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Appendix E: Essential Fish Habitat Assessment

Coastal Virginia Offshore Wind Commercial Project

Dominion Energy®

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APPENDIX E ESSENTIAL FISH HABITAT ASSESSMENT

REVISION LOG

Revision Number	Date	Description	Signed
1	10/2021	Initial Issue	Tetra Tech
2	5/6/2022	Response to BOEM Comments	Tetra Tech

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ACRONYMS AND ABBREVIATIONS

°C	degree Celsius
°F	degree Fahrenheit
µm	micrometer
ac	acre
ASMFC	Atlantic States Marine Fisheries Commission
BOEM	Bureau of Ocean Energy Management
CMECS	Coastal and Marine Ecological Classification Standard
COP	Construction and Operations Plan
CVOW	Coastal Virginia Offshore Wind
Dominion Energy	Dominion Energy Virginia
EA	Environmental Assessment
EFH	Essential Fish Habitat
EFHA	Essential Fish Habitat Assessment
EMF	electric and magnetic fields
FMC	Fishery Management Council
FMP	Fishery Management Plan
GARFO	Greater Atlantic Regional Fisheries Office
gpm	gallons per minute
ft	foot
ha	hectare
HAPC	Habitat Area of Particular Concern
HRG	High-Resolution Geophysical
km	kilometer
Lease Area	Outer Continental Shelf Offshore Virginia (Lease No. OCS-A-0483)
m	meter
MAFMC	Mid-Atlantic Fishery Management Council
MAG/TVG	Magnetometer/Transverse Gradiometer
MBES	Multibeam echo sounder
MCS	Multi-Channel Seismic
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSIR	Marine Site Investigation Report
NEFMC	New England Fishery Management Council
nm	nautical mile
NOAA	National Oceanographic and Atmospheric Administration
NOAA Fisheries	NOAA National Marine Fisheries Service
O&M	Operations and Maintenance
OCS	Outer Continental Shelf
Offshore Project Area	Project Components in Lease Area and Offshore Export Cable Route Corridor
PDE	Project Design Envelope
ppt	parts per thousand
Project	Coastal Virginia Offshore Wind Commercial Project
SBP	Sub-Bottom Profiler
SCS	Single-Channel Seismic

SSS	Side scan sonar
UHRS	Ultra-High Resolution Seismic
U.S.	United States
VMRC	Virginia Marine Resources Commission
WEA	Wind Energy Area
WTG	Wind Turbine Generator

E.1 INTRODUCTION

The Virginia Electric and Power Company, doing business as Dominion Energy Virginia (Dominion Energy), is proposing to construct, own, and operate the Coastal Virginia Offshore Wind (CVOW) Commercial Project (the Project). The Project will be located in the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS) Offshore Virginia (Lease No. OCS-A-0483) (Lease Area), which was awarded to Dominion Energy through the Bureau of Ocean Energy Management (BOEM) competitive renewable energy lease auction of the Wind Energy Area (WEA) offshore of Virginia in 2013. The Lease Area covers approximately 112,799 acres (ac; 45,658 hectares [ha]) and is approximately 27 statute miles (23.8 nautical miles [nm], 44 kilometers [km]) off the Virginia Beach coastline.

Federal jurisdiction of fisheries of the United States (U.S.) applies to marine waters between the state boundary (3 nm [5.6 km]) and the U.S. Exclusive Economic Zone (200 nm [370 km]). The Commonwealth of Virginia has jurisdiction in marine and tidal waters between the shoreline and the state boundary. The Virginia Marine Resources Commission (VMRC) manages fisheries in the state portion of the Offshore Project Area and shares responsibility for some managed species with the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) and/or the Atlantic States Marine Fisheries Commission (ASMFC).

The NOAA Fisheries and Fishery Management Councils (FMCs) created under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) jointly manage fishery resources in the federal portion of the Offshore Project Area. The Mid-Atlantic Fishery Management Council (MAFMC) and the New England Fishery Management Council (NEFMC) regulate commercially and recreationally valuable species and stocks through fishery management plans (FMPs) and designate Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC). EFH is designated as the seafloor, water column, and sediment-water interfaces necessary for spawning, breeding, growth, and maturity (16 U.S.C. § 1802[10]). Jurisdiction is determined by species rather than location, as species ranges often cross administrative boundaries.

Under the MSA, federal agencies must consult with NOAA Fisheries regarding any actions authorized, funded, undertaken, or proposed to be authorized, funded, or undertaken under their jurisdiction. For any proposed offshore wind projects located in the northwestern Atlantic Ocean, BOEM must consult with the NOAA Fisheries' Greater Atlantic Regional Fisheries Office (GARFO). The present EFH Assessment (EFHA) was prepared in accordance with 50 Code of Federal Regulations (CFR) § 600.920(e)(1) to support BOEM during consultation with GARFO under the MSA. Potential impacts of construction, operations and maintenance (O&M), and decommissioning of the Project on species with designated EFH for one or more life stages in the Offshore Project Area are discussed. Habitat maps within the Offshore Project Area have been prepared according to GARFO's Recommendations for Mapping Fish Habitat to ensure the benthic habitat information presented in this EFHA is sufficient for BOEM to meet consultation requirements (NMFS-GARFO 2021). For the purposes of this Assessment, the Offshore Project Area includes the portions of the Project Components located in the Lease Area and Offshore Export Cable Route Corridor (Figure E-1).

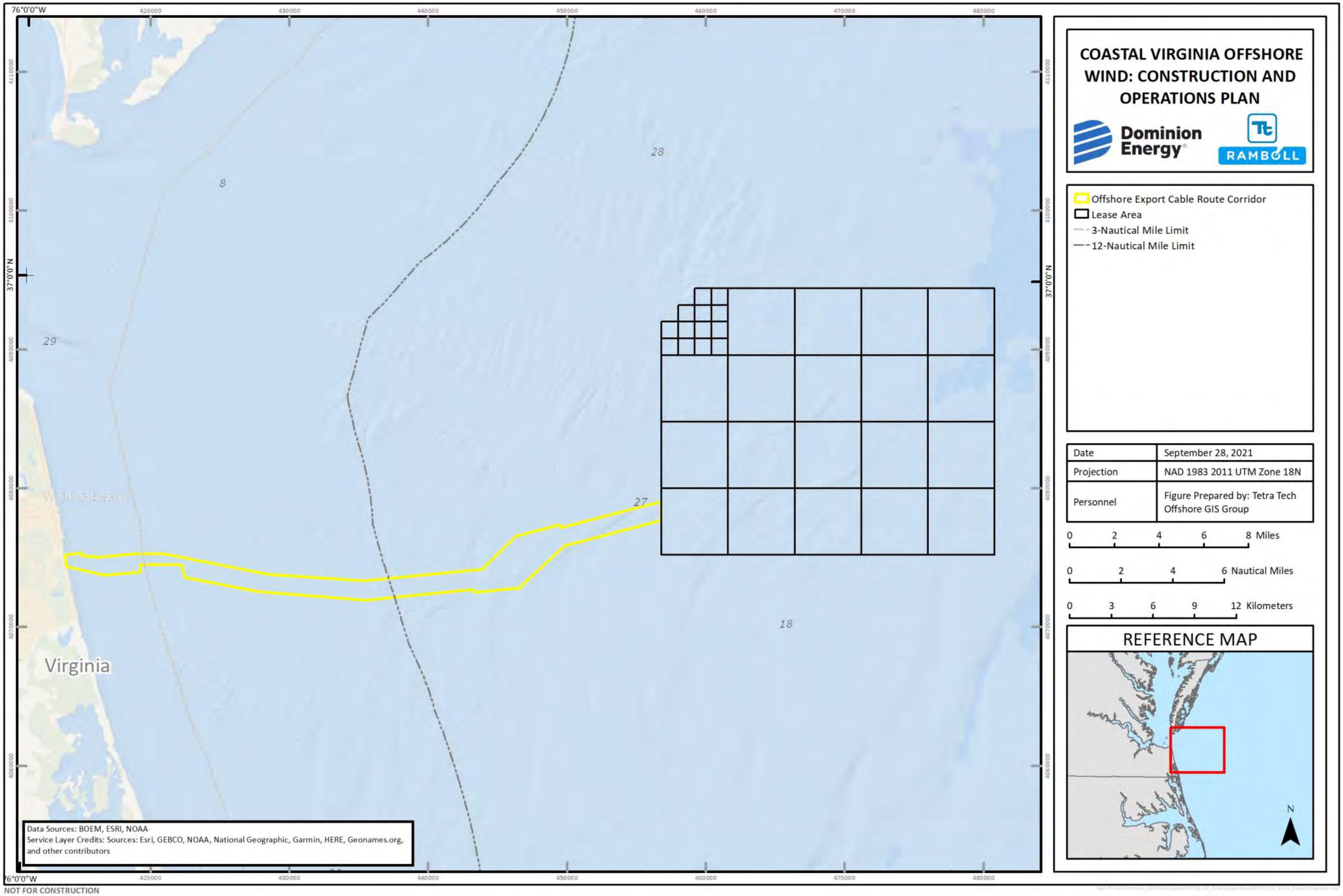

Figure E-1. CVOW Commercial Offshore Project Area Overview

This EFHA is an Appendix to the Construction and Operations Plan (COP), which presents a comprehensive description of the Project, affected environments, and potential impacts to numerous resources. A description of the affected physical and biological environments and potential impacts to benthic and pelagic habitats is presented in COP Section 4.1.1, Physical and Oceanographic Conditions; COP Section 4.1.2, Water Quality; and COP Section 4.2.4, Benthic Resources, Fishes, Invertebrates, and Essential Fish Habitat. This Assessment cross-references the COP sections and related appendices, including Appendix D, Benthic Resource Characterization Report; Appendix J, Sediment Transport Analysis; and Appendix Z, Underwater Acoustic Environment.

The required components of the EFHA are presented as follows:

- Summary of EFH for all life stages of managed species that may be exposed to stressors associated with the Project (Section E.2, Managed Species and Habitats in the Offshore Project Area);
- Description of the Project, including definitions of terms and descriptions of construction, operations and maintenance, and decommissioning activities; as well as avoidance, minimization, and mitigation measures incorporated into the Project (Section E.3, Description of the Proposed Action);
- Potential effects to designated EFH for all life stages of managed species (Section E.4, Effects of the Project on EFH);
- Summaries and determination of effects (Section E.5, Summary of Effects on EFH); and
- Literature cited (Section E.6, References).

Life history profiles of managed species with designated EFH for one or more life stages in the Offshore Project Area (including EFH maps) are presented in Attachment E-1, Profiles of Managed Species in the Offshore Project Area. Each species description includes a table and map of EFH acreages intersecting the Offshore Project Area for all relevant life stages. Attachment E-2, Oversized Tables presents the potential impacts of the Project on each managed species and life stage for which EFH intersects the Offshore Project Area. Attachment E-3, Oversized Maps presents the maps/charts generated from the HRG (High-Resolution Geophysical) survey data and geotechnical survey data, including seabed characterization in accordance with Coastal and Marine Ecological Classification Standard (CMECS) and NMFS-GARFO habitat mapping recommendations (NMFS-GARFO 2021). A detailed analysis of the seabed, resulting from the HRG surveys is included in Appendix C, Marine Site Investigation Report (MSIR).

E.2 MANAGED SPECIES AND HABITATS IN THE OFFSHORE PROJECT AREA

Approximately 600 fish species are resident or transient through the benthic and pelagic habitats of Virginia's coastal waters (BOEM 2014a). Benthic or pelagic EFH has been designated in the Offshore Project Area for one or more life stages of 33 species.

Species with EFH in the Offshore Project Area were identified using the NOAA Fisheries EFH Mapper (2021), NEFMC Omnibus Amendment 2 (2017), MAFMC FMPs, NOAA Fisheries Highly Migratory Species Amendment 10 (2017), and NOAA Fisheries EFH source documents. Dominion Energy further refined this list of species and life stages by conducting extensive surveys of the Lease Area and Offshore

Export Cable Route Corridor using multibeam echo sounder (MBES), side scan sonar (SSS), digital imagery, and sediment grab samples. The results of these surveys are described in detail in the Benthic Resource Characterization Report (Appendix D).

In the Offshore Project Area, the MAFMC and NEFMC share authority with NOAA Fisheries to manage and conserve fisheries stocks in federal waters. NOAA Fisheries' Highly Migratory Species Division is responsible for tunas and sharks in the Offshore Project Area. In addition, the ASMFC manages more than two dozen fish and invertebrate species in cooperation with the states and NOAA Fisheries; many of these species are also identified as NOAA Trust Resources.

State regulatory bodies manage and conserve fisheries stocks in state waters. The VMRC Fisheries Management Division develops and implements policies affecting saltwater recreational and commercial fisheries in the Commonwealth's tidal waters. The Division's Fisheries Plans and Statistics Department monitors the Commonwealth's finfish and shellfish fisheries and develops management plans with assistance from Fisheries Management Advisory Committees composed of representatives of fisheries interest groups. Together, the Department and Committees have developed FMPs for black drum, blue crab, bluefish, shad and river herring, spotted seatrout, striped bass, weakfish, and others (VMRC 2021a). Please note that scientific names of managed fish and invertebrate species are in Table E-1.

Table E-1 summarizes managed species that may occur seasonally or year-round in the Offshore Project Area; detailed life history profiles and EFH designations for these species are provided in Attachment E-1. EFH for temperate and subtropical–tropical managed species is organized into five life stages: egg, larva, juvenile, adult, and spawning adult. NOAA Fisheries' Highly Migratory Species Division has simplified these life stages to egg, larva, and spawning adult. Sharks are managed as neonates (newborns and pups aged less than 1 year), juveniles, and adults.

FMCs, councils, and divisions may also designate HAPCs, which are areas of EFH critical to the survival of given species. The nearest HAPC to the Offshore Project Area is Norfolk Canyon, located 21 nm (40 km) from the northeast corner of the Lease Area. There is no designated HAPC in the Offshore Project Area (NOAA Fisheries 2021).

Table E-1. Species in the Offshore Project Area Managed by Federal, Regional, and State Agencies

Common Name	Scientific Name	Essential Fish Habitat (EFH) Life Stages Designated within the Offshore Project Area
New England Fishery Management Council		
Atlantic cod	*Gadus morhua*	Egg, Larva
Atlantic herring a/	*Clupea harengus*	Juvenile, Adult
Atlantic sea scallop	*Placopecten magellanicus*	ALL
clearnose skate	*Raja eglanteria*	Juvenile, Adult
monkfish b/	*Lophius americanus*	ALL
pollock	*Pollachius virens*	Larva
red hake	*Urophycis chuss*	Adult
windowpane flounder	*Scophthalmus aquosus*	ALL
winter skate	*Leucoraja ocellata*	Juvenile
witch flounder	*Pseudopleuronectes americanus*	Egg, Larva
yellowtail flounder	*Limanda ferruginea*	Larva
Mid-Atlantic Fishery Management Council		
Atlantic butterfish	*Peprilus triacanthus*	ALL
Atlantic mackerel	*Scomber scombrus*	Egg, Juvenile, Adult

Common Name	Scientific Name	Essential Fish Habitat (EFH) Life Stages Designated within the Offshore Project Area
Atlantic surfclam	*Spisula solidissima*	Juvenile, Adult
black sea bass a/	*Centropristis striata*	Larva, Juvenile, Adult
bluefish a/	*Pomatomus saltatrix*	ALL
longfin inshore squid	*Doryteuthis pealeii*	Egg, Juvenile, Adult
scup a/	*Stenotomus chrysops*	Juvenile, Adult
spiny dogfish a/ b/	*Squalus acanthias*	Sub-adult Female, Adult Female, Adult Male
summer flounder a/	*Paralichthys dentatus*	ALL
NOAA Fisheries—Highly Migratory Species		
albacore tuna	*Thunnus alalunga*	Juvenile
Atlantic angel shark	*Squatina dumeril*	ALL
Atlantic bluefin tuna	*Thunnus thynnus*	Juvenile, Adult
Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	Juvenile, Adult
skipjack tuna	*Katsuwonus pelamis*	Juvenile, Adult
yellowfin tuna	*Thunnus albacares*	Juvenile, Adult
blacktip shark	*Carcharhinus limbatus*	Juvenile, Adult
common thresher shark	*Alopias vulpinus*	ALL
dusky shark	*Carcharhinus obscurus*	ALL
sand tiger shark	*Carcharias taurus*	ALL
sandbar shark	*Carcharhinus plumbeus*	ALL
Smooth hound shark complex (smooth dogfish)	*Mustelus canis*	ALL
tiger shark	*Galeocerdo cuvier*	Juvenile, Adult
Atlantic States Marine Fisheries Commission and Virginia Marine Resources Commission		
amberjack c/	*Seriola dumerili*	N/A—EFH is only designated for federally managed species
American eel	*Anguilla rostrata*	
American lobster	*Homarus americanus*	
American shad	*Alosa sapidissima*	
Atlantic croaker	*Micropogonias undulatus*	
Atlantic menhaden	*Brevoortia tyrannus*	
Atlantic sturgeon	*Acipenser oxyrinchus*	
billfish c/	Istiophoriformes	
black drum	*Pogonias cromis*	
blue crab c/	*Callinectes sapidus*	
channeled whelk c/	*Busycotypus canaliculatus*	
cobia	*Rachycentron canadum*	
groupers c/	Epinephelidae	
horseshoe crab	*Limulus polyphemus*	
jonah crab	*Cancer borealis*	
red drum	*Sciaenops ocellatus*	
river herring	*Clupeidae*	
sheepshead c/	*Archosargus probatocephalus*	
spadefish c/	*Chaetodipterus faber*	
spot	*Leiostomus xanthurus*	
spotted seatrout	*Cynoscion nebulosus*	
striped bass	*Morone saxatilis*	
tautog	*Tautoga onitis*	
tilefish c/	Malacanthidae	
weakfish	*Cynoscion regalis*	

