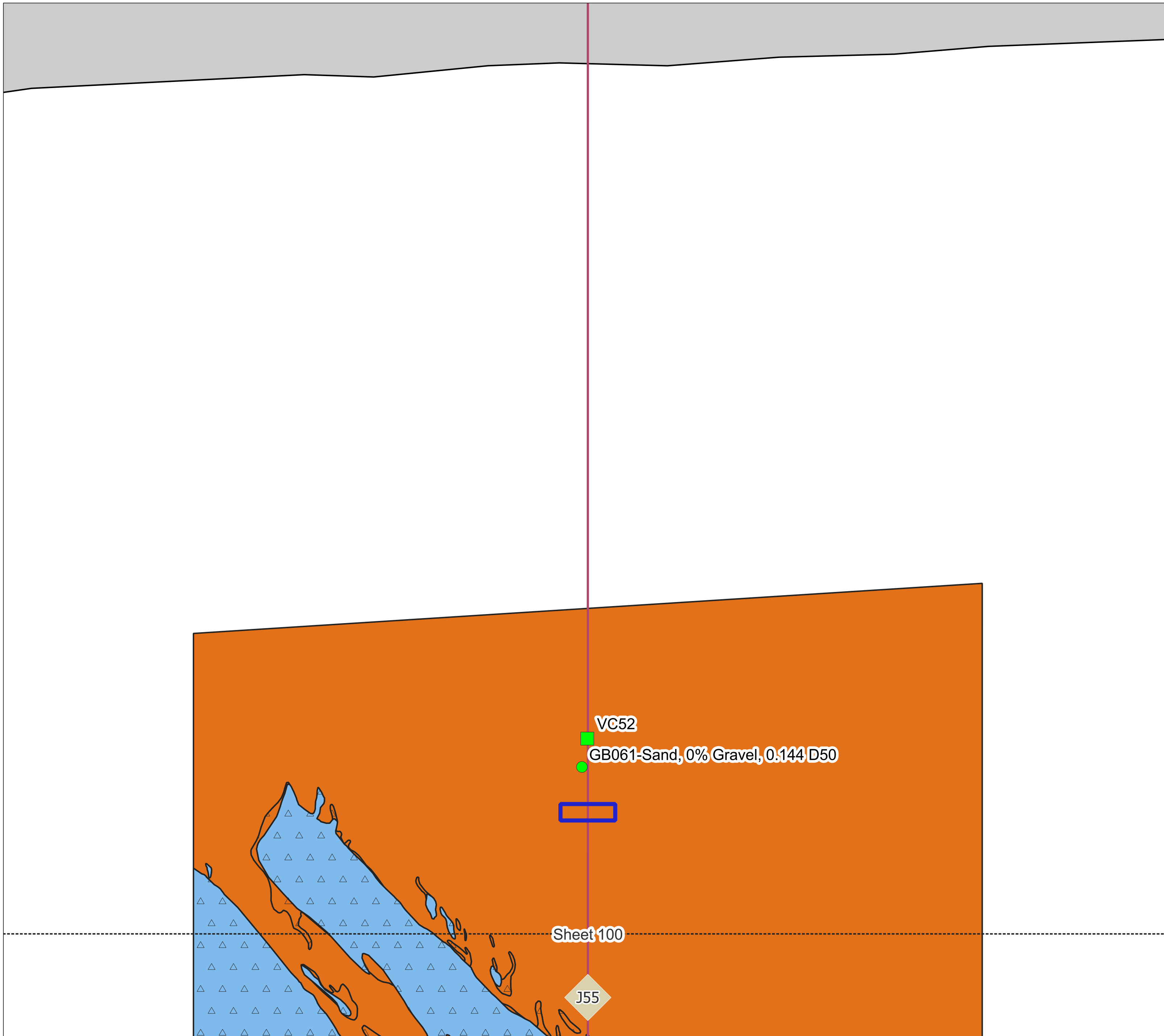

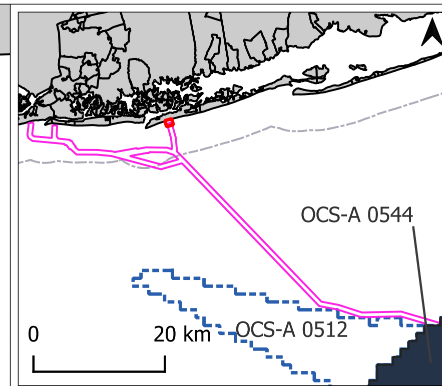

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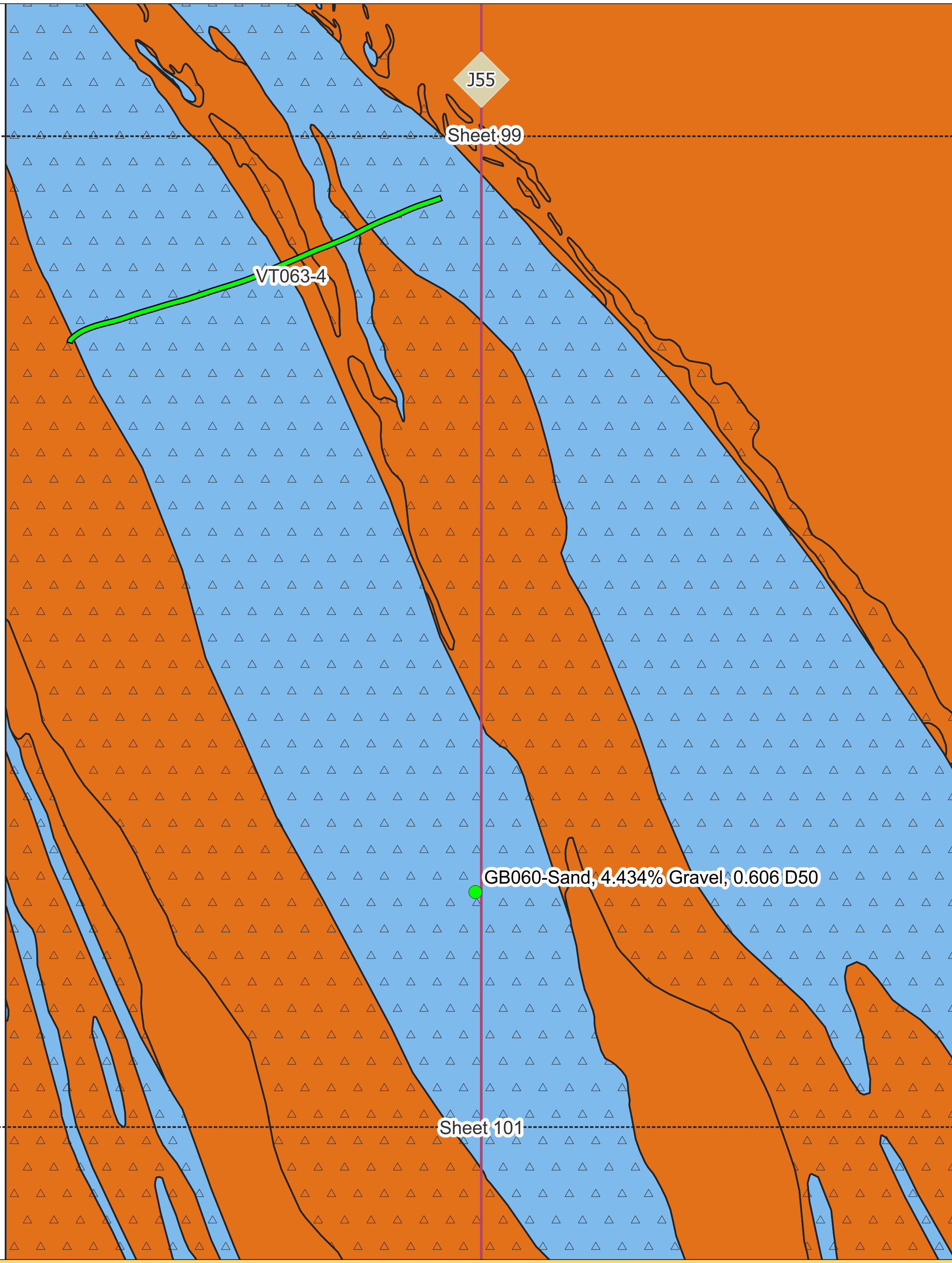