Notes:
a/ joint management with ASMFC
b/ joint management by NEFMC and MAFMC
c/ VMRC only

E.2.1 Previous EFHA Consultations for U.S. Atlantic Offshore Wind Projects

The MSA requires all federal agencies to consult with NOAA Fisheries on any actions, or proposed actions, permitted, funded, or undertaken by the agency that may adversely affect EFHs. BOEM has consulted with NOAA Fisheries on pre-COP activities such as leasing and developing Site Assessment Plans (SAPs) for several Lease Areas in the U.S. Atlantic OCS, including New Jersey, Delaware, Maryland, and Virginia (BOEM 2012); Rhode Island and Massachusetts (BOEM 2013); Massachusetts (BOEM 2014b); North Carolina (BOEM 2015a) and New York (BOEM 2016). Additionally, BOEM is conducting ongoing project-specific EFH consultations to evaluate construction and O&M impacts to EFH in the U.S. Atlantic OCS. These include the Block Island Wind Farm (USACE 2014), CVOW Pilot Project (BOEM 2015b), Cape Wind Energy Project (BOEM 2019), South Fork Wind Farm (BOEM 2021a, 2021b), Ocean Wind Offshore Wind Farm (Federal Register 2021a), Revolution Wind Offshore Wind Farm (Federal Register 2021b), and Atlantic Shores (Federal Register 2021c). Essential Fish Habitat Assessments prepared to support these consultations have determined that construction, installation, and conceptual decommissioning of these projects would have minor adverse effects on EFHs resulting from noise, seabed disturbance, water quality impacts from sediment suspension and deposition, vessel activity, lighting, and introduction of novel structures into the water column. Analyses and determinations resulting from project-specific EFH consultations on the Atlantic OCS similar to the CVOW Commercial Project are incorporated into the present EFHA to the extent practicable.

E.2.2 Review of EFH in the Project Area

EFH for temperate and subtropical-tropical managed species is designated for five life stages: egg, larval, juvenile, adult, and spawning adult. Highly Migratory Species are managed as eggs, larvae, and spawning adults. Sharks are managed as neonates (newborns and pups less than 1 year), juveniles, and adults. For most species, EFH for each of life stage is designated in 10 by 10-minute squares based on habitat features, literature reviews, fishery-independent data, and best professional judgement of fisheries managers.

Managed species with EFH in the Offshore Project Area were identified using the NOAA Fisheries EFH Mapper (2021), NEFMC Omnibus Amendment 2 (2017), MAFMC FMPs, NOAA Fisheries Highly Migratory Species Amendment 10 (2017), and NOAA Fisheries EFH source documents. Dominion Energy conducted extensive surveys of the Lease Area and Offshore Export Cable Route Corridor using MBES, SSS, digital imagery, and sediment grab samples to characterize EFH. The results of these surveys are described in detail in the Benthic Resource Characterization Report (Appendix D) and are available for viewing on the CVOW EFH Assessment Web Application (Tetra Tech 2021). Designated EFH by species and life stage is presented in Table E-2.

Table E-2. Designated EFH by Species and Life Stage in the Offshore Project Area

Managed Species	Lease Area				Offshore Export Cable Route Corridor							
					Federal Waters				State Waters			
	Life Stage											
	E	L	J	A	E	L	J	A	E	L	J	A
Atlantic cod (*Gadus morhua*)	-	X	-	-	X	X	-	-	X	-	-	-

Managed Species	Lease Area				Offshore Export Cable Route Corridor							
					Federal Waters				State Waters			
	Life Stage											
	E	L	J	A	E	L	J	A	E	L	J	A
Atlantic herring (*Clupea harengus*)	-	-	X	X	-	-	X	X	-	-	-	X
Atlantic sea scallop (*Placopecten magellanicus*)	X	X	X	X	-	-	-	-	-	-	-	-
clearnose skate (*Raja eglanteria*)	-	n/a	X	X	-	n/a	X	X	-	n/a	X	X
monkfish (*Lophius americanus*)	X	X	X	-	X	X	-	X	X	X	-	X
pollock (*Pollachius virens*)	-	X	-	-	-	X	-	-	-	-	-	-
red hake (*Urophycis chuss*)	-	-	-	X	-	-	-	-	-	-	-	-
windowpane flounder (*Scophthalmus aquosus*)	X	X	X	X	X	X	X	X	X	-	X	-
winter skate (*Leucoraja ocellate*)	-	n/a	X	-	-	n/a	X	-	-	n/a	-	-
witch flounder (*Pseudopleuronectes americanus)*	X	X	-	-	X	X	-	-	X	-	-	-
yellowtail flounder (*Limanda ferruginea*)	-	X	-	-	-	X	-	-	-	-	-	-
Atlantic butterfish (*Peprilus triacanthus*)	-	X	X	X	X	-	X	X	-	-	X	X
Atlantic mackerel (*Scomber scombrus*)	X	-	X	X	X	-	X	X	-	-	-	X
Atlantic surfclam (*Spisula solidissima*)	-	-	X	X	-	-	X	X	-	-	-	-
black sea bass (*Centropristis striata*)	-	X	X	X	-	X	X	X	-	-	X	X
bluefish (*Pomatomus saltatrix*)	X	X	X	-	X	X	X	X	-	-	X	X
longfin inshore squid (*Doryteuthis [Amerigo] pealeii*)	-	-	X	X	X	-	X	X	X	-	-	-
scup (*Stenotomus chrysops*)	-	-	X	X	-	-	X	X	-	-	X	X
spiny dogfish (*Squalus acanthias*)	n/a	-	-	X	n/a	-	-	X	n/a	-	-	X
summer flounder (*Paralichthys dentatus*)	X	X	X	X	X	X	X	X	-	-	X	X
albacore tuna (*Thunnus alalonga*)	-	-	X	-	-	-	X	-	-	-	X	-
Atlantic angel shark (*Squatina dumeril*)	n/a	X	X	X	n/a	-	-	-	n/a	-	-	-
Atlantic bluefin tuna (*Thunnus thynnus*)	-	-	X	X	-	-	X	X	-	-	X	X
Atlantic sharpnose shark (*Rhizoprionodon terraenovae*)	n/a	-	-	X	n/a	-	X	X	n/a	-	X	X
Atlantic skipjack tuna (*Katsuwonus pelamis*)	-	-	X	X	-	-	X	X	-	-	-	X
Atlantic yellowfin tuna (*Thunnus albacares*)	-	-	X	X	-	-	X	-	-	-	X	-
blacktip shark (*Carcharhinus limbatus*)	n/a	-	X	X	n/a	-	X	X	n/a	-	X	X
common thresher shark (*Alopias vulpinus*)	n/a	X	X	X	n/a	X	X	X	n/a	X	X	X

Managed Species	Lease Area				Offshore Export Cable Route Corridor							
					Federal Waters				State Waters			
	Life Stage											
	E	L	J	A	E	L	J	A	E	L	J	A
dusky shark (*Carcharhinus obscurus*)	n/a	X	X	X	n/a	X	X	X	n/a	X	-	-
sand tiger shark (*Carcharias taurus*)	n/a	X	X	X	n/a	X	X	X	n/a	X	X	X
sandbar shark (*Carcharhinus plumbeus*)	n/a	X	X	X	n/a	X	X	X	n/a	X	X	X
smooth hound shark complex / smooth dogfish (*Mustelus canis*)	n/a	X	X	X	n/a	X	X	X	n/a	X	X	X
tiger shark (*Galeocerdo cuvier*)	n/a	-	X	X	n/a	-	X	X	n/a	-	X	X

Notes:
X EFH for this life stage is designated in the given portion of the Offshore Project Area
- No EFH for this life stage is designated in the given portion of the Offshore Project Area
n/a No EFH is designated for this life stage
A Adult (including Sub-Adult)
E Egg
L Larva (or neonate if shark species)
J Juvenile

E.2.3 Categories of EFH: Habitat Types

The Offshore Project Area contains three broad categories of EFH that support managed species: water column (pelagic habitat), softbottom (benthic habitat), and hardbottom (benthic habitat; Table E-3).

Table E-3. Categories of Essential Fish Habitat in Offshore Project Area

EFH Category	Representative Habitats in CVOW Offshore Project Area
Pelagic Habitat: Water Column	All waters and associated currents from the seafloor to the sea surface, including bays and estuaries
Benthic Habitat: Softbottom	Seafloor substrate characterized by soft, unconsolidated sediments, including silt, mud, clay, sand, gravel, pebbles, cobbles, and shell fragments
Benthic Habitat: Hardbottom	Seafloor substrate characterized by complex, three-dimensional artificial reef habitat, including ships, tires, cable spools, and other intentionally deployed materials (e.g., Fish Haven)

E.2.3.1 Pelagic Habitat: Water Column EFH

Pelagic habitats are the open waters from the seafloor to the sea surface. They are characterized by physical parameters such as depth, distance from shore, light penetration, temperature, and turbidity. For example, the photic zone falls within the top 650 feet (ft; 198 meters [m]) of ocean where sunlight penetrates the water column. This zone strongly influences pelagic habitats by supporting photosynthetic phytoplankton and dispersing planktonic egg and larval stages (NOAA Fisheries 2017). Physiochemical conditions including dissolved oxygen, currents, pH, and temperature further influence the occurrence and abundance of these managed species (Pineda et al. 2007). Such conditions in the Offshore Project Area are described in greater detail in the COP (see Section 4.1.1, Section 4.1.2, and Appendix X, Metocean Assessment) and summarized here.

Current patterns, local weather, broad climactic events, and anthropogenic activities can influence dynamic water quality parameters such as conductivity, dissolved oxygen, and pH. Light penetration and temperature generally covary with depth, although these relationships may not be linear. Inner shelf waters (60–100 ft [18–30 m]) are influenced by nearshore conditions such as winds and tidal action; intermediate shelf waters (100–160 ft [30–50 m]) are mostly wind driven; and shelf edges (160–330 ft [50–100 m]) are influenced primarily by the southbound Labrador Current and northwest Gulf Stream (Lee et al. 1981; Atkinson and Targett 1983).

A persistent cross-shelf salinity gradient exists in the Mid-Atlantic Bight because of freshwater runoff from the Hudson-Raritan Estuary System, Delaware Bay, and Chesapeake Bay (Castelao et al. 2010). Following periods of high runoff, a strong vertical salinity gradient has been observed across portions of the continental shelf (Wilkin and Hunter 2013). Historical annual mean salinities for the entire Mid-Atlantic Bight range from 32.7 to 34.5 parts per thousand (ppt) (NOAA 2003). NEFSC seasonal trawl CTD data (conductivity, temperature, and depth data gathered by a sonde instrument) collected from 2003 to 2016 generated water column salinity profiles consistent with these historical values (Guida et al. 2017). Salinity was recorded within the euhaline range (29.8-34.0 ppt), indicating relative stability of this pelagic habitat feature (Guida et al. 2017).

The National Coastal Condition Report IV (EPA 2012) rated the condition of Virginia Beach shoreline waters near the Cable Landfall Location as “poor to fair” and the waters of the Offshore Project Area as “fair to good.” Wastewater treatment equipment, stormwater runoff, agricultural runoff, and other anthropogenic factors may indirectly influence dissolved oxygen by yielding occasional algal blooms and subsequent hypoxic events in the nearshore regions of the Offshore Project Area (VDEQ 2020). Concentrations of dissolved oxygen in offshore waters are expected to consistently exceed safe thresholds for marine organisms (i.e., more than 5 milligrams per liter) (BOEM 2015).

Water depth influences surface and bottom temperatures, light penetration, sediment movement, and other physiochemical parameters that define EFH. In the Offshore Project Area, charted water depths range from 0 to 62 ft (0 to 19 m) in the Offshore Export Cable Route Corridor and 62 to 134 ft (19 to 41 m) in the Lease Area (NOAA 2021). Depths increase seaward along roughly a southwest to northeast gradient, with the shallowest areas in the northwest and southwest corners and deepest areas in the northeast corner (Figure E-2).

During 2020 and 2021, Dominion Energy completed full-coverage HRG and geotechnical surveys in the Lease Area and Offshore Export Cable Route Corridor (TerraSond 2021; Alpine 2021). Relevant findings from those surveys are based on the interpretations of Sub-bottom Profiler (SBP), Ultra High-Resolution Seismic (UHRS), SSS, MBES, and Magnetometer/Transverse Gradiometer (MAG/TVG) equipment. MBES data were used to correlate SSS contact positions and prominent features of the seafloor during interpretation. Backscatter data were utilized to generate seafloor interpretations along with the MBES and SSS data, as summarized in Section E.2.3.2.2, Habitat Mapping. These surveys included a total of five vessels and approximately 20,000 km of survey lines in the Lease Area, and three vessels and approximately 3,300 km of survey lines in the Offshore Export Cable Route Corridor. The bathymetry of the entire Offshore Project Area (TerraSond 2021; Alpine 2021), is shown with bathymetric contours as an overview in Figure E-2 and Figure E-3, with additional detailed panels in Attachment E-3. Depth profiles and acreages are shown in Table E-4. Additionally, the full-coverage Offshore Project Area bathymetry based on geophysical survey data are available as a webmap tool, located at: https://cvowc.tetratech.com.

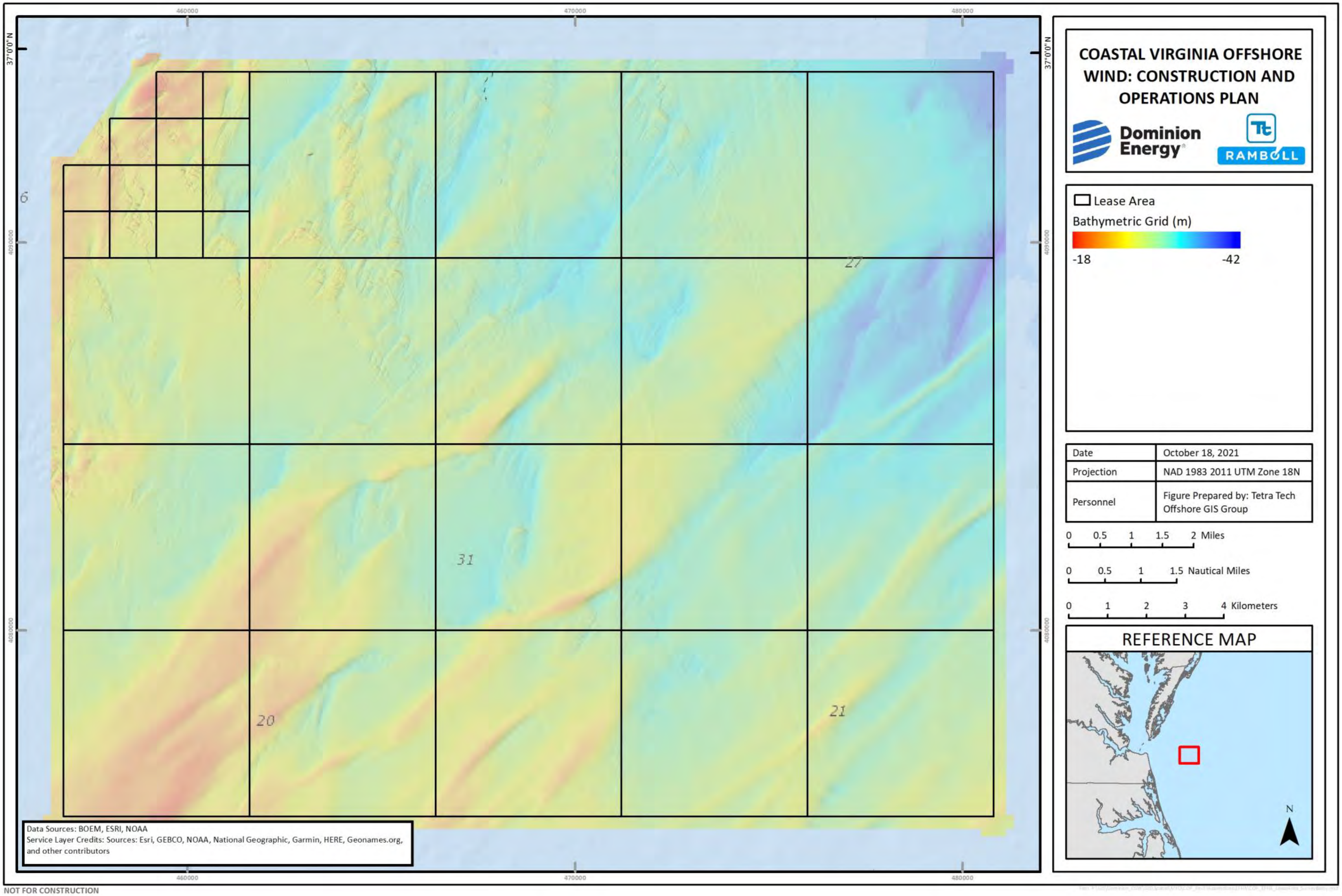

Figure E-2. Bathymetry Overview in the Lease Area (TerraSond 2021)

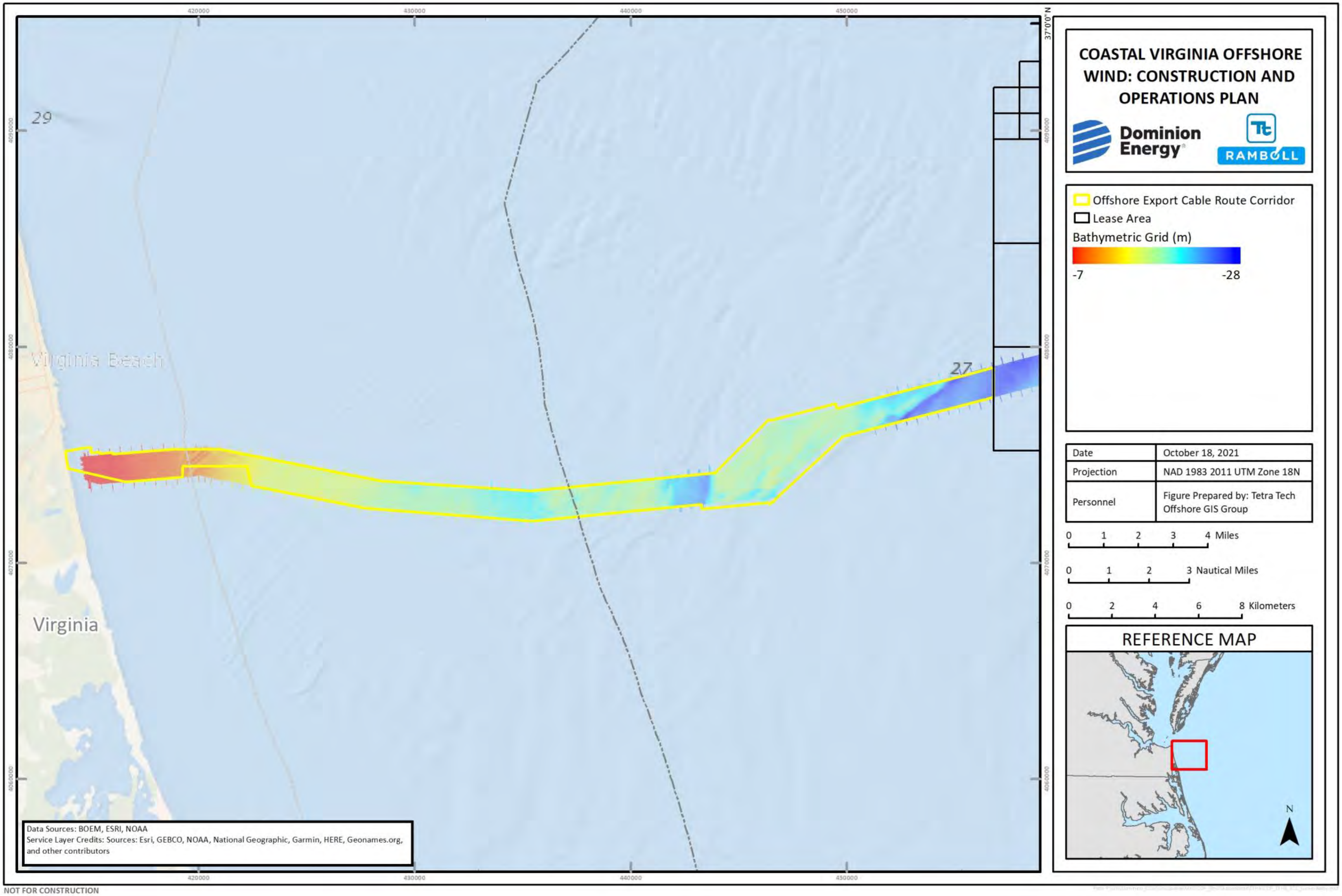

Figure E-3. Bathymetry Overview in the Offshore Export Cable Route Corridor (Alpine 2021)

Table E-4. Depth Profiles in the Offshore Project Area

Offshore Project Area	Depth Range (m)	Acres (Hectares) at Depth Range	% of Total Acreage
Offshore Export Cable Route Corridor: State Waters	0 to 5	86 (34.8)	4.7
	5 to 10	1,234 (499.4)	67.4
	10 to 15	449 (181.7)	24.5
Offshore Export Cable Route Corridor: Federal Waters	10 to 15	810 (327.8)	5.9
	15 to 20	8,957 (3,624.8)	64.9
	20 to 25	3,107 (1,257.4)	22.5
	25 to 30	720 (291.4)	5.2
Lease Area	15 to 20	120 (48.6)	0.1
	20 to 25	13,386 (5,417.1)	11.9
	25 to 30	65,048 (26,324)	57.7
	30 to 35	31,391 (12,703.5)	27.8
	35 to 40	2,777 (1,123.8)	2.5

Water temperatures in the Offshore Project Area vary greatly with depth and season. Seasonal variations include a range of 27 degrees Fahrenheit (˚F, 15 degrees Celsius [˚C]) at the seafloor and a range of 36˚F (20˚C) at the surface (Guida et al. 2017). April marks the initiation of thermal stratification, as ambient temperatures begin to raise surface water temperatures above those of bottom temperatures. Maximum surface-to-bottom thermal gradients include a range of 27˚F (15˚C) in August, followed by vertical turnover in September and October. Temperatures may drop 22˚F (12˚C) throughout the water column by the following January. These seasonal variations can trigger physiological and behavioral responses (e.g., gonadal development, seasonal migration) in managed species. Warm temperate species arrive from the south as Virginia's coastal waters warm in the summer; these species are replaced by cold temperate species from the north as water temperatures cool in the winter (BOEM 2014a). The thermal cycle redistributes highly mobile managed species and influences settlement timelines for planktonic stages of less mobile demersal species

The assemblage of pelagic species in the Offshore Project Area varies by season and with distance from shore. Bays and estuaries provide spawning, nursery, and foraging purposes habitats (MAFMC 2017; NEFMC 2017). Pelagic species tolerant of low salinities occur seasonally in bays and estuaries (e.g., Atlantic herring [*Clupea harengus*], Atlantic butterfish [*Peprilus triacanthus*], Atlantic mackerel [*Scomber scombrus*], bluefish [*Pomatomus saltatrix*], scup [*Stenotomus chrysops*]). Inshore habitat uses may be further divided by life stage. For example, Atlantic herring larvae occur in salinities as low as 2.5 ppt; juveniles also tolerate low salinities but exhibit increasing preference for higher salinities (>28 ppt) as they age (Reid et al. 1999; Stevenson and Scott 2005; NEFMC 2017).

In offshore waters over the continental shelf, the photic zone supports phytoplankton (e.g., diatoms and dinoflagellates), particularly in areas with high nutrient content, such as coastal zones enriched by runoff or shelf-break zones enriched by upwelling. Current dynamics provide a dispersal mechanism for planktonic eggs and larvae of managed species. The continental shelf of the Mid-Atlantic Bight receives Labrador Current cold-water influxes from the north and Gulf Stream warm-water influxes from the south. To the south of the Offshore Project Area, Cape Hatteras demarcates a dynamic ichthyoplankton faunal transition zone between two broad eco-regions: the Mid-Atlantic Bight, which extends from Delaware Bay to Cape Hatteras, and the South Atlantic Bight, which extends from Cape Hatteras to Cape Canaveral

(Grothues and Cowen 1999; Hare et al. 2001; Hare et al 2002). Ichthyoplankton from this transition zone are carried to the Offshore Project Area by prevailing currents.

As a result, larvae of species distributed throughout the U.S. Atlantic Coast occur in the Offshore Project Area (BOEM 2014a). Buoyant eggs and larvae are widely dispersed by currents during the weeks or months they remain in the plankton (Hare et al. 2001; Hare et al. 2002; Walsh et al. 2015). For example, the four- to eight-month planktonic larval stage of the Atlantic herring allows ample time for individuals to be distributed across the U.S. Atlantic Coast (NEFMC 2017). Such widespread phytoplankton and ichthyoplankton assemblages support some short-lived, highly fecund managed species (e.g., Atlantic mackerel) that serve as a forage base for longer-lived, highly migratory managed species (e.g., tunas and pelagic sharks) (see Attachment E-1; NEFMC 2017; NOAA Fisheries 2017).

E.2.3.2 Benthic Habitat – Softbottom EFH

E.2.3.2.1 Seabed Characterization

A detailed analysis of the seabed, resulting from the HRG surveys is included in Appendix C, MSIR, summarized in this section. Softbottom habitats are characterized by soft, unconsolidated sediments, including silt, mud, clay, sand, gravel, pebbles, cobbles, and shell fragments. The softbottom sediments offshore of Virginia are typical of the rest of the Mid-Atlantic Bight and are characterized by fine sand and punctuated by gravel and silt/sand mixes (Milliman 1972; Steimle and Zetlin 2000). Offshore Project Area substrates are consistent with this regional pattern and include unconsolidated sediments comprised of gravel (larger than 2000 micrometers [μm]), sand (62.5 to 2000 μm), silt (4 to 62.5 μm), clay (smaller than 4 μm), and shell debris (Williams et al. 2006).

Extensive HRG surveys have been performed in the Offshore Project Area (including the Lease Area) as part of BOEM's site Environmental Assessment (EA) (Fugro 2013) and leading up to the CVOW Pilot Project (Tetra Tech 2013; Tetra Tech 2014). These data are included in publicly available databases, technical literature, and site-specific reports that provide useful data collected in the Offshore Project Area. Numerous sources concur with Dominion Energy's 2020 findings that the Offshore Survey Area is dominated by fine, medium, and coarse-grain sand (Cutter and Diaz 1998; Diaz et al. 2004; Diaz et al. 2006; USACE 2009; Greene et al. 2010; Fugro 2013; Guida et al. 2017; MARCO 2021). Bottom topography in the Offshore Survey Area is characterized by a sedimentary fan, shelf valley tributaries to the north and east, and a series of sand ridges trending northeast to southwest (Guida et al. 2017). The slopes in the Offshore Survey Area generally fall within 1.2 degrees and there is virtually zero rugosity throughout the area (Guida et al. 2017). U.S. Fish and Wildlife Service (USFWS) benthic sampling programs determined that the most abundant taxa in Virginia nearshore habitats (in descending order) were polychaetes, bivalves, and amphipods (USACE 2009). Cutter and Diaz (1998) noted these taxa as well as decapods, sand dollars, and lancelets. Infaunal assemblages in grab samples collected in the Lease Area were characterized as highly diverse (Guida et al. 2017).

During 2020 and 2021, Dominion Energy completed full-coverage geophysical and geotechnical surveys in the Lease Area and Offshore Export Cable Route Corridor, which characterized the entire Offshore Project Area as softbottom habitat (TerraSond 2021; Alpine 2021). Seabed characterization and morphology features (e.g., sediment type, sandwaves, ridges, depressions, etc.) were also interpreted from the SBP, UHRS, SSS, MBES, MAG/TVG, and backscatter data. Sediment type and seabed morphology are features that define EFH for some species. CMECS softbottom habitat types interpreted from the HRG data account for the entirety of the Offshore Project Area and range from muddy sand to coarse sand in the Offshore Export Cable Route Corridor and fine sand to coarse sand in the Lease Area (TerraSond 2021; Alpine 2021). Grain size roughly increases along a west to east gradient along the Offshore Export Cable Route Corridor. Fine sand was identified as the dominant sediment type in the northwest portion of the Lease Area and coarse sand in the southeast portion of the Lease Area, varying with seabed morphology within the Lease Area. CMECS sediment types in the Offshore Project Area were interpreted from MBES, SSS, and backscatter data processed at 0.1 to 0.5 m^2 resolution, as listed in Table E-5.

Table E-5. Sediment Types in the Offshore Project Area, Interpreted from MBES, SSS, and Backscatter Data Processed at 0.1 to 0.5 m^2 resolution.

Offshore Project Area	Sediment Type (CMECS)	Acres	% of Total Acreage
Offshore Export Cable Route Corridor–Federal Waters	Construction Hash	76.89	0.5
	Gravel mixes	2.80	0.02
	Gravelly	1,691.22	10.6
	Mud	11.52	0.1
	Muddy sand	1,324.40	8.3
	Sand	10,598.67	66.7
	Unsurveyed	530.51	3.3
Offshore Export Cable Route Corridor–State Waters	Muddy sand	1,381.22	8.7
	Sand	45.96	0.3
	Unsurveyed	225.32	1.4
Lease Area	Coarse Sand/Very Coarse Sand	62,180.10	55.1
	Fine Sand/Very Fine Sand	22,725.62	20.1
	Medium Sand	27,893.18	24.7

E.2.3.2.2 Habitat Mapping

NMFS-GARFO has developed habitat mapping recommendations in coordination with BOEM to ensure that adequate data and information are included as part of EFHAs associated with offshore wind projects (NMFS-GARFO 2021 [March]). The primary goal of interpreting and mapping seabed features is to quantify and differentiate between complex (hard bottom, gravel mixes, shell, and vegetation) and non-complex sand/silt/mud habitats (grain sizes less than 2 mm) in accordance with the CMECS modifiers provided by NMFS-GARFO (2021). CMECS sediment types in the Offshore Project Area were interpreted from MBES, SSS, and backscatter data processed at 0.1 to 0.5 m^2 resolution, and displayed on maps at a scale of 1:10,000 throughout the Project Area, as shown in Attachment E-3 and the webmap tool, located at: https://cvowc.tetratech.com. Benthic features defined as sand waves, megaripples, ripples, and biogenic habitats are also important to delineate to characterize and quantify EFH types present in the Project Area (NMFS-GARFO 2021).

All acquisition, processing, and interpretation of data was consistent with the BOEM Guidelines and NMFS-GARFO recommendations (BOEM 2020; NMFS-GARFO 2021). In addition to providing data to support the overall Project design, the HRG surveys provide ultra-high-resolution data on the seafloor to support accurate interpretation of habitat features in the Offshore Project Area. To that end, the following data were collected within the survey area:

- MBES Bathymetry and Backscatter: Gridded at 0.5 m resolution;

- SSS Imagery: Collected at 200% coverage submitted at 0.25 m resolution;
- Multi-Channel Seismic (MCS): 150 m depth BSB, 1 m resolution;
- Single-Channel Seismic (SCS): 25 m depth BSB, 0.4 m resolution;
- Sub-Bottom Profiler (SBP): 12 m depth BSB, 0.2 m resolution;
- TVG: Gridded at 1 m resolution;
- Geotechnical and benthic samples (grab samples and imagery).

Benthic sampling (grab samples, still images, video images) was conducted during summer 2020 (Tetra Tech 2021) and Fall 2020 (Schnabel 2021) to provide information on benthic habitats and organisms. Specifically, a portion of the Schnabel Engineering LLC (Schnabel) survey was to "ground-truth" the seabed interpretations from the HRG survey data. A total of 120 grab samples were collected within the Lease Area by TerraSond subcontractor Schnabel. Eighty of the 120 sites were positioned based on a regular pattern (60% of the 80 placed on even corridors, 40% of the 80 on odd), and 40 sites were selected as areas of interest. The first 80 sites were selected by referencing the turbine layout. The remaining 40 sites were selected by reviewing the SSS and backscatter data and selecting areas where the acoustic signature suggested a more variable surficial sediment or appeared to have significant intensity difference from areas already sampled. The sampling locations are fully represented on the maps included in Attachment E-3 and the webmap tool, located at: https://cvowc.tetratech.com. In addition to Schnabel's grab sampling, benthic sampling results from previous work conducted by Tetra Tech was provided and used during subsequent interpretation to supplement the available data.

Habitat mapping recommendations were incorporated into the processes and methods used to interpret seabed habitats from the HRG survey data, as detailed in Appendix C, MSIR, and the HRG survey reports (TerraSond 2021; Alpine 2021). Backscatter data and sediment sample locations were imported into Blue Marble Geographics Global Mapper v20.0. A correlation of grain sizes in each grab sample with the backscatter amplitude was used to generate contours consistent with backscatter intensity. The generated contours were then adjusted on the basis of the bathymetry and SSS data. The resulting interpreted boundaries were classified using the CMECS Substrate Component (SC) and ASTM D2488 to describe the surficial sediments. The digitized regions were then imported into a GIS project using ESRI ArcCatalog 10.7.1 and ESRI ArcMap 10.7.1. Metadata were generated for the sediment boundaries in ESRI ArcCatalog 10.7.1.