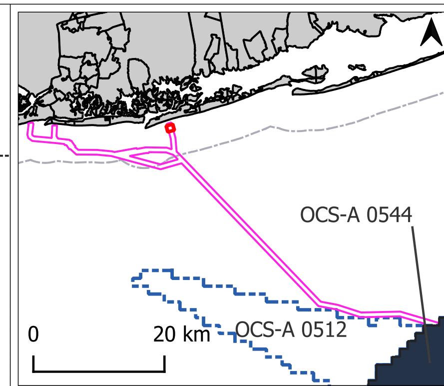

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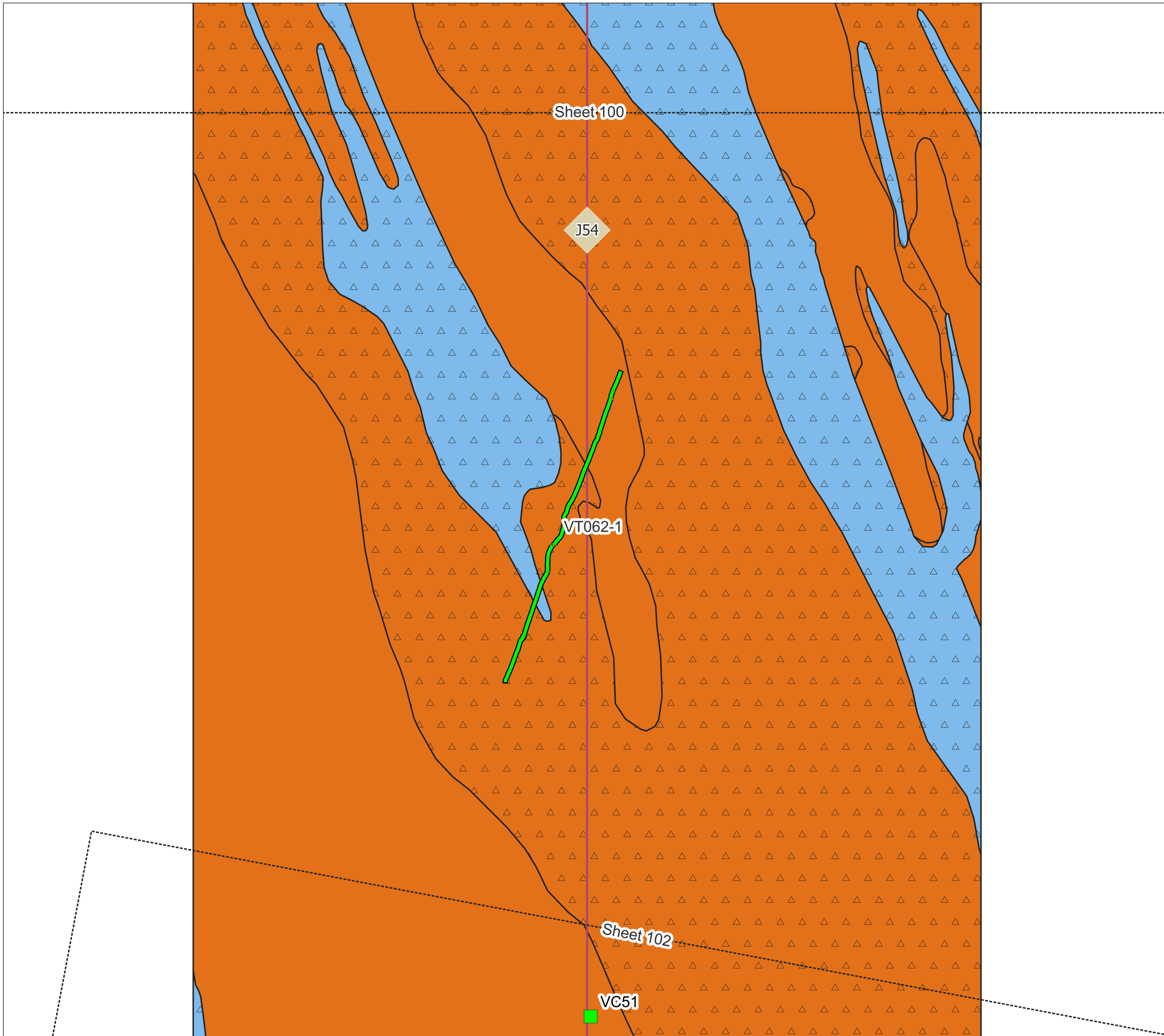

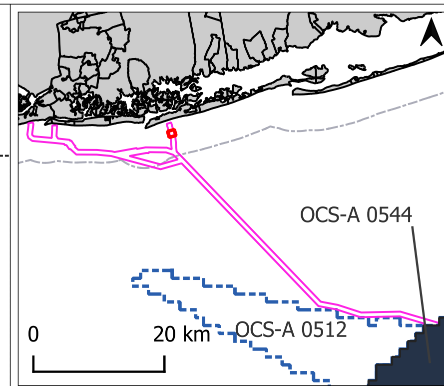

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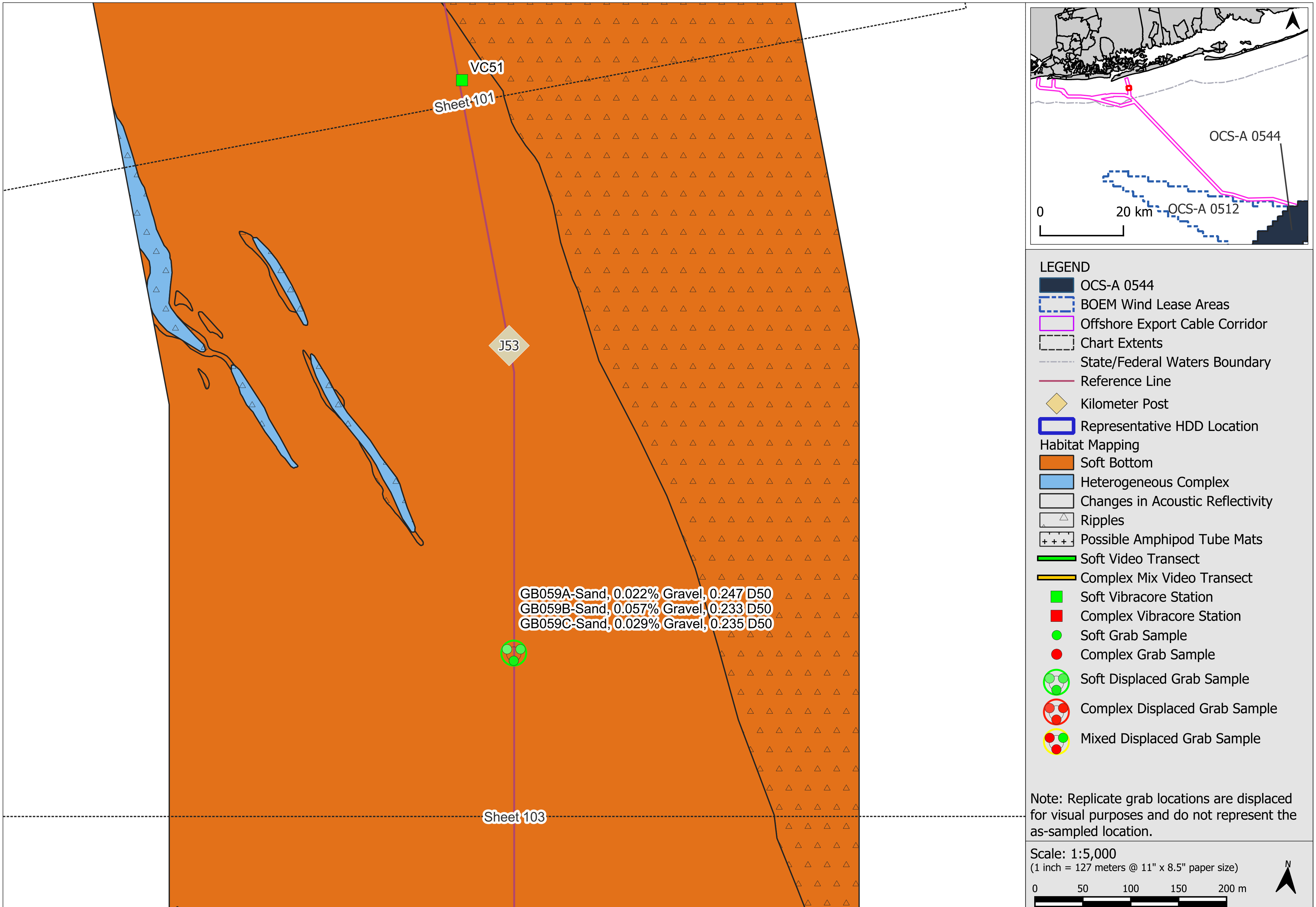

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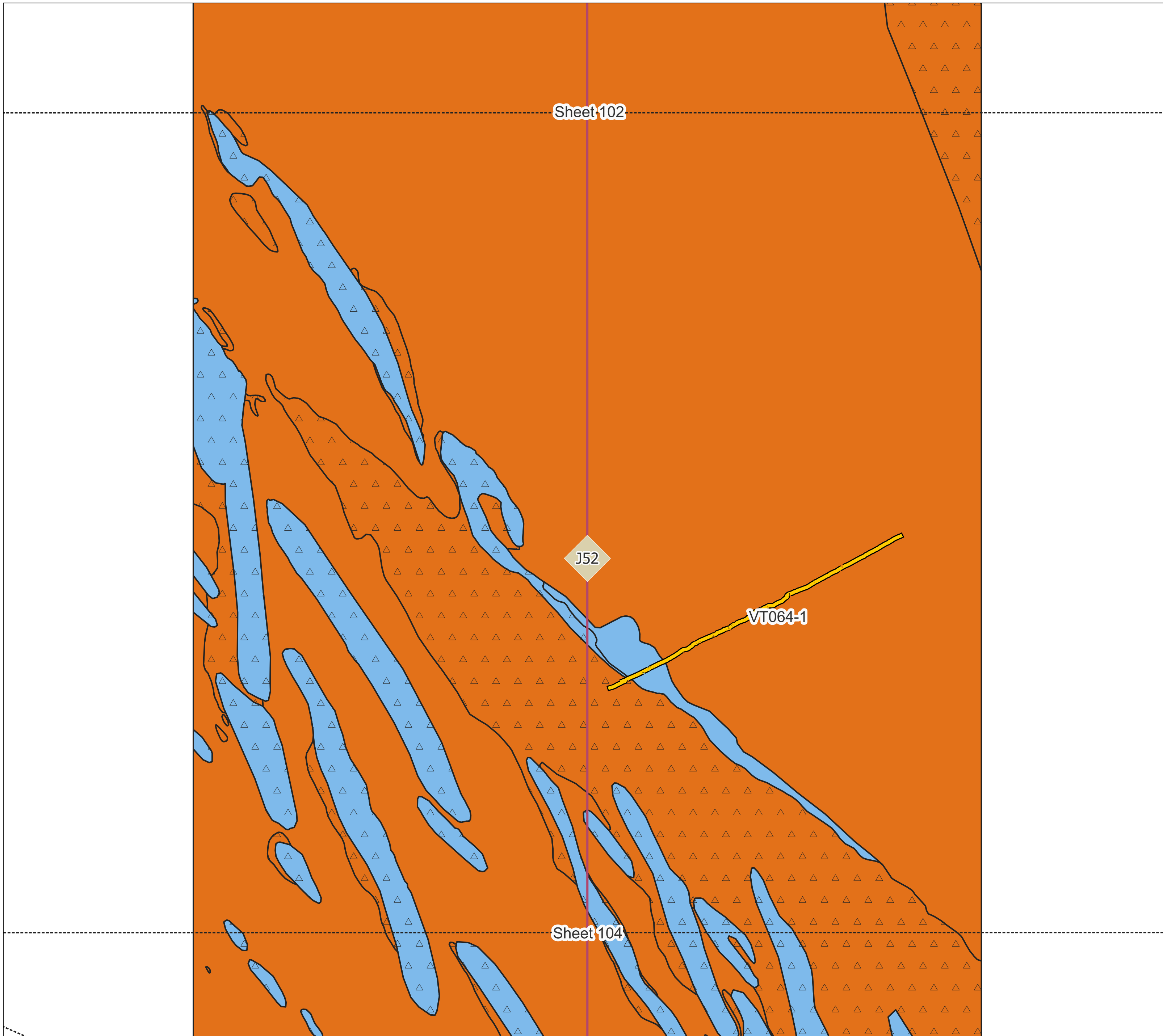

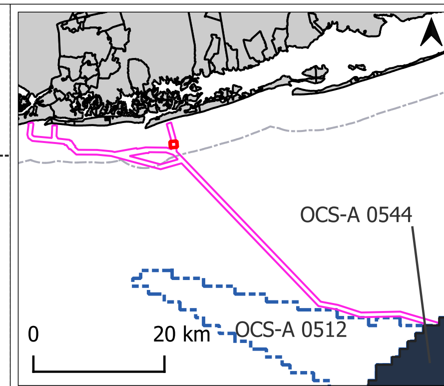

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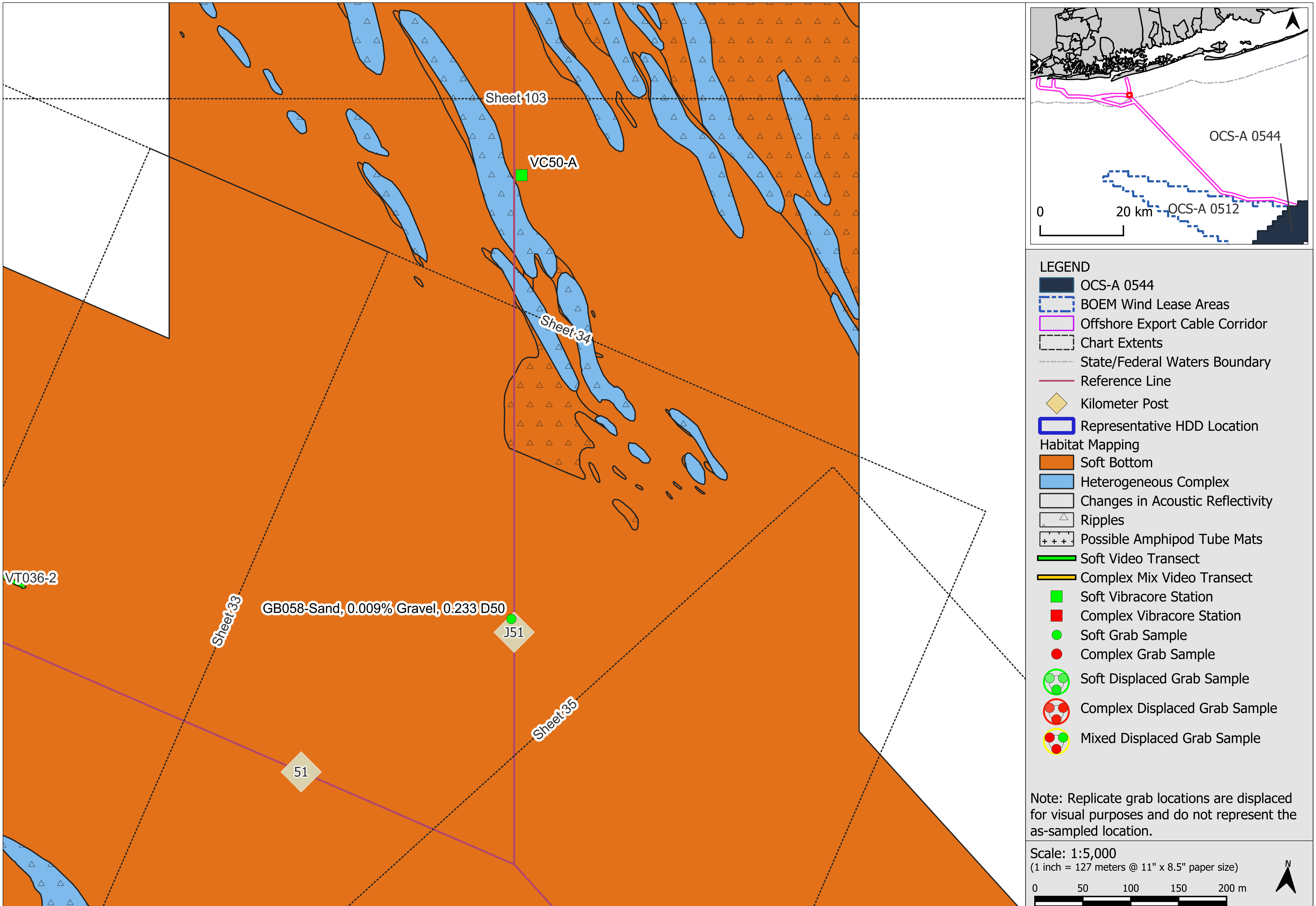

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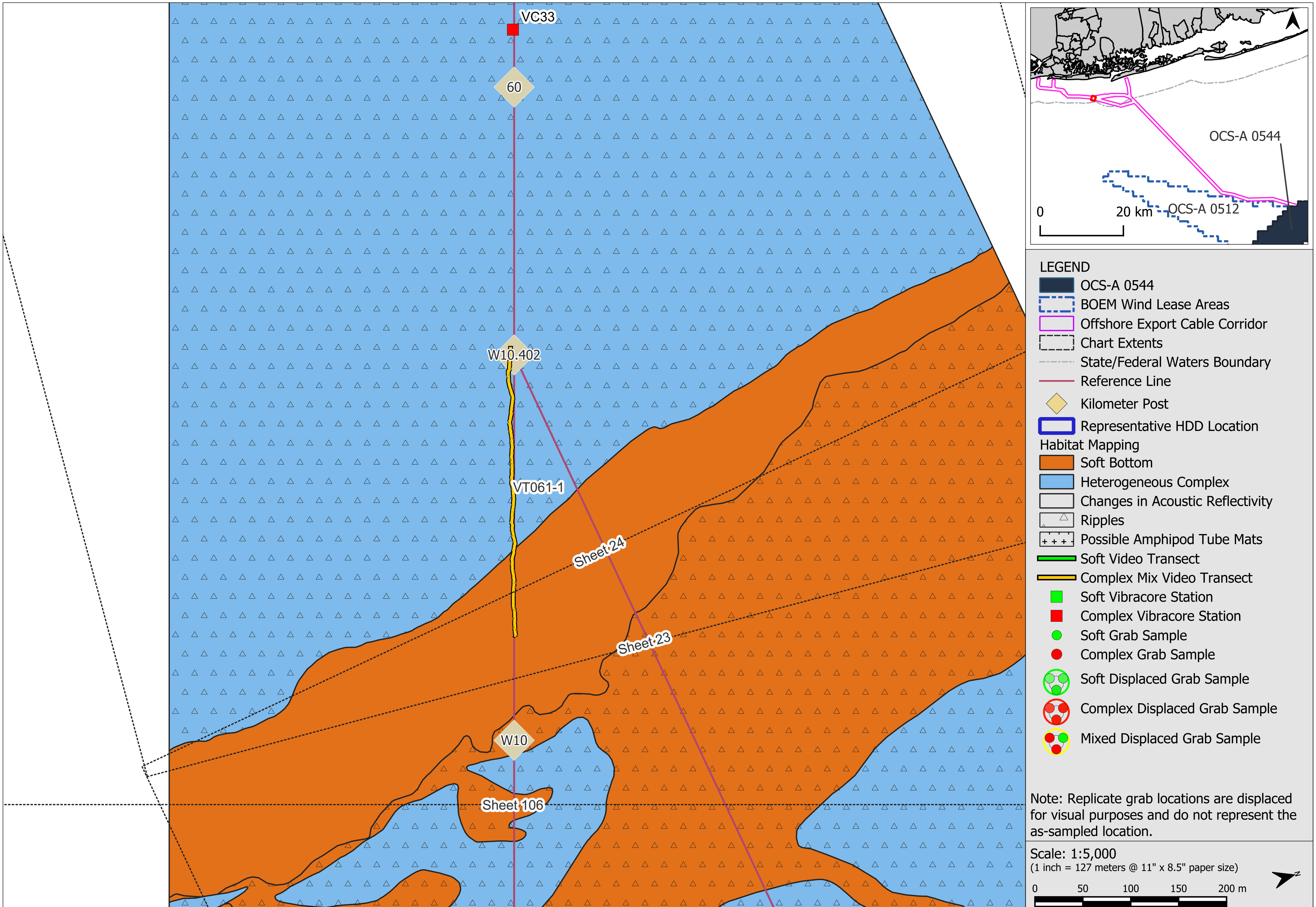