Methods used to interpret seabed habitats are summarized from TerraSond (2021) and Alpine (2021) below:

- Grain size sample location point coordinates were imported on the MBES backscatter mosaic in GIS software and the amplitude of the backscatter at each sampling location was measured.
- A plot of sediment size correlated to the backscatter was made to visualize and analyze their relationship and sampling results were ordered by increasing value of grain size (mm) and correlated with the backscatter intensity at the sampling location.
- The moving average with a window of 10 samples and a linear interpolation resulted in a general increase of the backscatter reflectivity with the increase of the grain size.
- Laboratory grain size data from the 202 grab samples resulted in CMECS classifications of 97 percent very coarse sand or finer, and 3 percent granule/pebble, with each of the granule/pebble samples located within the CMECS coarse sand mapped areas.

  - Muddy Sand (1 sample)
  - Fine/Very Fine Sand (41 samples)
  - Medium Sand (62 samples)
  - Coarse Sand (91 samples)
  - Very Coarse Sand (2 samples)
  - Granule (1 sample)
  - Pebble (4 samples)

- The samples were then ordered using CMECS classification, showing the backscatter amplitude for coarse sand, fine/very fine sand and medium sand. The average backscatter amplitude was calculated for all the classes and the midpoint between the average values of the various classes was used as backscatter amplitude threshold between the classes: Fine: -70.000 to -28.456 Medium: -28.456 to -24.611 Coarse: -24.611 to 0.000; see Figure E-4.
- These limits between classes were used in GIS software to generate contours of the backscatter values, and the resulting areas represent a first approximation of the distribution of seabed sediments grainsize on CVOWC Lease Area and Export Cable Corridor, using the CMECS classification.
- A certain amount of variation is observed in the backscatter amplitude for each grain size class. This observed variation is due to the accuracy of the sample positioning coordinates and to the variability in the backscatter ranges across the CVOWC Lease Area and Export Cable Corridor. This difference in backscatter is expected in large surveys when thousands of survey lines from different vessels are merged for the creation of a single mosaic covering the whole study area.
- Additional corrections in the backscatter class limits were performed in a few portions of the area, showing a general positive or negative variation in the backscatter amplitude. The values were selected to obtain the maximum possible continuity of the sediment class areas previously generated using the average values.
- Additional manual editing of the mapped areas was performed on the basis of the sample grain sizes, the low frequency SSS mosaic and the geomorphology observed in bathymetric data. This manual editing was done to remove spikes and artifacts, as well as to improve the general interpretation of the class areas.

Resulting seabed morphology and sediment types are shown as overview maps (for informational purposes only) in Figure E-5 through Figure E-8, with additional detailed panels shown at a 1:10,000 scale in Attachment E-3. Additionally, the full-coverage and full-resolution Offshore Project Area seabed CMECS habitat interpretations based on geophysical survey data are available to BOEM and NMFS as a webmap tool, located at: https://cvowc.tetratech.com. This tool can be used to generate custom-view data-based habitat maps that display the characterized delineations and complex/non-complex or heterogeneous complex benthic features, provided at user-defined scales appropriate to habitat features, consistent with the NMFS-GARFO habitat mapping and minimum mapping unit recommendations (NMFS-GARFO 2021).

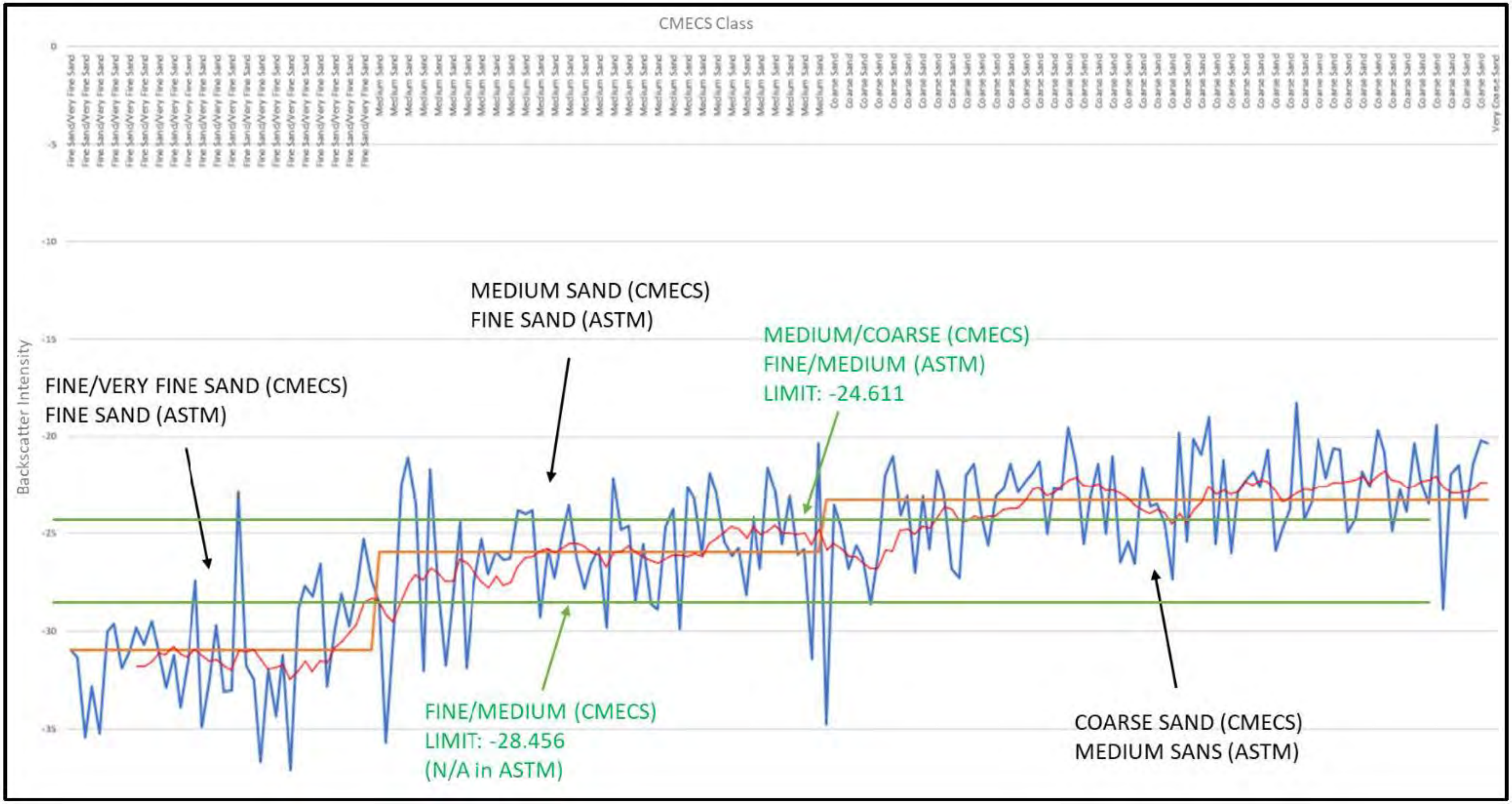

Figure E-4. Grain size and backscatter correlation based on samples classification

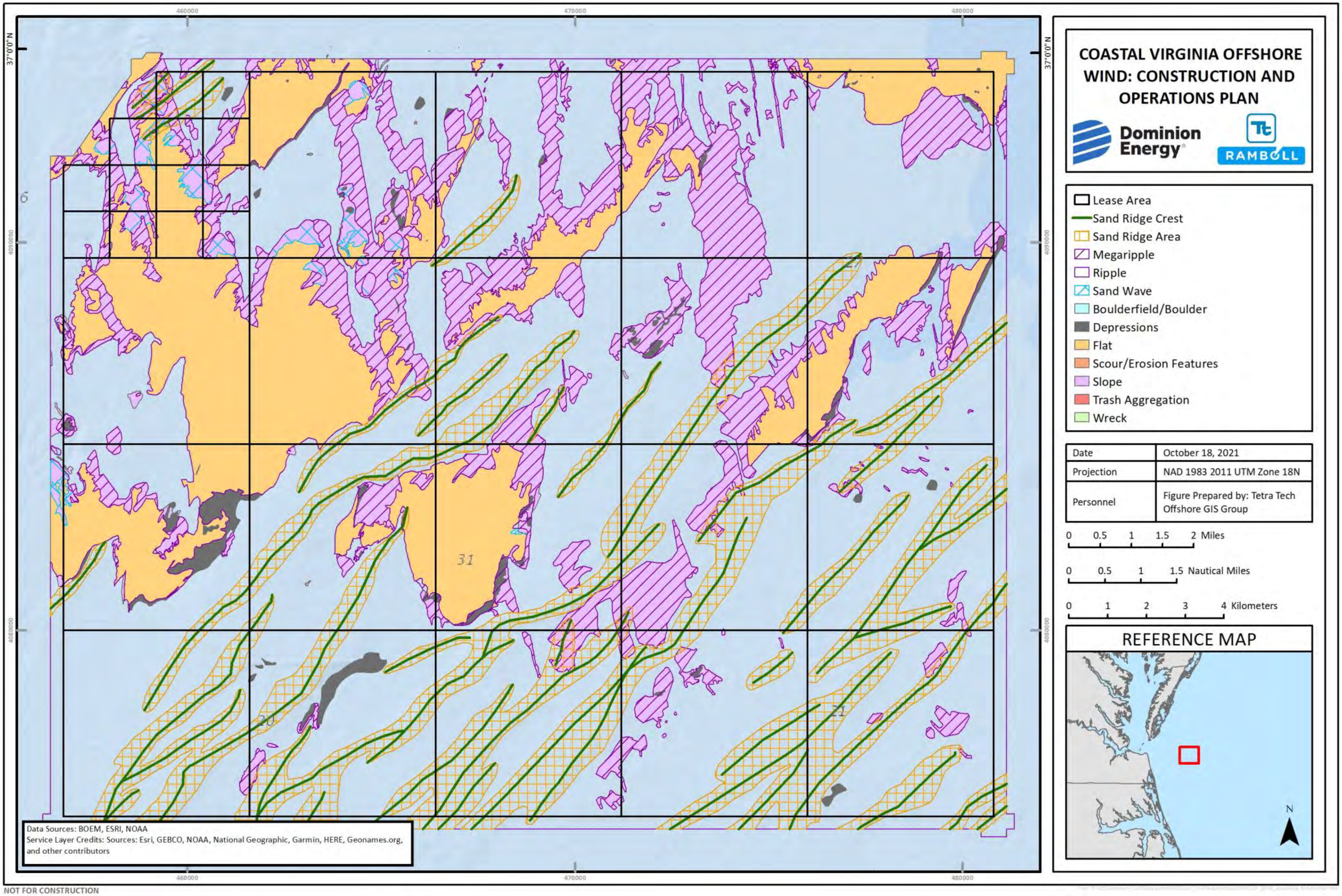

Figure E-5. Seabed Morphology Overview in the Lease Area (TerraSond 2021), See Attachment E-3 for full-scale maps

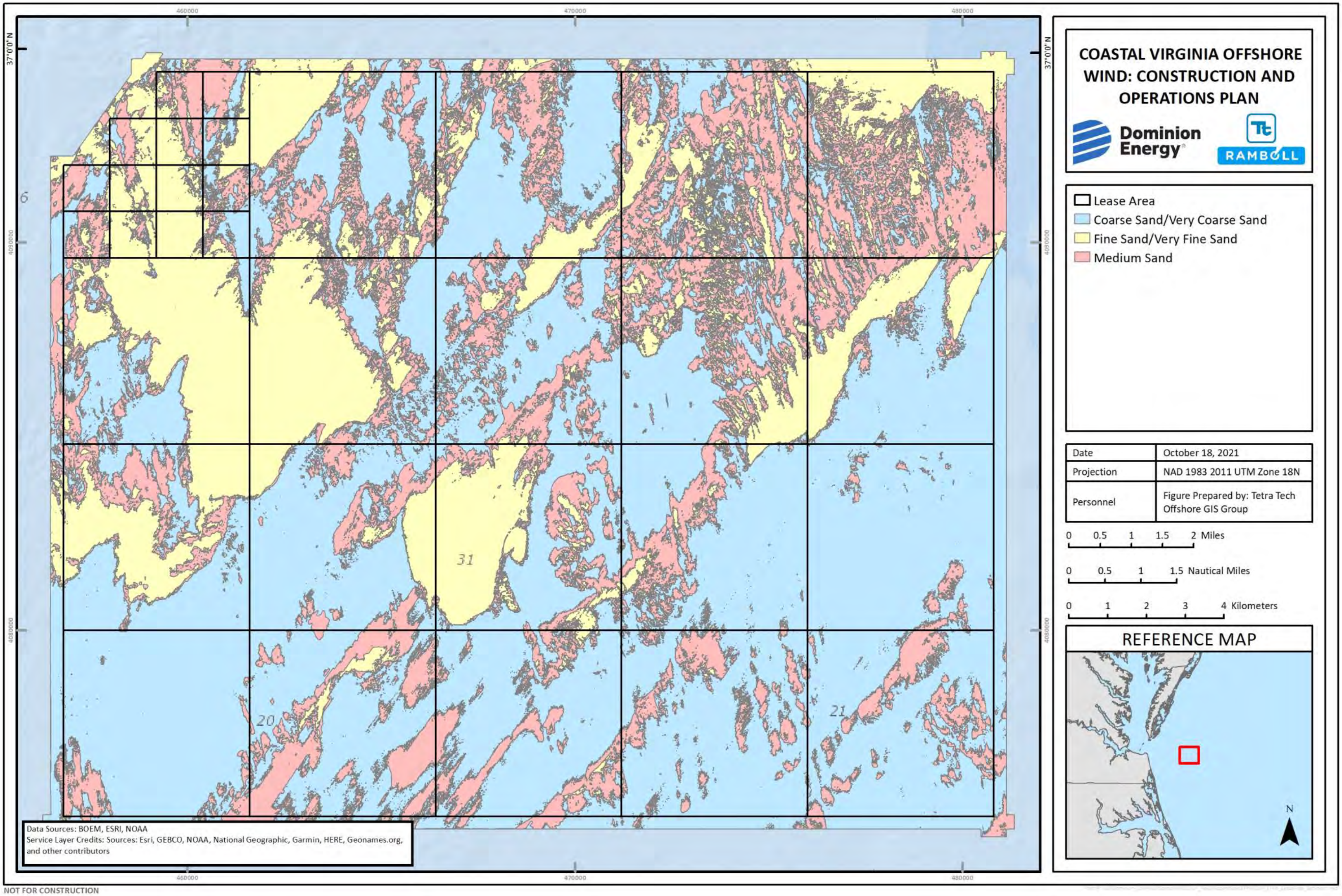

Figure E-6. Seabed Habitat Interpretation Overview as CMECS in the Lease Area (TerraSond 2021), See Attachment E-3 for full-scale maps