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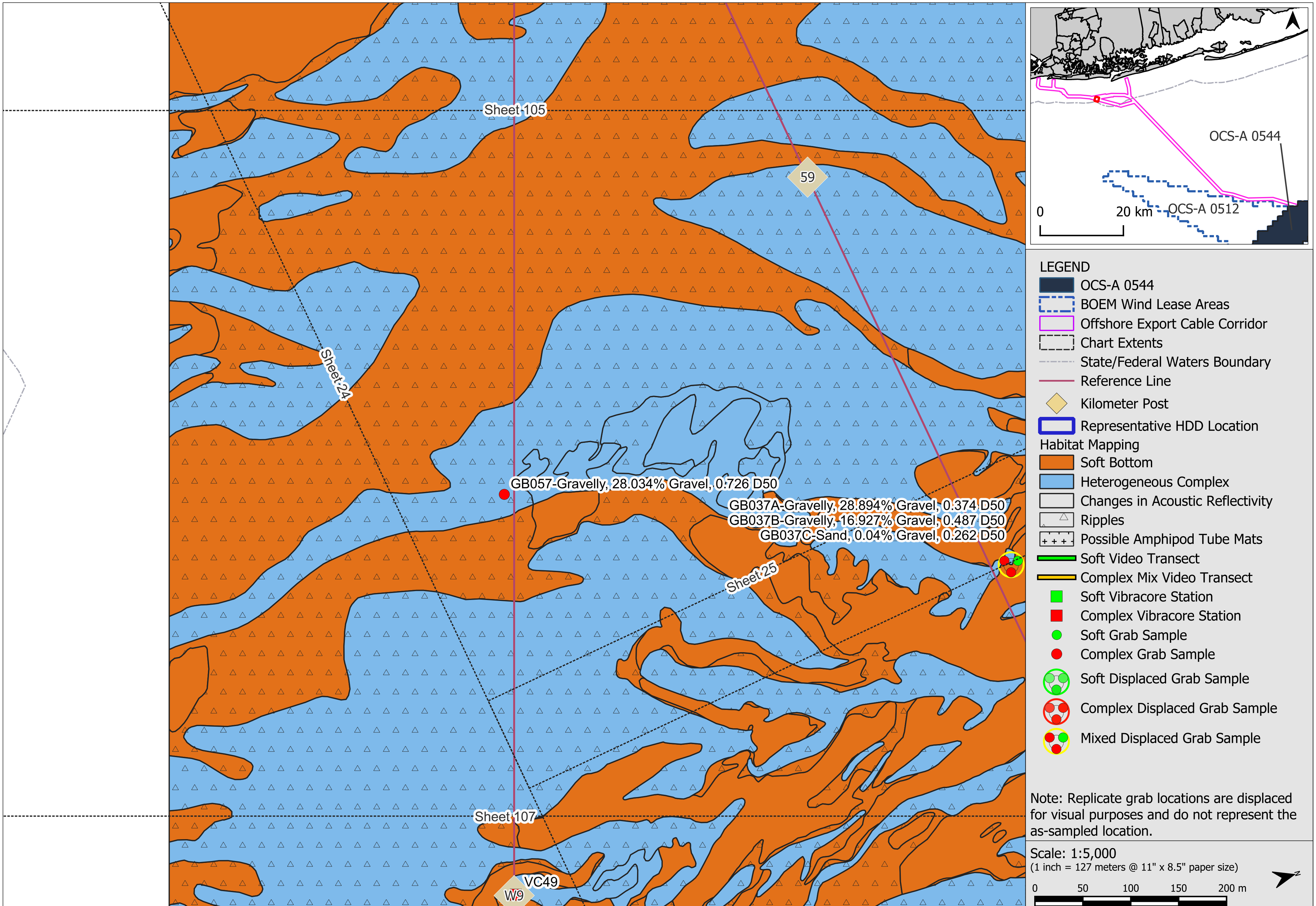

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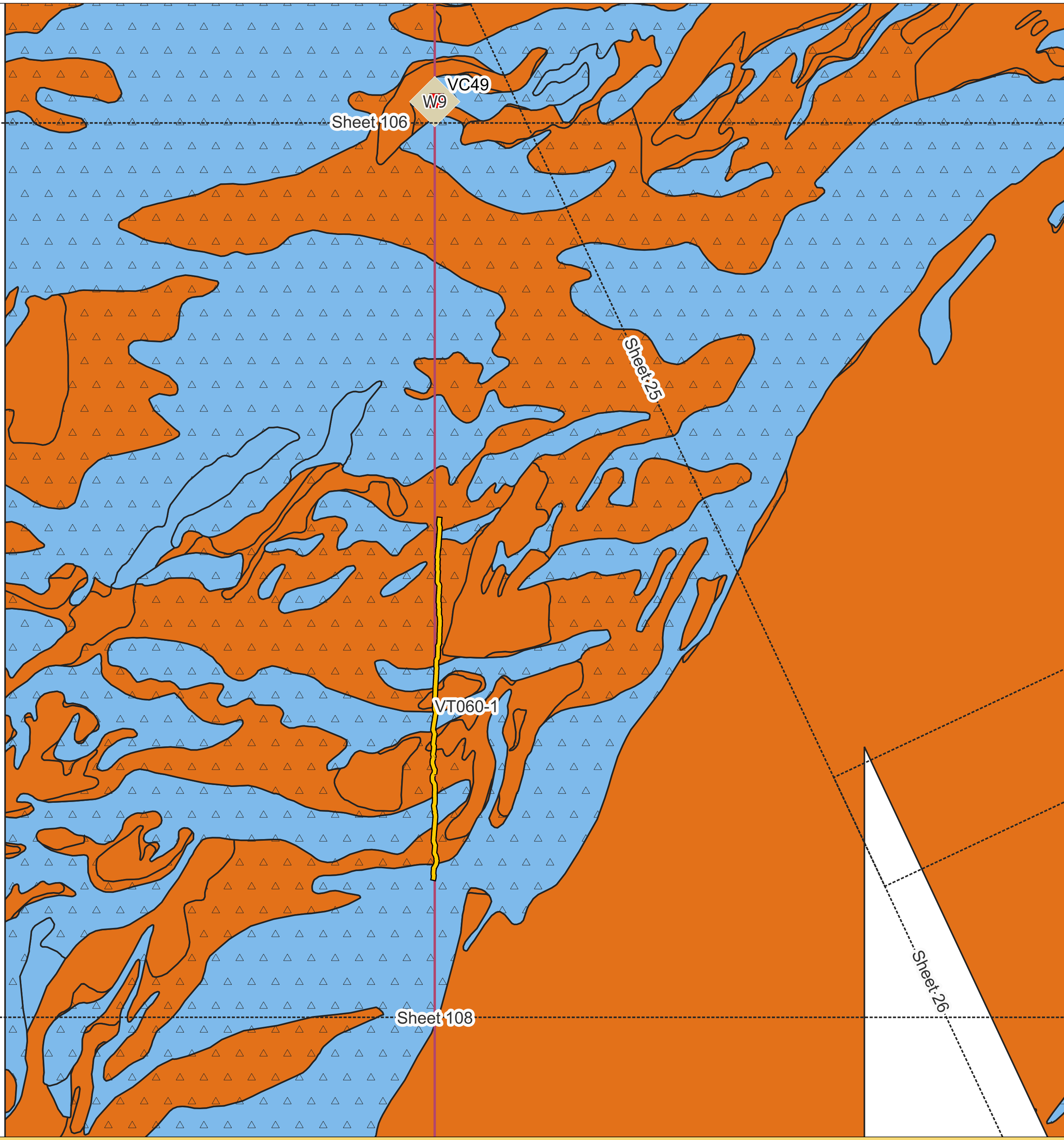

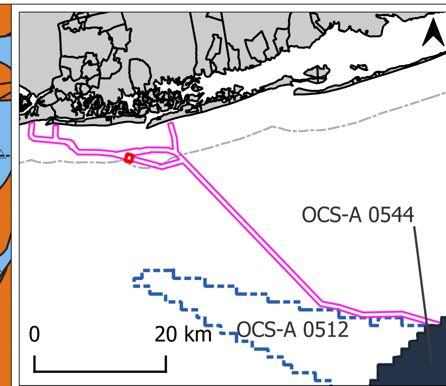

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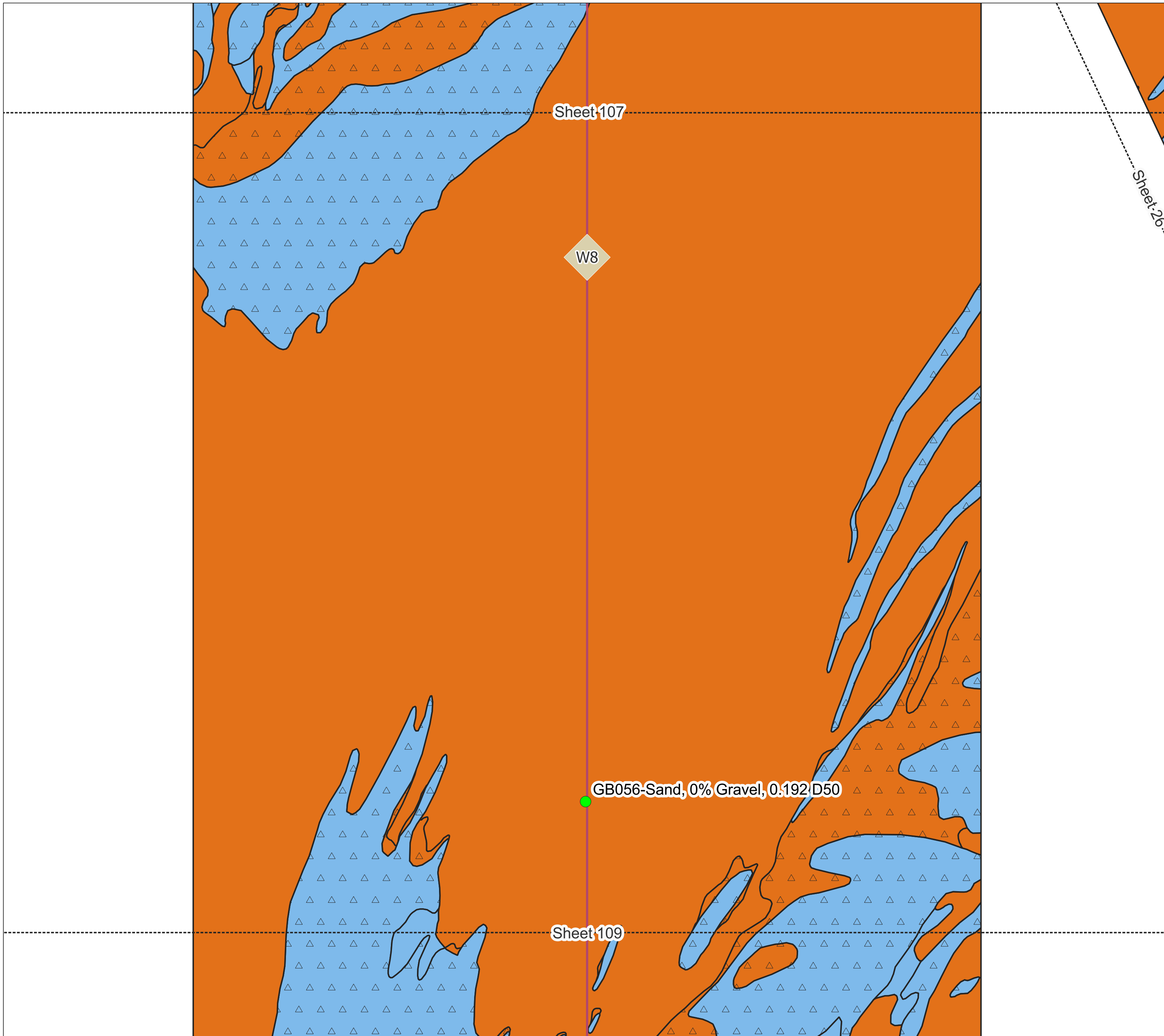

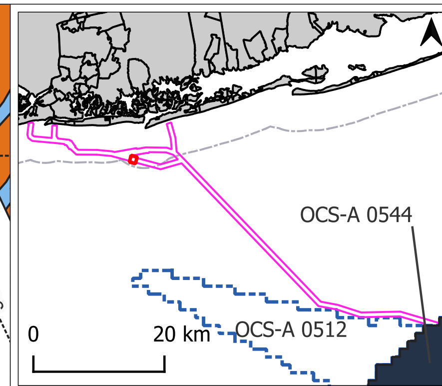

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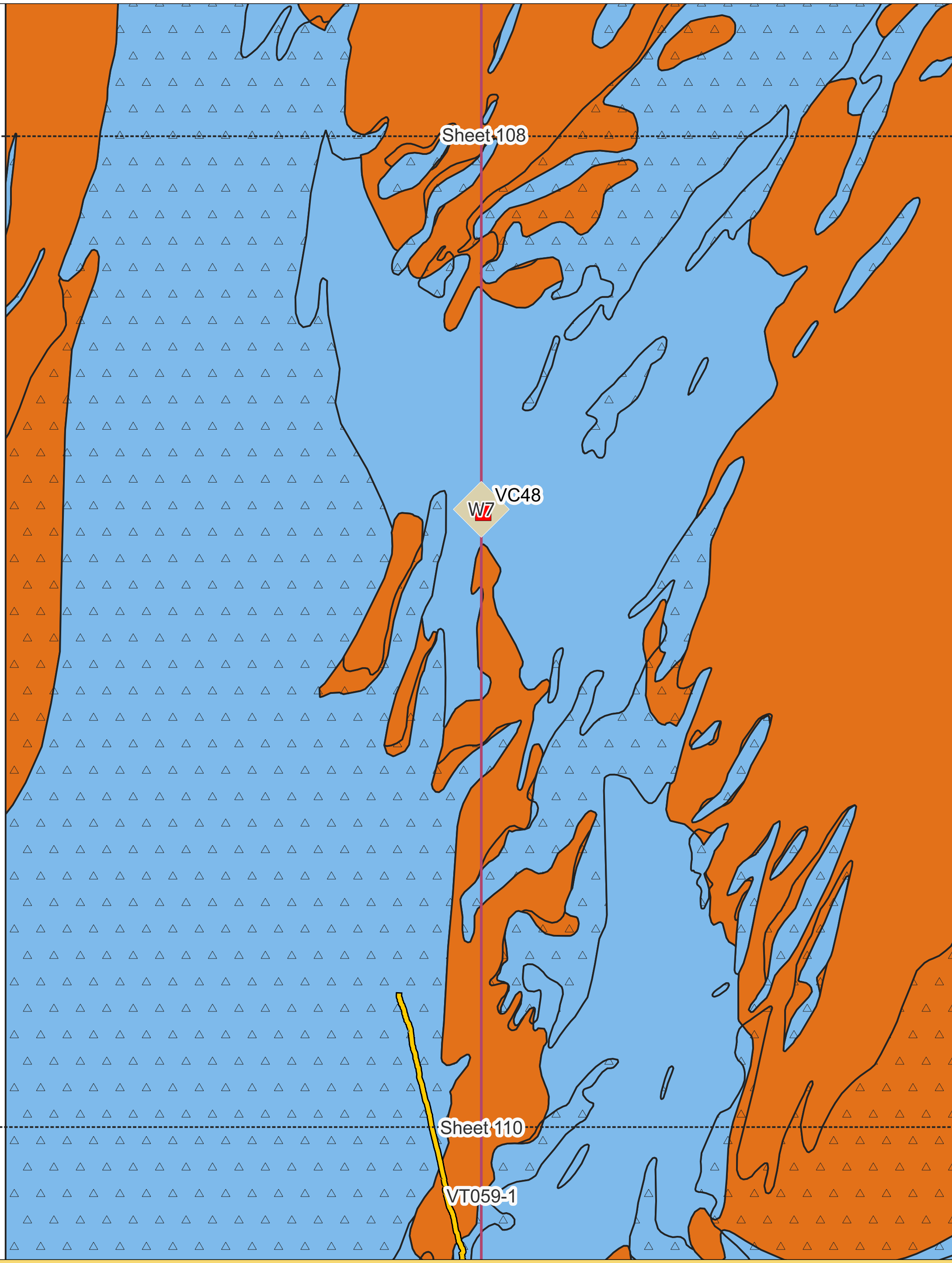

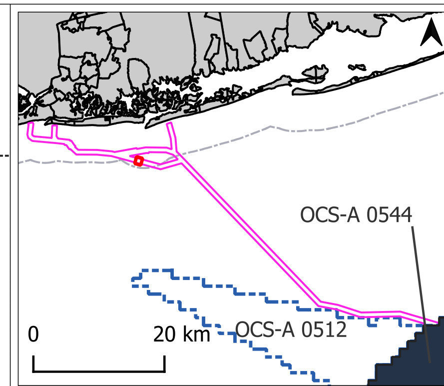

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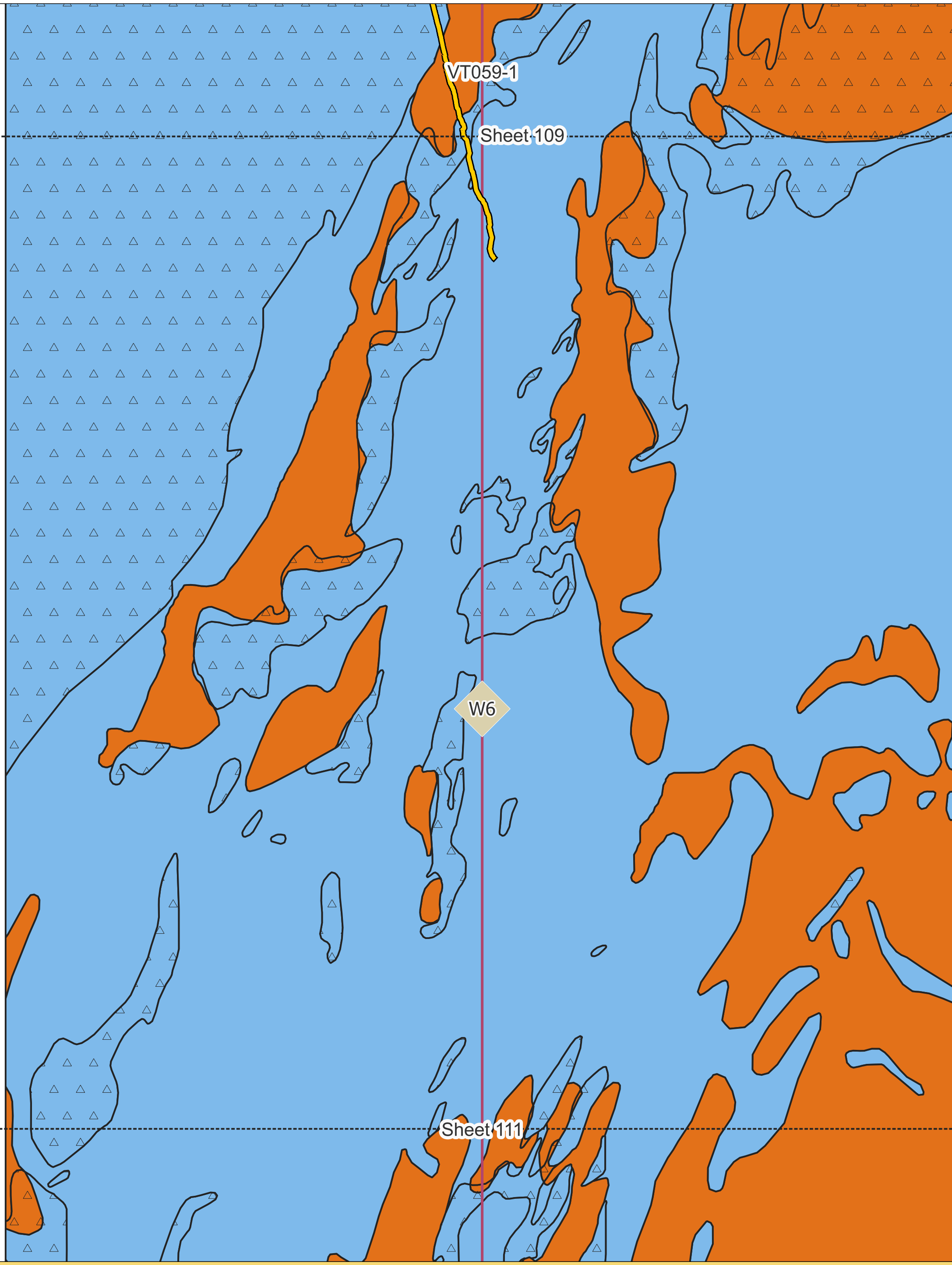