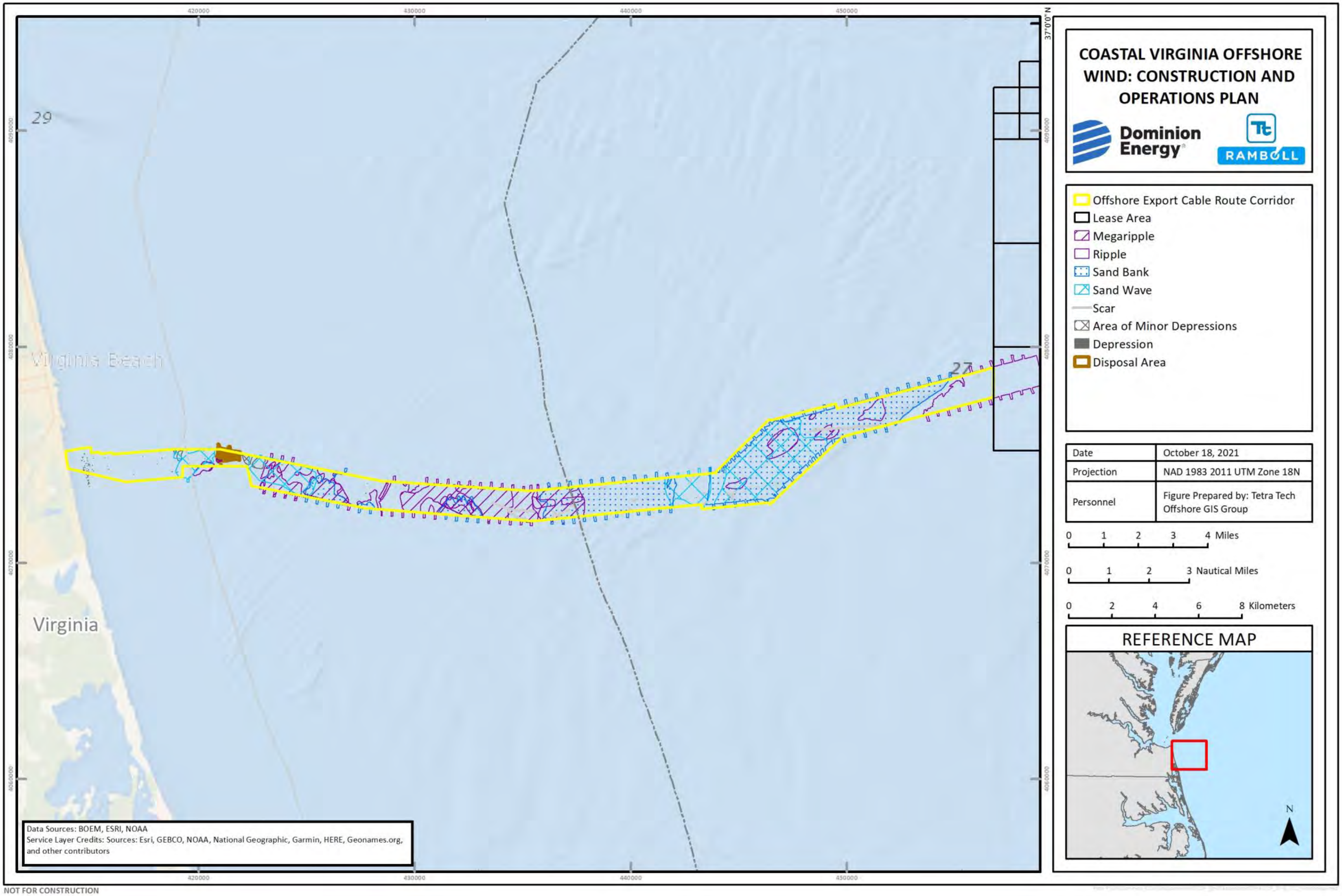

Figure E-7. Seabed Morphology Overview in the Offshore Export Cable Route Corridor (Alpine 2021), See Attachment E-3 for full-scale maps

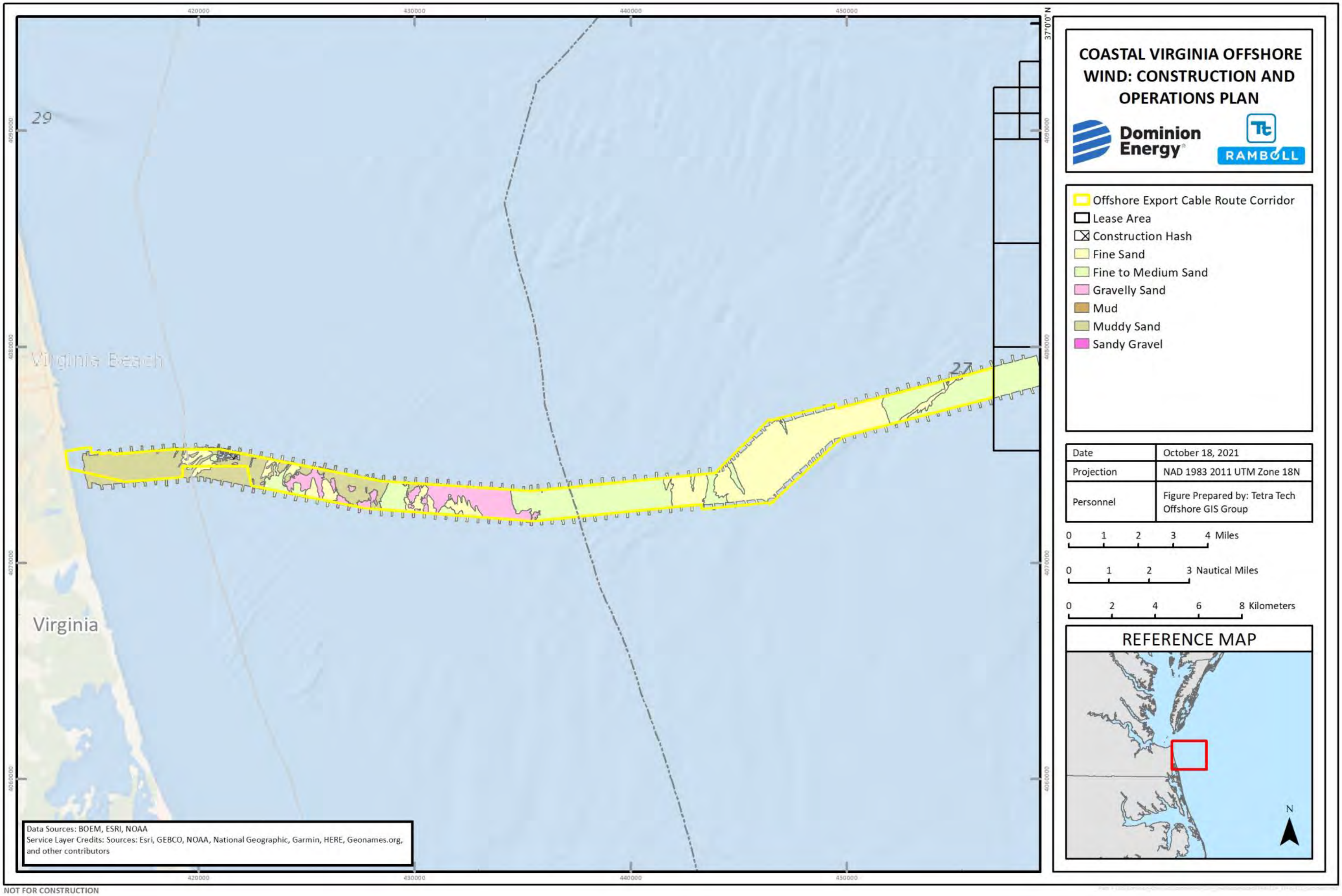

Figure E-8. Seabed Habitat Interpretation Overview as CMECS in the Offshore Export Cable Route Corridor (Alpine 2021), See Attachment E-3 for full-scale maps

Benthic resources were further characterized in summer 2020 (Tetra Tech 2021) and fall 2020 (TerraSond 2021; Alpine 2021) with benthic characterization surveys completed in the Offshore Project Area using digital imagery, sediment grab, and water quality samples. Grab samples from all surveys (total of 202 grab samples) were analyzed for particle size distribution, total organic carbon, and benthic infauna to ground-truth the sediment types observed in digital imagery. Mean sediment composition for the 202 grab samples collected during summer and fall 2020 was approximately 97 percent coarse sand or finer, with only 3 percent consisting of granule or pebble (TerraSond 2021). Mean total organic content (TOC) for the summer 2020 grab samples was 0.3 percent (range 0.1 to 1.2 percent).

Survey results corroborated the habitats generated by the EFH Data Inventory for the EFH Mapper desktop analysis (Table E-2), depicting habitat suitable for temperate, softbottom-associated species and life stages. Habitat observed in the Offshore Project Area was generally homogenous, with summer bottom temperatures spanning 54.7 to 66.6°F (12.6 to 19.2°C), salinities within 31.9 to 32.8 Practical Salinity Units, and unconsolidated sediment grain sizes ranging from fine sand with silt and clay to medium/coarse sand and gravel with shell hash. Depths gradually increase in the surveyed portion of the Offshore Export Cable Route Corridor from 43 to 98 ft (13 to 30 m) and 98 to 131 ft (30 to 40 m) in the surveyed portion of the Lease Area.

Observed biogenic habitat during the benthic survey was limited to a single mussel bed (*Mytilus edulis*) within the Offshore Export Cable Route Corridor. Sessile and slow moving epifauna observed along transects throughout the Offshore Project Area were characteristic of the Mid-Atlantic softbottom habitat and included sand dollars (*Echinarachnius parma*), sea stars (*Asteroides* spp.), sea urchins (*Echinoida* spp.), moon snails (*Neverita lewisii*), whelks (*Busycon carica*), and various portunid and hermit crabs. No managed species were observed in the Offshore Export Cable Route Corridor. Of the managed species with designated EFH in the Lease Area, black sea bass (*Centropristis striata*), butterfish (*Peprilus triacanthus*), clearnose skate (*Raja eglanteria*), and scup (*Stenotomus chrysops*) were observed in digital imagery (Figure E-9) in areas of fine to medium sand punctuated by shell hash, sand dollars, and egg masses (e.g., Loliginid, Naticid, Rajid eggs). Results are described in detail in Appendix D, Benthic Resource Characterization, a supplemental filing to the COP. These uniform, sandy habitats and associated infaunal assemblages support an array of both managed and unmanaged demersal species. Softbottom sediments are dynamic and prone to transport by physical processes and restructuring by biological processes, such as feeding and burrowing. Managed species using these softbottom habitats for spawning, development, and foraging include Atlantic cod (*Gadus morhua*), pollock (*Pollachius virens*), flounder species, skate species, red hake (*Urophycis chuss*), monkfish (*Lophius americanus*), several migratory sharks, and others (see Attachment E-1; NEFMC 2017; MAFMC 2017; NOAA Fisheries 2017).

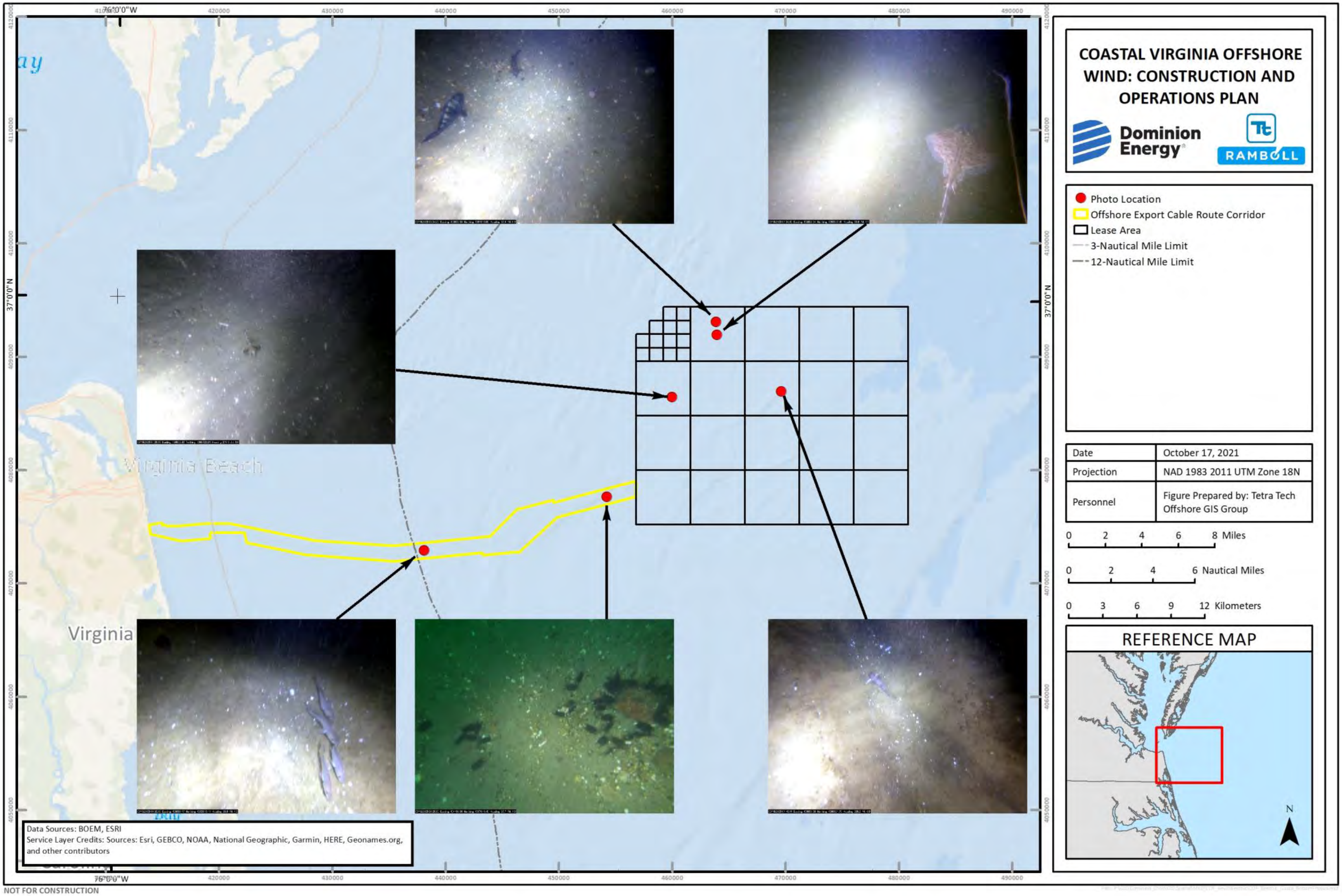

Figure E-9. Representative Plan View Bottom Images in the Offshore Project Area Collected during Summer 2020 Surveys

The assemblage of species using softbottom habitats varies with season and distance from the shoreline, just as pelagic assemblages do. Such species inhabit a spectrum of inshore-offshore habitats according to preferred thermal and depth gradients. For example, blacktip shark (*Carcharhinus limbatus*) neonates and young-of-year prefer shallow coastal waters from the shoreline to depths of 66 ft (20 m) in temperatures of 70 to 90°F (21 to 32°C); juveniles and adults prefer even shallower waters (NOAA Fisheries 2017). Witch flounder (*Glyptocephalus cynoglossus*) juveniles and adults, in contrast, exhibit preferences for depths of 66 to 5,135 ft (20 to 1,565 m) in temperatures of 32 to 59°F (0 to 15°C) (NEFMC 2017). Some demersal species make inshore-offshore seasonal migrations. For example, resident red hake juveniles and adults exhibit limited seasonal migrations, preferring inshore waters in spring and fall and offshore waters in summer and winter (Steimle et al. 1999).

E.2.3.3 Benthic Habitat: Hardbottom EFH

Naturally occurring hardbottom habitats and structured reefs are rare in the Mid-Atlantic Bight; no hardbottom was detected in the 2020-2021 HRG or benthic surveys in the Offshore Project Area (TerraSond 2021; Alpine 2021; Attachment E-3), which is consistent with previous hydrographic surveys in this region (Cutter and Diaz 1998; Diaz et al. 2004; Poppe et al. 2005; Diaz et al. 2006; USACE 2009; Greene et al. 2010; Fugro 2013; Guida et al. 2017; MARCO 2021). An artificial reef habitat was created in the northern portion of the Lease Area known as the Fish Haven (Figure E-10), where several large World War II-era tankers and transport ships, tires, and other structures were placed beginning in the 1970s (Lucy 1983). The VRMC continues to facilitate artificial reef development by adding scuttled cables, tires, and other materials to the Fish Haven (VMRC 2021b).

Artificial reefs provide hard vertical relief and structural complexity in the form of crevices and interstitial spaces; such complexity offers refuge from predation and energy-depleting currents, as well as a forage base resulting from increased biomass of prey. During Dominion Energy’s 2020 surveys, several cables and other anthropogenic debris associated with Triangle Reef were observed along transects located within Fish Haven. Notably, managed species with EFH designated in the Offshore Project Area, including black sea bass, butterfish, and clearnose skate, were observed aggregating either directly on these cables or within the same transect in the vicinity of the artificial habitat.