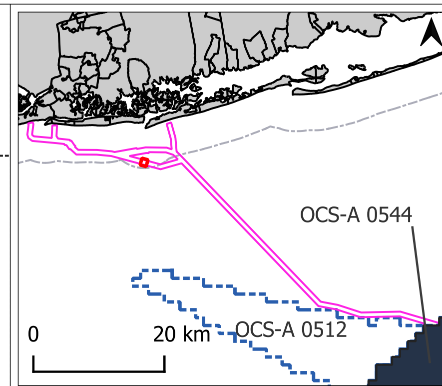

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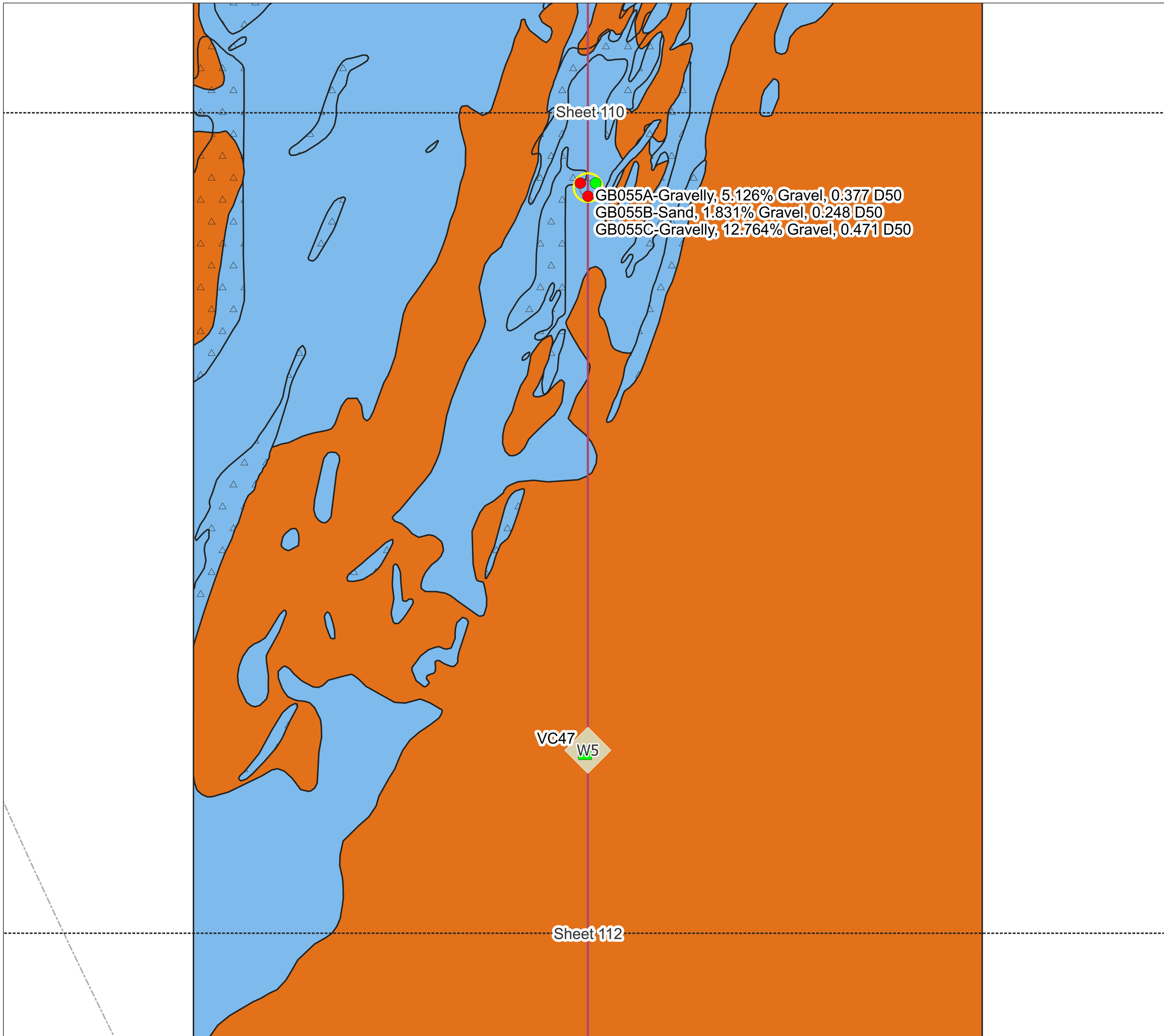

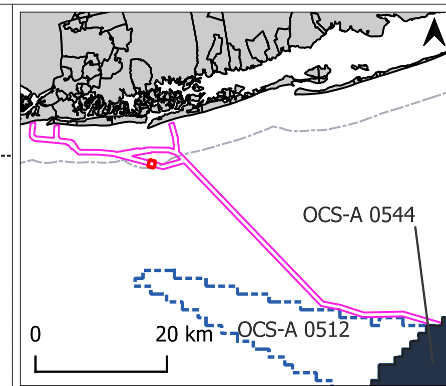

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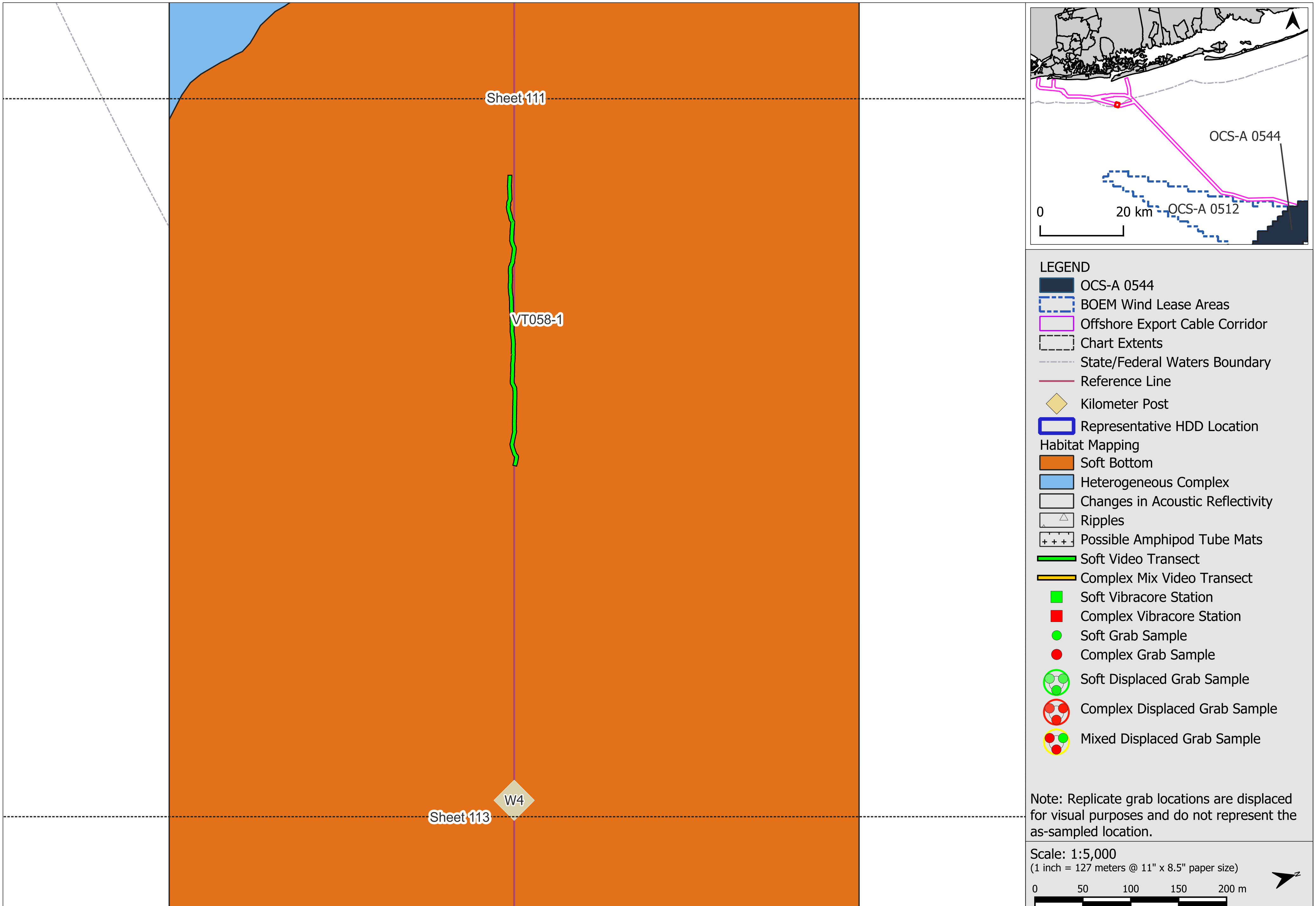

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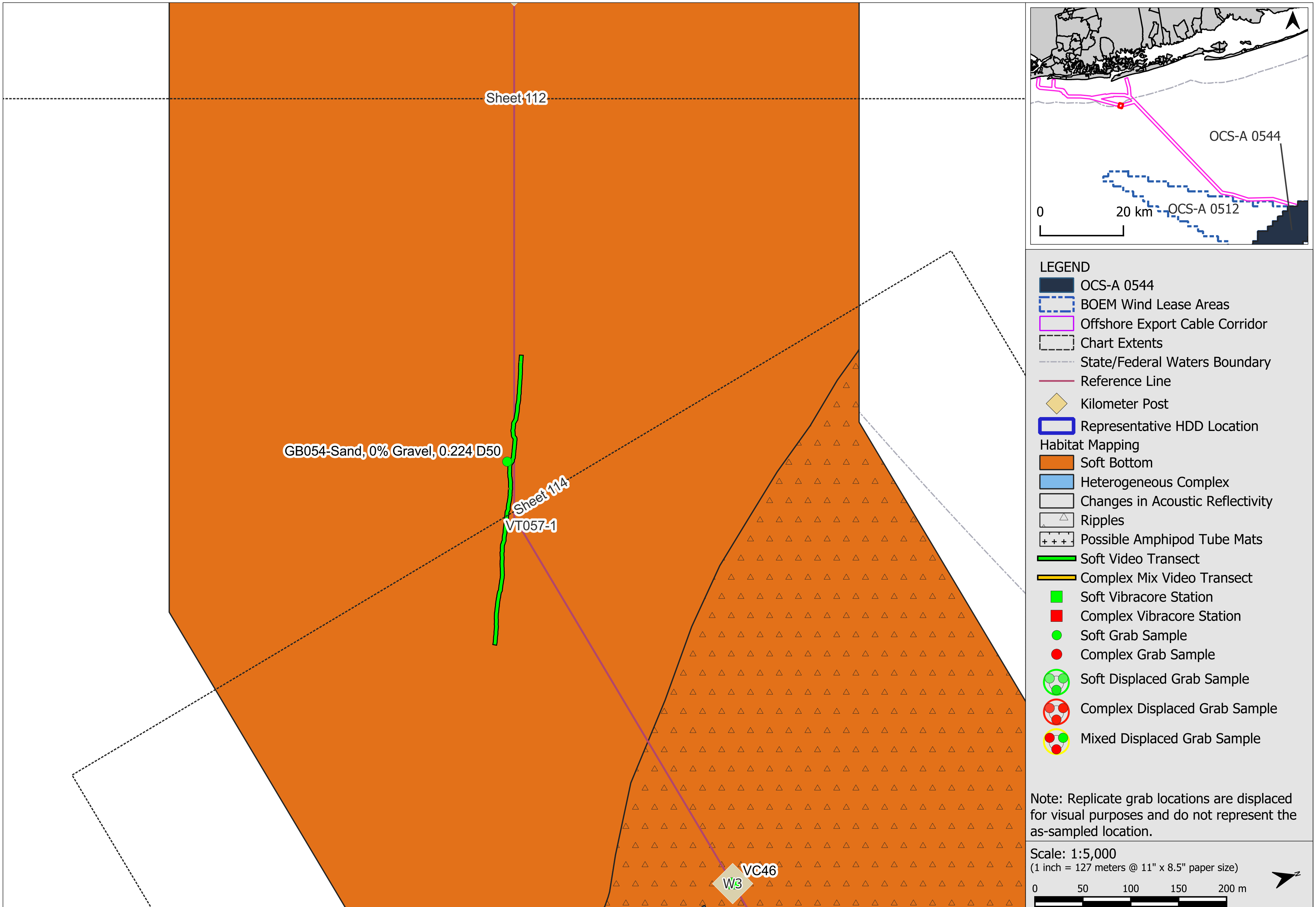

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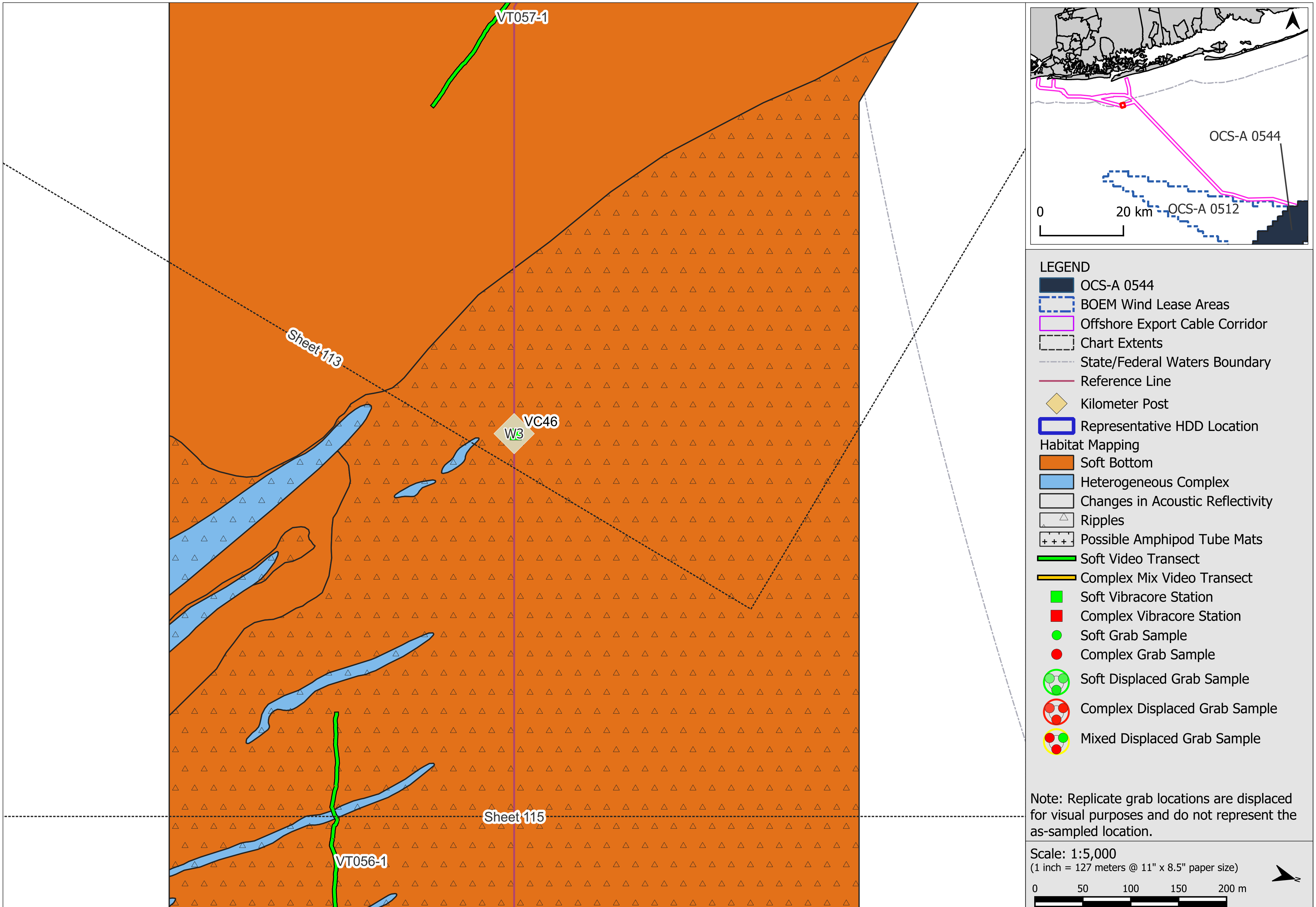
VT057-1
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Sheet 115
VT056-1
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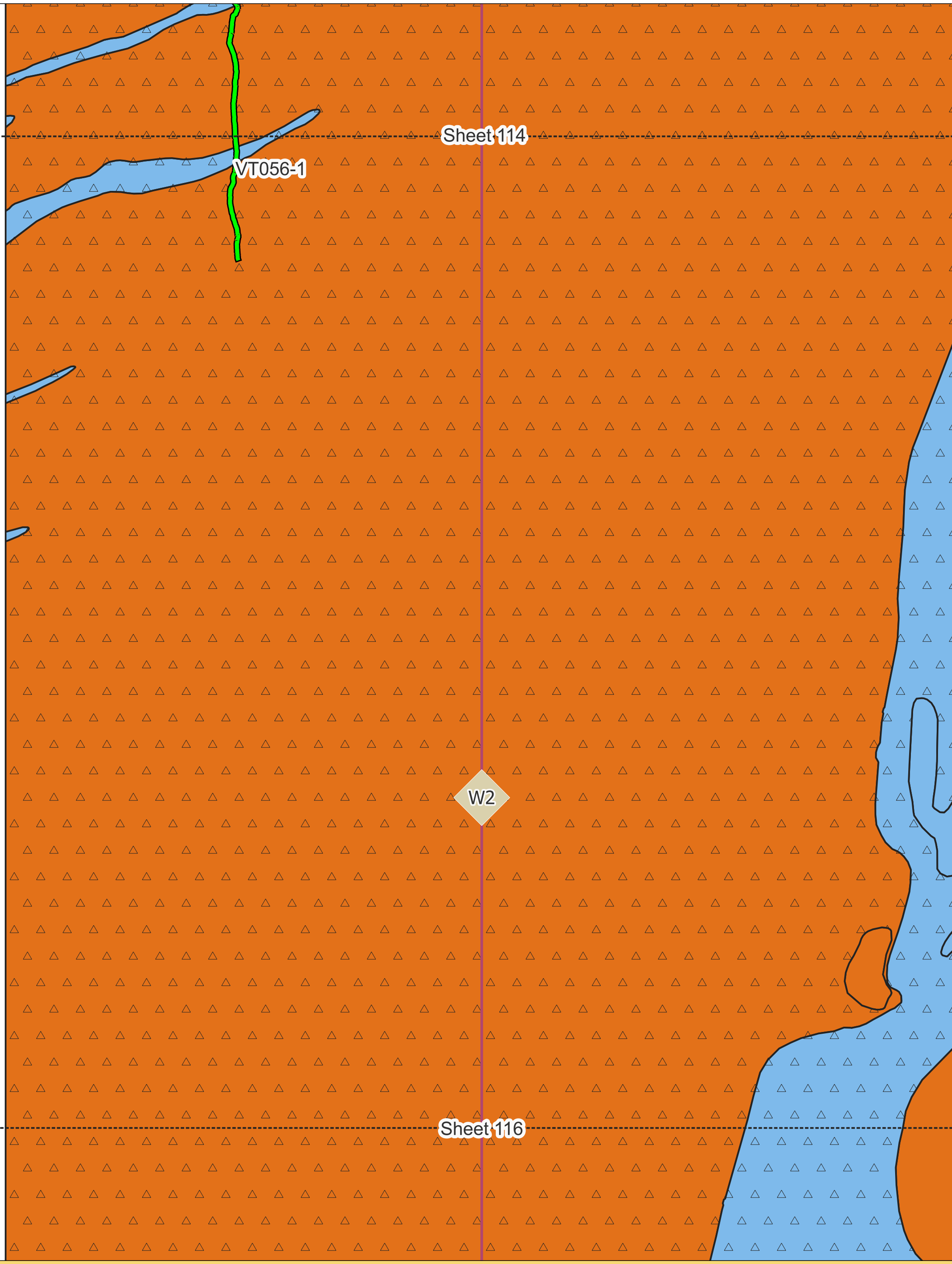