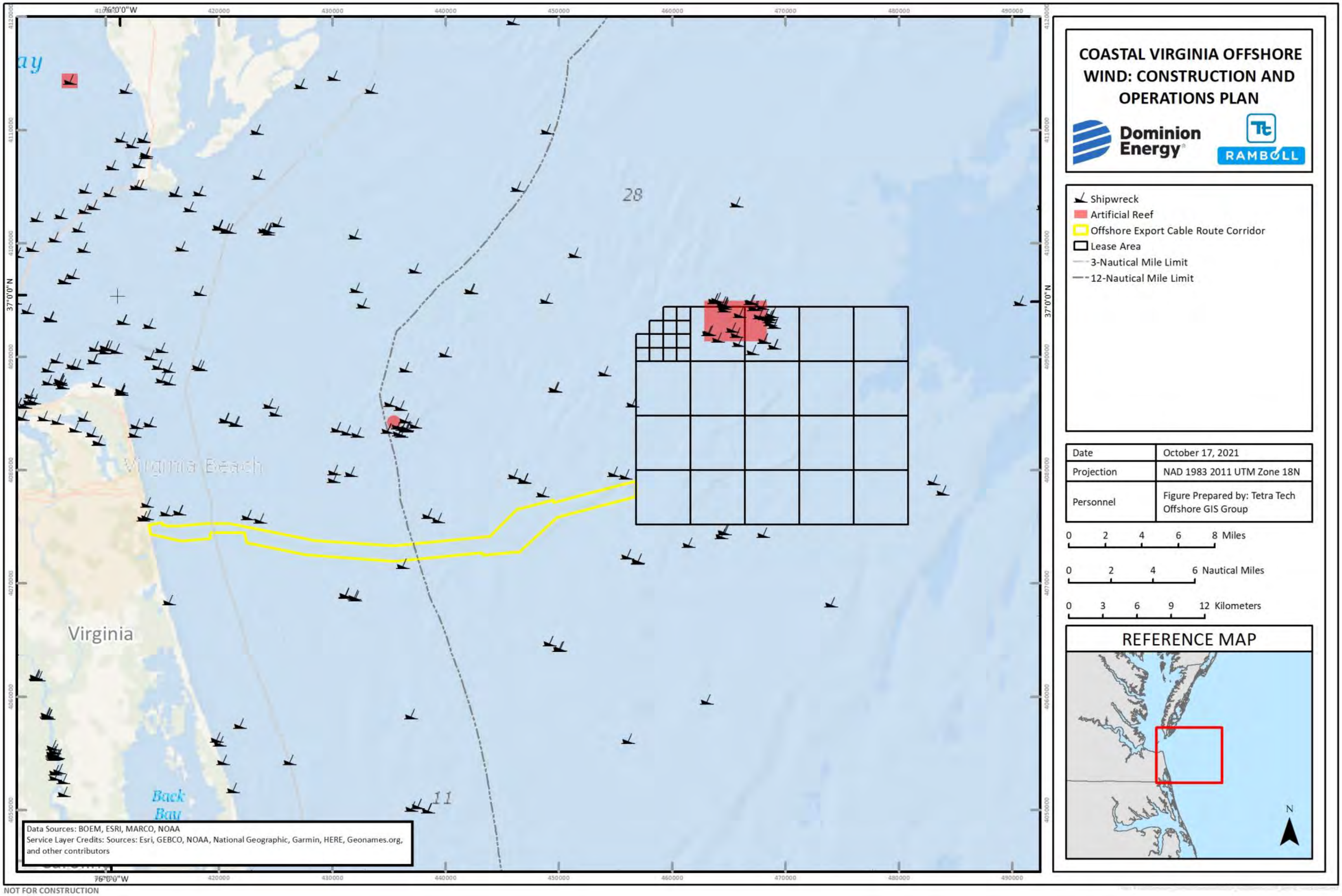

Figure E-10. Publicly Documented Shipwrecks and Artificial Reefs in the Offshore Project Area and Vicinity

E.2.3.4 Benthic-Pelagic Coupling

The energy transfer that occurs between the seafloor and water column as organisms eat, excrete waste, and decompose is termed benthic-pelagic coupling. Most marine organisms are neither wholly benthic nor wholly pelagic, but rather rely on the habitat continuum to support their various life stages. The Atlantic sea scallop (*Placopecten magellanicus*), for example, has benthic egg and planktonic larval stages. After hatching, scallop larvae mature in the plankton for 5 to 6 weeks before transforming into juveniles and settling on benthic substrates. Adults spend the rest of their lives filter-feeding on plankton in the water column of the pelagic habitat, enriching the sediment with their wastes, and releasing new generations to repeat the cycle (Munroe et al. 2018). Longfin inshore squid (*Doryteuthis [Amerigo] pealeii*), by contrast, have pelagic larval, juvenile, and adult stages; however, adults anchor egg masses, or "mops," to hard substrates in benthic habitats (Cargnelli et al. 1999a; Jacobson 2005). Bivalve mollusks such as the Atlantic surfclam (*Spisula solidissima*) use softbottom sediments and extend their siphons into the water column to feed on plankton and nutrient-rich detritus (Cargnelli et al. 1999b).

Per NOAA Fisheries, EFH includes the waters and substrates necessary for species' growth to maturity (including spawning, breeding, and feeding) [16 U.S.C. § 1801(10)], where "necessary" indicates a level required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. The joint contribution of benthic and pelagic habitat components to EFH is evident in the seafloor substrates, water column depths, and the intersection of the two at the sediment-water interface.

E.2.4 Other NOAA Trust Resources

The ASMFC, in cooperation with the states and NOAA Fisheries, manages more than two dozen fish and invertebrate species separately from the MSA; many of these species are also identified as NOAA Trust Resources. Of these species, the Project may potentially affect the American eel (*Anguilla rostrate*), American shad (*Alosa sapidissima*), Atlantic croaker (*Micropogonias undulatus*), Atlantic menhaden (*Brevoortia tyrannus*), Atlantic striped bass (*Morone saxatilis*), Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), black drum (*Pogonias cromis*), cobia (*Rachycentron canadum*), horseshoe crab (*Limulus polyphemus*), Jonah crab (*Cancer borealis*), red drum (*Sciaenops ocellatus*), river herring (*Alosa* spp.), spot (*Leiostomus xanthurus*), spotted seatrout (*Cynoscion nebulosus*), tautog (*Tautoga onitis*), and weakfish (*Cynoscion regalis*).

American eel. The American eel occurs along the entire U.S. Atlantic Coast from Maine to Florida and historically comprised more than 25 percent of the total fish biomass of East Coast streams (ASMFC 2018a). The species inhabits fresh, brackish, and coastal waters; eggs are spawned and hatch in the Sargasso Sea and leptocephali larvae are transported by ocean currents to the coasts of North and South America. Eels transit through coastal waters on their way to and from freshwater rivers. The 2012 Benchmark American Eel Stock Assessment found that the American eel population has been depleted by a combination of historical overfishing, habitat loss and alteration, productivity and food web alterations, predation, changing climactic and oceanic conditions, toxins and contaminants, and disease (ASMFC 2014). Though Virginia recorded average counts in 2012, stock assessment updates in 2017 identified downward trends in eel recovery and the stock remains depleted (ASMFC 2014, 2018).

American shad. The anadromous American shad spends most of its life in coastal waters along the North American Atlantic Coast and migrates seasonally to freshwater to spawn. Because the species exhibits high fidelity to its natal streams, each major tributary along the Atlantic Coast has its own discrete spawning stock. In Virginia, shad populations are monitored within the James, Potomac, Rappahannock, and York Rivers. Historically, the state has not had a significant commercial shad fishery, though limited recreational fisheries occur in several Virginia rivers. The 2020 benchmark stock assessment indicates that American shad stocks have continued their decline since the previous two benchmark stock assessments (1998 and 2007) and are currently at all-time lows (ASMFC 2020a). In Virginia, the James River stock status is unknown, the Rappahannock and York River stocks are experiencing sustainable mortalities, and the Potomac River stock is depleted and experiencing unsustainable mortality (ASMFC 2020a).

Atlantic croaker. The Atlantic croaker is a sciaenid species that inhabits demersal estuarine and nearshore waters along the North American Atlantic Coast from the Gulf of Maine to Argentina. The species spawns in pelagic waters in fall and winter months and larvae and juveniles settle in estuaries to mature. The Chesapeake Bay is an important spawning and nursery habitat for croaker. The 2017 Benchmark Stock Assessment was not recommended for management use; however, the report indicated that the Atlantic croaker spawning biomass is increasing and that the species is experiencing sustainable mortality (ASMFC 2017a). The current fishery includes both commercial and recreational fisheries that experience cyclical declines and recoveries

Atlantic menhaden. The Atlantic menhaden is a euryhaline species that inhabits nearshore and inland tidal waters along the North American Atlantic Coast from Nova Scotia to Florida. The species spawns at sea and larvae are carried to estuaries where they mature to juveniles; during winter months, the majority of the adult population migrates to Virginia and North Carolina capes. According to the 2017 Atlantic Menhaden Stock Assessment Update, the species is not overfished based on fishing mortality and fecundity data (ASMFC 2017b). The current commercial fishery is divided into the reduction fishery, which processes Atlantic menhaden to obtain fish oil and fish meal, and the bait fishery, which supplies bait to other fisheries (e.g., blue crab, lobster). Landings for the bait fishery have increased in recent years. However, the reduction fishery, which is the larger component of the commercial fishery, has seen substantial declines and there is currently only one reduction plant along the U.S. Atlantic Coast located in Reedville, VA (ASMFC 2017b).

Striped bass. The anadromous striped bass spends most of its life in coastal estuaries and marine waters but migrates seasonally to freshwater to spawn. The 2018 benchmark stock assessment indicates the Atlantic striped bass stock is overfished and overfishing continues to occur (ASMFC 2019a). The current fishery is predominantly recreational (88 percent of total removals in 2018), and most commercial and recreational landings are sourced from Chesapeake Bay (ASMFC 2019a).

Atlantic sturgeon. The anadromous Atlantic sturgeon spends most its adult life in estuarine and marine waters (Stein et al. 2004; Laney et al. 2007). Five distinct population segments (DPSs, or geographic portions of a species' or subspecies' population) of the Atlantic sturgeon are listed under the ESA and in Virginia, as described in Section 4.2.4 of the COP. In the Mid-Atlantic, mature females generally spawn every 1 to 5 years by migrating upriver from April to May and September to October and deposit more than 400,000 eggs on gravel or other hard substrates (USACE 2015). The nearest Atlantic sturgeon spawning areas to the Offshore Project Area are the James and York Rivers, which provide important habitat for the

Chesapeake Bay DPS (VIMS 2021). The 2017 Atlantic sturgeon stock assessment reported that all DPSs remain depleted relative to historic distributions (ASMFC 2017c). Indices from the New York Bight and Carolina DPSs indicated a greater than 50 percent chance of population increase since 1998, although the index from the Chesapeake Bay DPS only had a 36 percent chance of population increase during the same time (ASMFC 2017c). The Navy, in partnership with BOEM, is conducting ongoing research to determine seasonal presence/absence of Atlantic sturgeon in and around the Virginia WEA and to characterize the habitat use and feeding grounds of observed individuals. To date, several sturgeon have been identified and coordinated through data-sharing networks such as the Atlantic Cooperative Telemetry network. Results will help identify the causal mechanisms for Atlantic sturgeon habitat selection in the offshore environment (Watterson 2020 unpublished).

Black drum. The black drum is a demersal species that inhabits nearshore waters along the North American Atlantic Coast from the Gulf of Maine to Argentina. The species spawns in winter and early spring; recruitment is sporadic, with infrequent but large events. The first Benchmark Stock Assessment for black drum concluded that the species is not overfished or experiencing overfishing (ASMFC 2015). The black drum fishery is growing; Virginia and North Carolina comprise the majority of the commercial fishery.

Cobia. The cobia is a highly migratory pelagic species that occurs in tropical and warm-temperate waters. The species occurs along the North American Atlantic Coast from Nova Scotia to Argentina. The species aggregates inshore to spawn during warm months and overwinters south and offshore. The 2020 Benchmark Stock Assessment determined that the Atlantic stock of cobia is not overfished or subject to overfishing (ASMFC 2020b). While the commercial fishery is small, the Atlantic cobia supports an expanding recreational fishery from the Mid-Atlantic to South Atlantic region.

Horseshoe crab. The horseshoe crab resides in estuaries and on the continental shelf along the North American Atlantic Coast from Maine to the Gulf of Mexico. Spawning coincides with the high tide during the full and new moon, and the Delaware Bay supports the largest spawning population in the world. The 2019 Benchmark Stock Assessment concluded that the Delaware Bay and southeast stocks are in good condition and that the horseshoe crab is not overfished or subject to overfishing (ASMFC 2019). The species is harvested as bait for American eel and conch fisheries; the species also provides blood to the biomedical industry to produce Limulus Amoebocyte Lysate.

Jonah crab. The Jonah crab occurs along the North American Atlantic Coast from Canada to Florida. It has a poorly understood life history, but females are believed to migrate nearshore in spring and summer and overwinter offshore. The status of the fishery remains unknown, as there is no stock assessment for the Jonah crab. Though once considered bycatch, Jonah crab currently support a growing commercial fishery.

Red drum. The red drum resides in estuaries and offshore waters along the North American Atlantic Coast from Massachusetts to Florida. Juveniles and sub-adults reside in nursery estuaries and begin to conduct seasonal inshore-offshore migrations as adults. The 2017 Benchmark Stock Assessment was not recommended for management use but indicates that overfishing may be occurring (ASMFC 2017d). The southern stock is the target of a robust recreational fishery and the northern stock is the target of a smaller commercial fishery centered in North Carolina.

River herring. The term river herring collectively refers to alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*), which are anadromous species that spend most of their lives in coastal waters but migrate seasonally to spawn in freshwater rivers. Historically, river herring have spawned in virtually every river and tributary along the North American Atlantic Coast; the alewife spawns in lakes and ponds, while the blueback herring spawns in swift-moving rivers. Currently, the alewife is most abundant in the mid-Atlantic and northeastern states, while blueback herring is most abundant from the Chesapeake Bay south; both species currently occur in all of Virginia's major rivers (ASMFC 2017e). The most recent comprehensive assessment of river herring stocks concluded that both species exhibit signs of overexploitation, including reductions in average age, decreases in percent of repeat spawning, declines in recruitment, and decreases in adult abundance. The Virginia commercial herring fishery collapsed in the 1970s and in 2012 the VMRC implemented a moratorium on river herring in state waters that is currently upheld (ASMFC 2017e).

Spot. The spot is a sciaenid species that resides in estuarine and coastal waters along the North American Atlantic Coast from the Gulf of Maine to Florida. The species migrates to inshore bays and estuaries in the spring and offshore to spawn in late summer and fall. The first Benchmark Stock Assessment was not recommended for management use but indicated that both Mid-Atlantic and South Atlantic stocks are experiencing significant declines (ASMFC 2017f). The species supports a robust fishery in the South Atlantic, though the fishery experiences annual fluctuations in landings.

Spotted seatrout. The spotted seatrout occurs along the U.S. Atlantic Coast from the Florida Keys, Florida, to Cape Cod, Massachusetts, primarily in estuaries and in nearshore ocean waters during cold periods. It is most abundant from Chesapeake Bay southward and exhibits strong site fidelity to natal estuaries. A 2014 stock assessment specific to North Carolina and Virginia indicated that the age structure of the stock had expanded since 2004, but that there was a sharp decline in spawning stock biomass after 2007 and in recruitment after 2010 (ASMFC 2018b). Despite these declines, fishing mortality is below the threshold and the stock is not currently deemed overfished (ASMFC 2018b).

Tautog. The tautog occurs in coastal and estuarine waters along the North American Atlantic Coast from Nova Scotia to Georgia, though it is most abundant from Cape Cod, Massachusetts, to Cape Hatteras, North Carolina. Stocks north of Cape Cod prefer nearshore coastal waters less than 60 ft (18 m) deep, while stocks south of Cape Cod have been found up to 40 mi (64 km) offshore at depths up to 120 ft (37 m) (ASMFC 2017g). The 2016 stock assessment indicates the Delaware-Maryland-Virginia stock remains overfished but that overfishing is not currently occurring. Historically, most commercial fishing for tautog in Delaware-Maryland-Virginia has been based in Virginia, though landings have declined in the last decade (ASMFC 2017g).

Weakfish. The weakfish occurs along the North American Atlantic Coast from Novia Scotia to southeastern Florida, though it is most common from New York to North Carolina. The species spends most of its life in coastal waters but completes a seasonal inshore and northerly migration to spawn in nearshore sounds, bays, and estuaries. Most commercial landings occur in North Carolina and Virginia, while recreational catches are more common in North Carolina and New Jersey (ASMFC 2019c). Commercial landings have declined dramatically since the early 1980s and recreational catches have declined since 1987; the 2017 stock assessment indicates that the stock has been depleted since 2003 (ASMFC 2019c).

Species profiles for managed species with EFH are included in Attachment E-1.

E.3 DESCRIPTION OF THE PROPOSED ACTION

Dominion Energy is proposing to construct, own, and operate the Project to generate energy using renewable wind resources. The purpose of this Project is multifaceted and includes the following: to provide between 2,500 and 3,000 megawatts of clean, reliable offshore wind energy and to increase the amount and availability of that renewable energy to Virginia consumers; to displace electricity generated by fossil fuel-powered plants; and to offer substantial economic and environmental benefits to the Commonwealth of Virginia. Greater detail regarding the purpose and need for the Project is provided in the COP (Section 1, Introduction).

Dominion Energy has adopted a PDE approach to describe Project facilities and activities. A PDE represents "a reasonable range of project designs" associated with various components of the project, including Foundation and WTG options (BOEM 2018). The PDE is used to assess the potential effects on key environmental and human-use resources by focusing on the design parameter (within the defined range) that represents the greatest potential impact (i.e., the "maximum design scenario") for each resource (Rowe et al. 2017). The primary goal of applying a design envelope is to allow for meaningful assessments by the jurisdictional agencies of the proposed project elements and activities. This conservative approach likely overstates the actual effects on resources from the as-built Project, which will include design refinement and implementation of avoidance, minimization, and mitigation measures. Detailed information on the Project Description and PDE is included in Section 3 of the COP.

For the purposes of this EFHA, the design that permanently converts the largest area of benthic substrate to artificial substrate, including WTG and Offshore Substation Foundations, scour protection, and cable armoring, is considered the maximum PDE for benthic habitat and managed demersal fish species. The design that permanently introduces the greatest surface area of hard structure into the water column is considered the maximum design scenario for managed pelagic fish species. The design with the longest duration of pile driving is considered the maximum design scenario for acoustic impacts to all managed species. The parameters provided in Table E-6 represent that maximum potential effect of full build-out of the Project.

Table E-6. Summary of Maximum Design Scenarios for Essential Fish Habitat as Outlined in Project Design Envelope

Parameter	Realistic Maximum Design Scenario	Rationale
Construction		
Wind Turbine Generators (WTGs)	14 megawatts (MW)	Representative of the smallest-sized WTG and therefore the maximum number of structures in the Offshore Project Area: 205 WTGs and 3 Offshore Substations.
WTG Monopile Foundation	*Maximum monopile diameter*: 31 ft (9.5 m) *Maximum monopile area*: 754.77 square feet (ft^2; 70.1 square meters [m^2]) *Maximum base diameter including scour protection*: 230 ft (70 m) *Maximum base area including scour protection*: 41,547.6 ft^2 (3,859.9 m^2)	Representative of the maximum area of softbottom benthic habitat loss due to foundation and scour protection installation that would result in the greatest surface area of hardbottom introduced to the Offshore Project Area for a single WTG monopile foundation.

Parameter	Realistic Maximum Design Scenario	Rationale
Softbottom habitat loss: WTG Foundations and scour protection	Based on 14 MW WTGs with maximum scour protection (230 ft base diameter) corresponding to the maximum overall footprint in the Offshore Project Area: 205 WTGs x 41,547.6 ft^2 (3,859.9 m^2). *Maximum base area including scour protection:* 8,517,258 ft^2 (791,279.5 m^2)	Representative of the maximum area of softbottom benthic habitat loss due to foundation and scour protection installation, which would result in the greatest total surface area of hardbottom introduced to the Offshore Project Area.
Offshore Substation Piled Jacket Foundations	*Maximum number of piles per jacket foundation*: 4 *Maximum pile diameter*: 9.0 ft (2.8 m) *Base dimensions*: 306.8 ft x 283.8 ft (93.5 m x 86.5 m) *Scour protection diameter per pile*: 230 ft (70 m) *Seafloor footprint without scour protection*: 87,070 ft^2 (8,088 m^2) *Seafloor footprint with scour protection*: 497,092 ft^2 (46,181 m^2)	Representative of the maximum area of softbottom benthic habitat loss due to foundation and scour protection installation, which would result in the greatest surface area of hardbottom introduced to the Offshore Project Area for a single Offshore Substation.
Softbottom habitat loss: Offshore Substation Foundations and scour protection	Based on maximum seafloor footprint with scour protection for 3 Offshore Substations corresponding to the maximum overall footprint in the Offshore Project Area: 3 x 497,092 ft^2 (46,181 m^2). *Maximum base area including scour protection*: 1,491,276 ft^2 (138,543 m^2)	Representative of the maximum area of softbottom benthic habitat loss due to foundation and scour protection installation, which would result in the greatest total surface area of hardbottom introduced to the Offshore Project Area.
Inter-Array Cables	*Maximum total length per cable:* 29,961 ft (9,132.1 m) *Maximum burial depth*: 9.8 ft (3 m) *Maximum temporary trench width*: 16.4 ft (5 m) *Maximum temporary seafloor footprint*: 9.5 acres (ac; 3.8 hectares [ha]) *Maximum duration of installation*: 15 months	Representative of the maximum installation length per cable, burial depth, temporary trench width, and maximum temporary seafloor footprint.
Offshore Export Cables	*Maximum burial depth*: 16.4 ft (5 m) *Maximum temporary trench width:* 3,840 ft (1,170 m) *Maximum Offshore Export Cable Route Corridor (width of construction corridor from Offshore Work Area to Offshore Substations)*: 2,892.4 ac (1,170.4 ha). *Maximum temporary area impacted by cable installation*: 4,338.9 ac (1,755.9 ha) *Maximum duration of installation*: 30 months	Representative of the maximum burial depth, Offshore Export Cable Route Corridor area, and maximum temporary seafloor footprint.
Underwater noise: Foundation installation method	Pile driving *Maximum projected blow energy:* 4,000 kJ *Maximum duration:* 45 blows per minute for 87 minutes per monopile	Representative of the installation method that would introduce the loudest underwater noise for the longest installation duration.
Underwater noise: Pile driving	*Method*: 100% pile driving monopile *Pile diameter*: 36 ft (11 m) *Maximum penetration*: 197 ft (60 m) *Maximum hammer energy*: 4,000 kilojoules (kJ) *Maximum number of hammer blows at maximum energy*: 3,915 *Soft-start hammer energy:* 800-3,200 kJ *Maximum number of hammer blows at soft-start energy*: 540 *Total pile driving time including soft-start procedures*: 1.65 hours	Representative of the maximum design scenario per monopile and therefore the largest impact footprint and potential acoustic stress to benthic and pelagic resources. 3,915 is considered the maximum number of hammer blows per monopile at maximum hammer energy, plus an additional 540 hammer blows at soft-start hammer energy.

Parameter	Realistic Maximum Design Scenario	Rationale
Underwater noise: Project-related vessels	Based on 14 MW WTGs corresponding to the maximum number of structures in the Offshore Project Area (205 WTGs, 3 Offshore Substations, 230 Inter-array Cables, and 9 Offshore Export Cables) and maximum number of associated construction vessels.	Representative of the maximum predicted Project-related construction vessels for underwater vessel noise.
Operations		
Underwater noise: Project-related vessels	Based on 14 MW WTGs corresponding to the maximum number of structures in the Offshore Project Area (205 WTGs, 3 Offshore Substations, 230 Inter-array Cables, and 9 Offshore Export Cables) and maximum number of associated operations and maintenance vessels.	Representative of the maximum predicted Project-related construction vessels.
Electric and magnetic fields (EMF): Inter-Array Cables	Based on 14 MW WTGs for the maximum number of offshore structures (205 WTGs and 3 Offshore Substations) to be connected. *Maximum number of cables*: 230 *Maximum operating voltage*: 66 kV *Maximum cable diameter*: 7.9 inches (200 millimeters) *Maximum length per cable*: 31,804 ft (9,694 m) *Maximum total length of cables*: 265.3 miles (427 km)	Representative of the maximum number, voltage, diameter, and length of Inter-array Cables, which would result in the maximum exposure of marine life to EMF within the Offshore Project Area.
EMF: Offshore Export Cables	*Number of cables*: 9 *Maximum operating voltage*: 230 kV *Maximum cable diameter*: 11.4 inches (290 millimeters) *Maximum total length of* cables: 42.6 nautical miles (79 km)	Representative of the maximum number, voltage, diameter, and length of Offshore Export Cables, which would result in the maximum exposure of marine life to EMF within the Offshore Project Area.

Advances in decommissioning methods and technologies are expected to occur throughout the life of the Project. Dominion Energy would submit a full decommissioning plan to BOEM for approval prior to any decommissioning activities, and potential impacts would be evaluated at that time. BOEM currently requires that infrastructure be fully removed or severed 15 ft (4.6 m) below the sediment surface. Predictive ecosystem modeling indicates that the site-specific benthic-pelagic coupling relationships established during the O&M stage of the Project would be decoupled and regional connectivity would return to pre-construction conditions (van der Molen et al. 2018).

E.4 EFFECTS OF THE PROJECT ON EFH

The MSA requires federal agencies to consult with NOAA Fisheries on proposed activities that may adversely affect EFH, where an adverse effect is defined as “any impact which reduces the quality and/or quantity of essential fish habitat” (NOAA Fisheries 2004). Direct and indirect physical, chemical, and biological alterations of EFH and subsequent injury to or mortality of managed species and their forage base may constitute adverse effects. These are not restricted to site-specific stressors and may extend beyond the designated EFH in the Offshore Project Area.

Stressors potentially resulting from Project construction and O&M were identified based on a review of the following literature:

- EFHAs for similar projects by other proponents;
- EFH consultations and biological opinions prepared by NOAA Fisheries for similar projects;

- EFH source documents, FMPs, and stock assessments prepared by NOAA Fisheries and FMCs; and
- Peer-reviewed articles examining site-specific and cumulative effects on benthic and pelagic habitats and species in the U.S. and worldwide.

Most FMPs identify and describe potential fishing and non-fishing activities that may impact EFH. Commercial fishing pressures may impact managed species through gear interactions with EFH (e.g., hydraulic clam dredging, bottom trawling) and intense fishing pressures on unmanaged forage species, which could alter habitat ranges and feeding habits of managed species (MAFMC 2017; NEFMC 2017; NOAA Fisheries 2017). Non-fishing impacts to EFH include both climactic and anthropogenic stressors. Largescale regional changes to physiochemical oceanic conditions (e.g., increased sea surface and bottom temperatures, changes in pH, variations in current dynamics) have been connected to shifts in community assemblages along the U.S. Atlantic Coast, including the Mid-Atlantic Bight. These stressors are described in further detail in the COP (see Section 4.2.4, Benthic Resources, Fishes, Invertebrates, and Essential Fish Habitat). Anthropogenic impacts to EFH that may compound climactic stressors include seismic surveys, dredging and dredged material disposal, mining, ocean dumping, cooling water intake and discharge, impounding and diverting of coastal hydrology, and point and non-point source pollution and sedimentation from coastal infrastructure and agriculture (NOAA Fisheries 2008; MAFMC 2017; NEFMC 2017; NOAA Fisheries 2017).

Offshore renewable energy developments were included in the list of non-fishing anthropogenic activities that may impact EFH. These alternative energy efforts include wind, wave, solar, underwater current, and hydrogen. Construction, O&M, and decommissioning of these activities have been determined to potentially impact managed species and EFH by disturbing benthic and pelagic habitat quality and introducing sound and vibrations into the environment (MAFMC 2017; NOAA Fisheries 2017). This EFHA has been conducted in the context of these identified impacts.

The potential effects of the Project on EFH would vary by species, life stage, and habitat type. Dominion Energy assessed potential effects of construction and O&M of the Project on water column, softbottom, and hardbottom habitats designated as EFH. The text below discusses groups of managed species based on their relative probability of exposure to Project impacts (e.g., least likely to be affected [Section E.4.1], most likely to be a affected by Construction or O&M [Section E.4.2]).

E.4.1 Species Least Likely to be Affected by the Project

Project construction and O&M activities would be least likely to affect water column EFH and pelagic life stages of managed species. Most Project-related stressors are oriented toward benthic habitats; exposure of pelagic organisms to benthic disturbance would be limited to physical interactions with construction vessels and equipment; localized temporary turbidity; and sediment deposition. Mobile pelagic organisms are expected to avoid exposure to excessive sound by temporarily vacating the ensonified area. Construction and O&M are not expected to cause substantial changes to pelagic or benthic prey. Encrusting algal and invertebrate species would likely increase in the area as WTG Foundations are colonized, but such changes would be localized.

The life stages of managed species listed in Table E-7 are least likely to experience impacts from the Project. Potential effects to these life stages would be temporary and reversible following construction activities.

Table E-7. Managed Species and Life Stages Least Likely to be Affected by the Project

Species	Life Stages with Water Column EFH in the Offshore Project Area
Atlantic cod	E, L
Atlantic herring	J, A
Atlantic sea scallop	L
monkfish	E, L
pollock	L
windowpane flounder	E, L
witch flounder	E, L
yellowtail flounder	L
Atlantic butterfish	E, L, J, A
Atlantic mackerel	E, J, A
black sea bass	L
bluefish	E, L, J, A
longfin inshore squid	J, A
summer flounder	E, L

Notes:
A Adult (including Sub-Adult)
E Egg
L Larva
J Juvenile

E.4.2 Species and Life Stages Most Likely to be Affected by the Project

Benthic organisms and EFH are most likely to experience short-term direct effects of physical interactions with construction equipment (including entrainment), burial by sediments, and pile driving noise and vibration. The sessile, demersal, or benthic-dependent life stages of managed species in Table E-8 are expected to experience short-term impacts during construction or O&M (see Attachment E-2 for expanded descriptions).

Table E-8. Managed Species and Life Stages Most Likely to be Adversely Affected by Construction and O&M

Species	Benthic Life Stages Likely Affected in the Offshore Project Area		
	Construction	O&M	Require Softbottom
Atlantic sea scallop	E, J, A	E, J, A	✓
clearnose skate	J, A	J, A	✓
monkfish	J, A	-	-
red hake	A	-	-
windowpane flounder	J, A	J, A	✓
winter skate	J	J	✓
Atlantic surfclam	J, A	J, A	✓
black sea bass	J, A	-	-
longfin inshore squid	E	-	-
scup	J, A	-	-
summer flounder	J, A	J, A	✓

Notes:
A Adult
E Egg
J Juvenile
\- Does not apply

Some managed species/life stages with EFH in the Offshore Project Area use hardbottom substrate and artificial structures for settlement, protection from predators and energy-draining currents, and foraging opportunities (see Attachment E-1). The species in Table E-9 are expected to aggregate, or become concentrated, around complex structure and hardbottom provided by foundations and scour protection.

Table E-9. Managed Species and Life Stages Attracted to Artificial Structures

Species	Life Stages with EFH in the Offshore Project Area	
	Attaches to Hard Substrate	Associates with Hardbottom/Structure
Atlantic sea scallop	L	-
monkfish	-	J, A
red hake	-	A
black sea bass	-	J, A
longfin inshore squid	E	-
scup	-	J, A
spiny dogfish	-	A
All HMS	-	ALL (in water column)

Notes:
A Adult (including Sub-Adult)
E Egg
HMS Highly Migratory Species
L Larva (or neonate if shark species)
J Juvenile
- Does not apply

Project-related stressors and potential short- and long-term effects of construction and O&M are discussed in the following sections, with an emphasis on the species most likely to be affected.

E.4.3 Analysis of Potential Construction Impacts

Construction activities (e.g., pre-lay grapnel runs, cable installation and armoring, pile driving, and scour protection placement) would temporarily disturb benthic EFH such as bedforms, sand waves, megaripples, and ripples in the Offshore Project Area. These bedforms are dynamic by nature and would naturally reform within days to weeks under the influence of the same physical conditions that formed them initially. Construction activities would alter pelagic EFH by creating a sediment plume, increasing turbidity, and potentially introducing chemical contamination into the water column.

These potential stressors were analyzed in the COP (see Section 4.2.4) and determined unlikely to occur at a magnitude that would adversely affect managed species or EFH in the Offshore Project Area. The COP findings are considered applicable to this EFHA and are not considered further in this section. The most substantial construction-related impacts would be those that cause direct injury to/mortality of managed organisms or their softbottom prey. The impacts described in this section have been determined to cause minimal, moderate, or less than substantial adverse effects on managed species or EFH.

E.4.3.1 Disturbance, Injury, or Mortality of Managed Species

Construction activities disrupting softbottom habitat may injure or kill sessile or slow-moving organisms (listed in Table E-8). Direct seafloor disturbance would crush or bury Atlantic sea scallop eggs and juveniles, Atlantic surfclam juveniles and adults, and longfin inshore squid egg mops located directly in the footprint of pile driving or scour protection placement.

Prior to installation of Offshore Export and Inter-Array Cables, pre-lay grapnel runs would clear debris from the cable corridors; physical effects on benthic habitats would be similar to bottom dredges and trawls, minus the collection of organisms (Hiddink et al. 2017). Construction vessel anchors and spud cans may similarly cause injury or mortality to sessile organisms. However, Dominion Energy would require any necessary anchors and spud cans to be placed within previously cleared and disturbed areas to the extent possible to reduce the spatial extent of direct effect. Consistent with NOAA Fisheries (2015) analysis of benthic impacts of the Block Island Wind Farm, Dominion Energy estimated that each vessel anchor would temporarily disturb an area of 0.12 ac (0.05 ha).

Jet plowing, jet trenching, chain cutting, trench forming, hydroplowing, mechanical plowing, pre-trenching, and mechanical trenching methods are all considered in the PDE for Inter-Array and Offshore Export Cable burial following pre-lay clearing and grapnel runs. Each of these methods would involve the creation of a temporary trench into which the cable would be fed as the equipment is towed along the seabed. Cable installation equipment is slow-moving and would allow time for most mobile organisms to escape injury or mortality (Table E-8); such equipment would continuously move through installation corridors and would therefore represent a minor, short-term impact on managed species and EFH at any given point. Any displacement of demersal organisms would be temporary.

Sessile organisms in or immediately adjacent to the temporary trenches would likely be buried, injured, or killed by these activities. Atlantic surfclams that burrowed deeper into sediments in response to pre-lay activities would be displaced by the cable-laying equipment. Surfclam mortality associated with clam dredging ranges from 1 to 12 percent, largely due to the impacts of dredge teeth (Sabatini 2007; Kuykendall et al. 2019). Of the equipment under consideration for cable-laying activities, only chain cutting involves the use of metal teeth; other equipment types would avoid the same level of mortality. Surfclams would subsequently reposition themselves at suitable depths in the sediment following completion of Inter-Array and Offshore Export Cable installation. Chain cutting would be used only as a last resort in locations where the substrate is too hard for other cable installation tools to be effective. Surf clams would not be expected to occur in any such areas because they require unconsolidated sediments for burial. No long-term population-level impacts on surf clam are expected to result from cable installation.