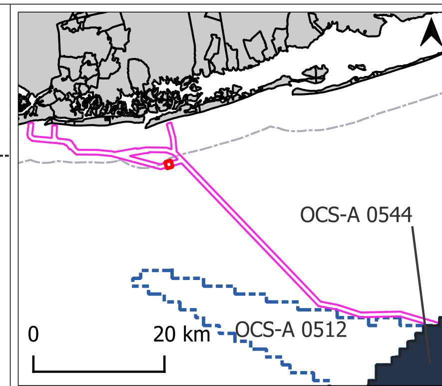

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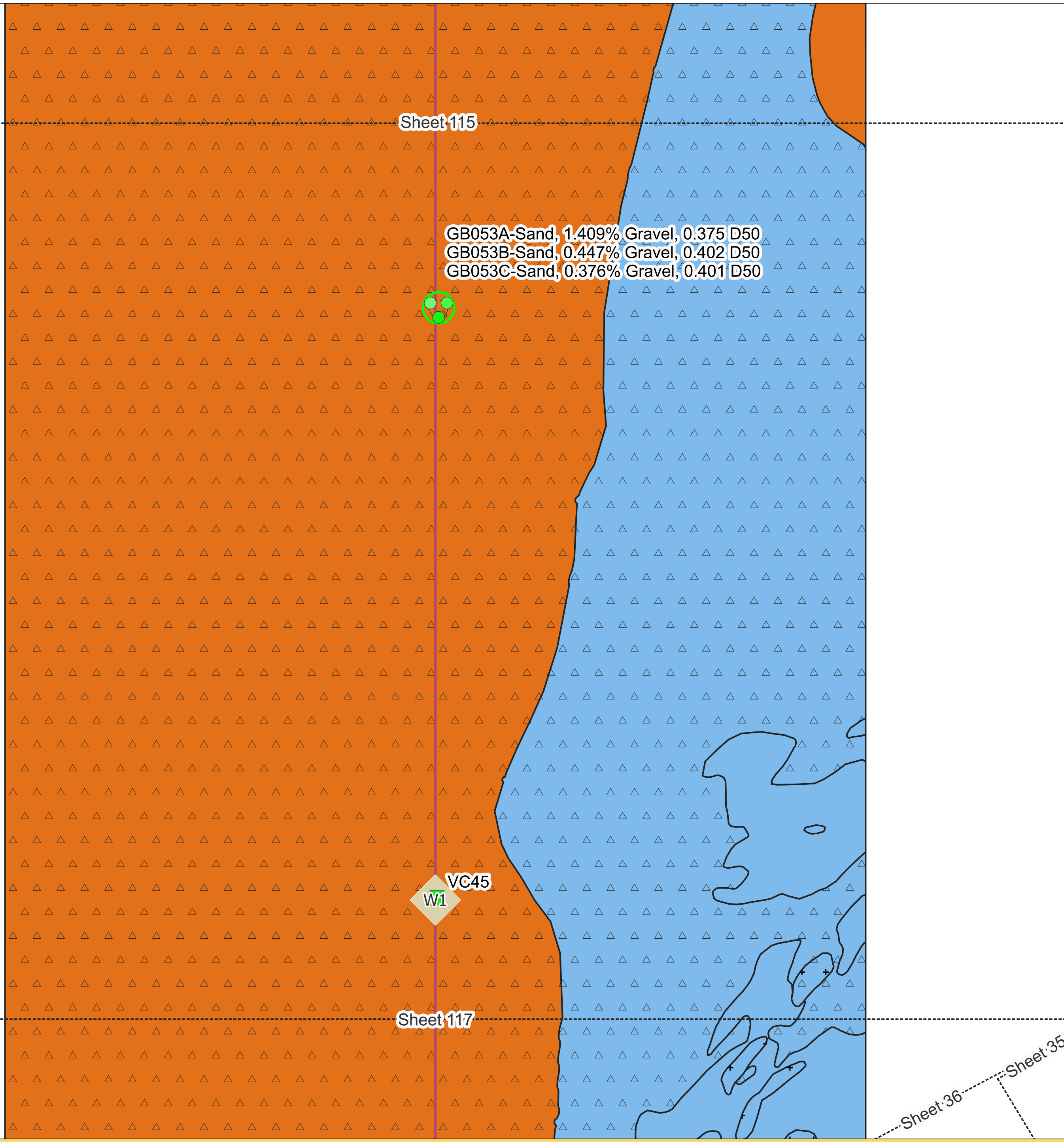

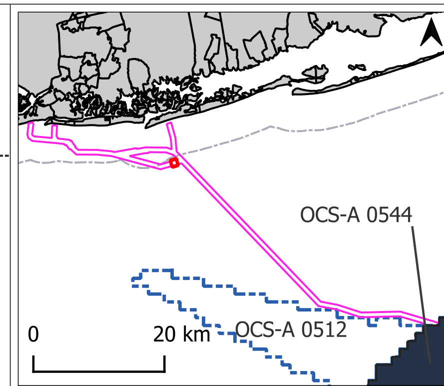

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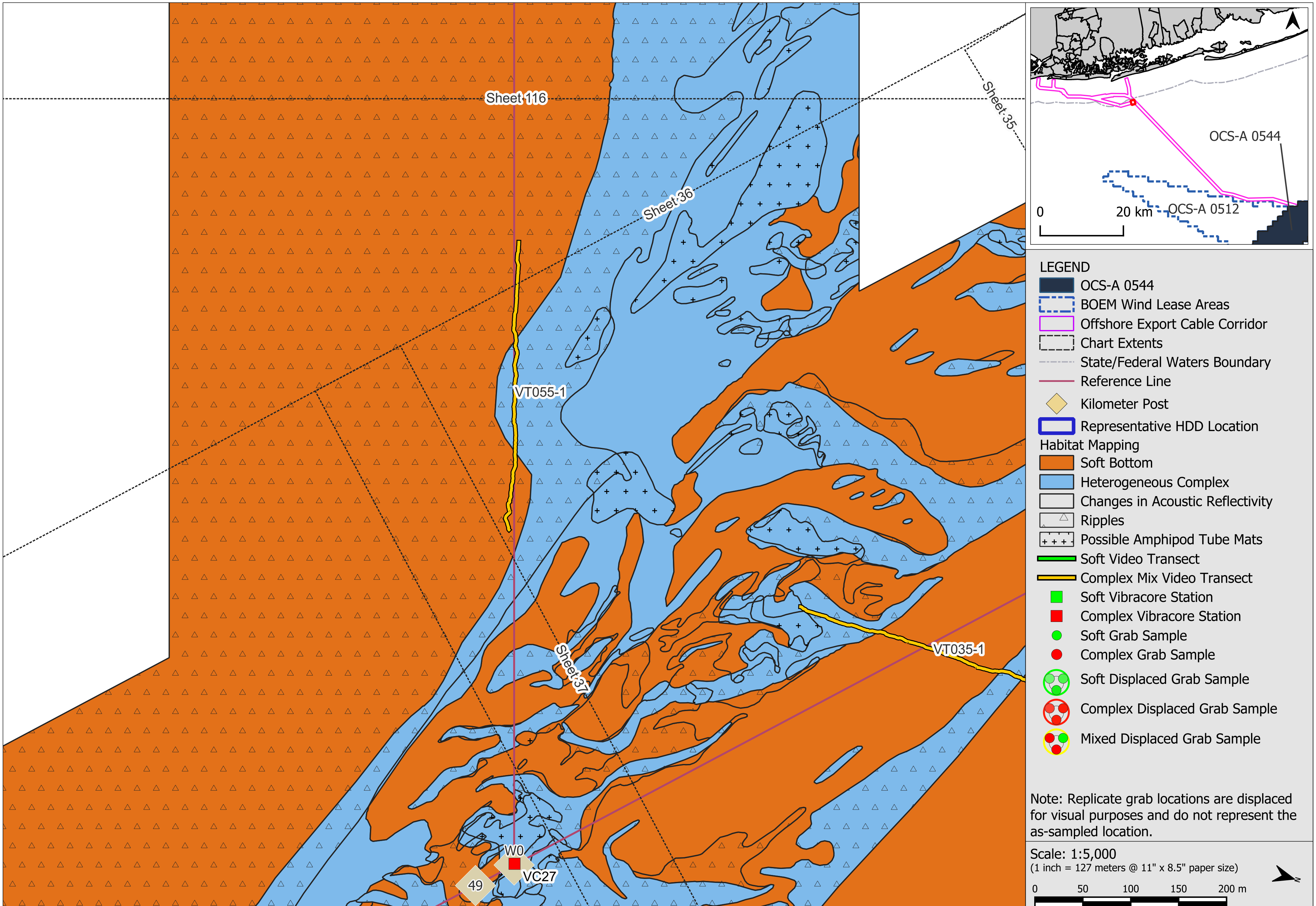

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