Studies have demonstrated that cables typically result in minimal damage to resident biota. Andrulewicz et al. (2003) found no difference in benthic diversity, abundance, or biomass on a cable route buried in soft-bottom substrate in the Baltic Sea one year after installation. Kogan et al. (2003, 2006) found no difference in abundance and distribution of 17 benthic taxa within 100 m of a surface-laid coaxial cable and no difference in infaunal communities in 138 sediment cores of varying distances from the cable. In areas of high energy and large sediment supply (e.g., up to 80 m water depth on the continental shelf), benthic habitats typically recover rapidly (several weeks to 2 years) after cable installation by plowing. Installation by water-jetting causes greater disturbance that may take up to 5 years to be recovered. Repeated surveys suggest that evidence of physical habitat recovery is a good predictor of biotic community recovery. In most cases studied, benthic habitats and communities recover completely with no signs of long-term impacts of cable burial studied (Kraus and Carter 2018). Due to the localized nature of cable activity, the overall biological impact is likely to be negligible, particularly if the habitat distribution throughout the wider area is homogenous (Vize et al. 2008). A recent BOEM study evaluating recovery of benthic assemblages on the outer continental shelf concluded that sessile species inhabiting sand and gravel substrates where natural disturbances are common generally recover quickly from sand mining and other anthropomorphic disturbances (Niedoroda et al. 2014). Mobile epifauna such as *Cancer* crab and dog whelk (*Nucella* spp.) were displaced by the initial surge created by a large dump of dredged material, but returned to the area about 20 minutes later (Roegner et al. 2021).

Monopiles have been selected as the WTG Foundations for this Project (see Section E.3, Table E-6). The maximum design scenario assumes rock or other hard material would be placed within a 230 ft (70 m) diameter surrounding each foundation, corresponding to a maximum footprint of 41,547.6 ft^2 (3,859.9 m^2) to prevent bottom scour. Additional protective rock or other hard material would be placed atop approximately 0.1 percent of the Offshore Export Cable for added protection where cable burial is insufficient (Dominion Energy does not currently anticipate the need for additional cable protection on Inter-Array Cables). Armoring material would be lowered or released to the seafloor by a construction vessel stabilized by dynamic positioning, spuds, or anchors. Mobile life stages of managed species would be expected to vacate the area to avoid physical disturbance, but organisms that consume demersal prey (e.g., flounders, monkfish, red hake, skates) would likely return to scavenge sessile or infaunal organisms injured by the construction activity (Table E-8; Vallejo et al. 2017; ICF 2020). Any displacement of demersal organisms would be temporary.

E.4.3.2 Burial of Organisms by Sediment Deposition

To predict the duration of sediment suspension and area of likely deposition associated with construction activities, Dominion Energy modeled sediment transport in the Offshore Project Area (see COP Appendix J, Sediment Transport Analysis).

Sediments would be suspended in the water column within the Offshore Project Area during seafloor clearing and preparation, pile-driving, foundation placement, Inter-Array Cable and Offshore Export Cable installation, scour protection and cable armor placement. Most sediment deposition following cable burial activities has been shown to occur within tens of meters of the disturbed bottom (Vize et al. 2008; NIRAS 2015). Coarser sediments (e.g., sand, gravel) settle relatively quickly and close to the origin of disturbance, while finer sediments (e.g., clay, silt) may remain suspended for longer times and thus travel farther from their place of origin. The sandy sediments of the Offshore Project Area would settle to the seafloor near the point of disturbance. The height of sediment deposits above the bottom would be influenced by bottom currents and particle size (see COP Appendix J). Modeled deposition thicknesses were less than 0.27 inch (0.69 centimeter) within 82 ft (25 m) of the cable trench centerline during flood tides and less than 0.09 inch (0.25 centimeter) within that distance during ebb tides.

Sediment deposition may bury some Atlantic sea scallop eggs and juveniles and Atlantic surfclam juveniles and adults; while this may cause mortality in younger life stages, adults would likely move vertically to accommodate the presence of additional sediment. For example, surfclams are capable of very rapid recovery following sedimentation, reburying to desired depths within minutes of disturbance by experimental trawls (Sabatini 2007). Both *Crepidula fornicata* (Powell-Jennings and Callaway 2018) and *Mytilus edulis* (Hutchison et al. 2016) were shown to recover from burial beneath 2 cm of sediment, more than double the depth of sedimentation predicted by the model (see COP Appendix J). Squid egg mops may be dusted with a fine layer of sediment but are not likely to be completely buried except within the narrow footprint of placed structures. Mobile organisms are expected to vacate the area to avoid burial. Following deposition, mobile demersal consumers (e.g., flounders, monkfish, red hake, skates) would likely return to scavenge benthic prey displaced or injured by sediment disturbance (Table E-8; Kaiser and Hiddink 2007; Vallejo et al. 2017; ICF 2020).

E.4.3.3 Entrainment of Plankton and Ichthyoplankton

Planktonic organisms may be entrained by the intake pumps of cable installation equipment. Pelagic eggs and larvae of the following species are expected to occur in the Offshore Export Cable Route Corridor: Atlantic cod, monkfish, pollock, windowpane flounder (*Scophthalmus aquosus*), yellowtail flounder (*Limanda ferruginea*), Atlantic butterfish, Atlantic mackerel, black sea bass, bluefish, and summer flounder (*Paralichthys dentatus*) (see Attachment E-1; NOAA Fisheries 2021). Risks to these organisms from entrainment include injury from movement through the pump and high-pressure discharge into the seafloor. As no data are available on the probability of survival of entrained organisms in cable installation equipment, mortality of all entrained individuals is assumed. This represents an overestimate of entrainment-induced mortality on managed species in the Offshore Project Area.

Water jetting installation equipment would operate within a narrow centerline of each of the Offshore Export Cables, disturbing a negligible fraction of sediment and water column. Individuals immediately surrounding the intake pumps as the equipment moved continuously along the corridor would be at risk of entrainment. The volume of water withdrawn by the pump is expected to be approximately 7,925 gallons per minute (approximately 30 m^3 per minute) depending on the type of cable burial tool used (NYSERDA 2021). The targeted nature of such cable burial tools would result in water being pumped from a small zone surrounding the pump intake and would only temporarily affect plankton in a given area, since the cable burial tool is continuously moving while in use. Ichthyoplankton of EFH species in the immediate vicinity of the jet plow water intake may be subject to entrainment during cable installation activities. Some unknown portion of the organisms entrained through the jet plow pumps would likely result in mortality.

Actual entrainment estimates are influenced by season, cable installation tool, water depth, time of day, and other highly dynamic oceanic variables that cannot be predicted at this time. However, mortality resulting from entrainment would represent a negligible loss against the naturally high mortality of planktonic organisms and would not be detectable within the background of existing sources of entrainment in the Offshore Project Area (e.g., commercial vessels, military vessels, hydraulic clam dredges). The water intake rate of the jet plow (approximately 7,925 gallons per minute [30 m3 per minute]) is equivalent to the lower range of a single transit of commercial/military vessels that routinely transit the Offshore Project Area. For comparison, the cooling water intakes of such vessels are approximately; 6,840 gpm (gallons per minute, 26 m3 per minute) for an in-transit oceanographic research vessel, 38,889 gpm (147 m3 per minute) for a liquefied natural gas carrier vessel, and 170,000 gpm (644 m3 per minute) for an in-transit aircraft carrier (EPA 1999). The cooling water intake rate of an onshore power plant that utilizes once-through cooling typically ranges from 86,000 to 690,000 gpm (325 to 2,612 m3 per minute). Furthermore, while cable installation is a one-time activity, repeated tows of hydraulic clam dredges across the same seafloor area are common and compound the effect of ichthyoplankton entrainment in such areas (Stevenson et al. 2004). The de minimis effect of cable installation on entrainment mortality of ichthyoplankton is consistent with findings at Vineyard Wind (BOEM 2019). Likewise, South Fork Wind Farm estimated that zooplankton and ichthyoplankton entrained by jet plows installing inter-array cables amount to no more than 0.001

percent of the total populations in the area, based on data from NOAA's Marine Resource Monitoring, Assessment and Prediction Program and Ecosystem Monitoring sampling (BOEM 2021b).

E.4.3.4 Disturbance from Pile-driving Noise and Vibration

The type and size of piling and the method of driving determine the level of underwater noise and seafloor vibrations generated. Dominion Energy modeled monopile installation with a maximum impact hammer energy of 4,000 kilojoules (see COP Appendix Z) as the worst-case scenario of acoustic stressors in the PDE. The modeling parameters were set to overestimate noise and vibration by assuming the maximum rated hammer energy; during actual construction, some energy would be lost to heat and friction.

The biological effects of underwater noise on fishes and invertebrates are influenced by the magnitude of the sound, distance of the organism from the sound origin, and the physiology of the organism. Many fishes are sensitive to sound pressure and particle motion, or the sound-induced oscillation of water molecules; fishes with swim bladders connected to the ear are most sensitive to these pressures (Popper et al. 2014; Popper and Hawkins 2019; ICF 2020). To better understand acoustic sensitivity in the marine environment, NOAA Fisheries initiated a Working Group on Effects of Sound on Fish and Turtles, which established interim threshold criteria finalized under the ANSI report (Popper et al. 2014). The Working Group developed general guidelines for predicting acoustic impacts according to basic morphological traits of marine organisms and established quantitative thresholds for temporary threshold shifts, recoverable injury, and mortality (Table E-10). Categories of sensitive fish included species lacking swim bladders (e.g., flounders, monkfish, skates), species with swim bladders involved in hearing, and species with swim bladders not involved in hearing. Injury thresholds for young life stages, including eggs and larvae, were based on thresholds for fishes with swim bladders not connected to the ear (Popper et al. 2014). See also, COP Appendix Z for additional discussion of Project-specific modeling approaches used for this analysis.

Table E-10. Acoustic Threshold Levels for Fishes in Response to Impulsive Noise

Hearing Group	Impulsive Sounds		
	Mortality and Potential Mortal Injury	Recoverable Injury	Temporary Threshold Shift
Fish without swim bladders	> 213 dB (L_{PK}) > 219 dB SEL_{cum}	> 213 dB (L_{PK}) > 216 dB SEL_{cum}	>> 186 dB SEL_{cum}
Fish with swim bladder not involved in hearing	207 dB (L_{PK}) 210 dB SEL_{cum}	207 dB (L_{PK}) 203 dB SEL_{cum}	186 dB SEL_{cum}
Fish with swim bladder involved in hearing	207 dB (L_{PK}) 207 dB SEL_{cum}	207 dB (L_{PK}) 203 dB SEL_{cum}	186 dB SEL_{cum}
Eggs and larvae	207 dB (L_{PK}) 210 dB SEL_{cum}	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Source: Popper et al. (2014)
Notes:
dB: decibel; L_{PK}: peak sound pressure (dB re 1 μPa); F: far (1,000s of meters); I: intermediate (100s of meters); μPa: micropascal; N: near (10s of meters); N/A: not applicable; PTS: permanent threshold shift; SEL_{cum}: sound exposure level (dB re 1 $μPa^2·s$); SPL RMS: root mean square sound pressure (dB re 1 μPa)

In reality, mobile organisms vulnerable to impact pile driving would likely reduce their exposure to injurious noise by moving away from the pile driving. Acoustic stress of pile driving at the Block Island Wind Farm was determined to be unlikely to adversely affect the Atlantic sturgeon or its prey (NOAA Fisheries 2015). Underwater acoustic measurement results obtained during the CVOW Pilot Project pile installation activities were also incorporated into the underwater acoustic impact assessment. The bubble curtain technology used for the CVOW Pilot Project will also be incorporated for this Project, accounting for feedback received during consultation with NOAA Fisheries and BOEM (see Appendix Z, Underwater Acoustic Assessment). The highly mobile Atlantic sturgeon would be injured by noise only if it remained for some time in the vicinity of the pile during installation. These findings can reasonably be extrapolated to mobile life stages of other managed species that are not endangered.

Pile-driving in the Lease Area would expose benthic invertebrates to sound pressure, particle motion, and substrate vibrations. The interim criteria developed by the Working Group did not include consideration of particle motion and sediment vibration impacts on invertebrates, in part because conditions determining the probability of detection and response to particle motion in the field cannot be replicated in a laboratory setting (Roberts et al. 2016; Hawkins and Popper 2017). Although few studies have examined the effect of sound-generated vibrations of sediment on marine invertebrates (Andersson et al. 2017; Popper and Hawkins 2019), and some evidence of behavioral effects has been reported. The Atlantic sea scallop, Atlantic surfclam, and longfin inshore squid could be vulnerable to such effects. Juvenile and adult scallops and surfclams would likely respond to the impact hammer sounds and vibrations by "flinching," or closing their valves, which prevents feeding (Day et al. 2017). They would likely resume feeding immediately after the disturbance; the short-term interruption of foraging would not affect the health of individuals or decrease abundance of the local populations of bivalves.

In most species of squid, statocysts and lateral lines aid in the detection of particle motion (Mooney et al. 2010; Solé et al. 2013). However, squid behavioral responses to construction-related noise may vary by species, life stage, and even by individual. A variety of body pattern changes, inking, jetting, and startle responses have been observed in the longfin inshore squid in response to pile-driving, making it difficult to predict potential impacts to the species in advance of construction (Jones et al. 2020). Ichthyoplankton cannot avoid auditory stressors by fleeing the area, because of their limited directional-swimming abilities (Pineda et al. 2007). Recovery capabilities of damaged squid sensory cells remain unknown, although the damaged sensory hair cells of some larval fishes can regenerate within a few weeks (Solé et al. 2013). Survival and abundance of monkfish and cod eggs were unaffected by seismic sounds similar to those that affected squid hatchlings (Carroll et al. 2017).

Dominion Energy's underwater acoustic modeling of maximum project design elements is presented in COP Appendix Z. No population-level effect on fishes, squid, or other invertebrates is expected to occur given the limited temporal and spatial extent of pile driving, relative to available habitat for these species. Most mobile species would move outside the ensonified construction areas for a short time. A small fraction of the overall range of managed species in the Lease Area would be affected by pile-driving noise; therefore, impacts would be temporary and localized. These conclusions are consistent with modeling and field measurements for other Greater Atlantic offshore wind projects that reported only short-term adverse effects on fishes, invertebrates, and EFH exposed to pile-driving (BOEM 2020b). Dominion Energy would commit to using soft-start procedures and noise mitigation systems to avoid or minimize impacts to managed species.

E.4.4 Analysis of Potential Operations and Maintenance Impacts

O&M-related activities would alter EFH in the Offshore Project Area by introducing EMF in the vicinity of Inter-Array and Offshore Export Cables; potentially facilitating spread of non-indigenous species; increasing artificial lights, underwater noise, and vibrations; and degrading water quality via incidental fuel and chemical spills. These potential stressors were analyzed and determined unlikely to adversely affect managed species or EFH in the Offshore Project Area (see COP Section 4.2.4). The COP findings are considered applicable to this EFHA.

Although the installation of hard structures occurs during the construction phase, the development of artificial reefs in areas that were previously softbottom is a result of long-term presence of the Project (i.e., occurs during the O&M phase). The conversion of softbottom to hardbottom habitat represents the most notable effect of the Project in the Offshore Project Area. During the life of the Project, the loss of softbottom habitat and development of artificial reefs on foundations, scour protection, and cable mattresses is likely to have minimal, moderate, or less than substantial adverse effects on managed species and EFH.

E.4.4.1 Loss of softbottom habitat

Installation and O&M of Offshore Project Components would cause long-term disturbance, displacement, and/or modification of softbottom EFH. Foundation types and associated scour protection vary in the extent to which they modify benthic substrate. The 31 ft (9.5 m) diameter monopile WTG foundations and Offshore Substation piled jacket foundations and associated scour protection would convert the largest area of softbottom habitat to artificial hardbottom within the Offshore Project Area (Section E.3, Table E-6). Under this maximum design scenario, approximately 204 ac (83 ha) of softbottom in the Offshore Project Area would be permanently converted to hardbottom by foundations, scour protection, and Offshore Export Cable armoring. Of the demersal species with EFH intersecting the Offshore Project Area, EFH source documents indicate that the Atlantic sea scallop, Atlantic surfclam, clearnose and winter skates, and summer and windowpane flounders rely on softbottom habitats (Attachment E-1). Sea scallops aggregate in beds on sand and gravel substrates, while surfclams bury in unconsolidated substrates to depths of up to 3 ft (1 m) below the water/sediment interface (Cargnelli et al. 1999b; Packer et al. 1999a). Flounder and skate species rely on softbottom prey assemblages that include infaunal and epifaunal invertebrates, such as polychaetes, amphipods, decapods, gastropods, and bivalves (Chang et al. 1999; Packer et al. 1999b; Packer et al. 2003a; Packer et al. 2003b). These species would be displaced laterally following loss of softbottom habitats and prey sources.

However, the area of softbottom habitat replaced by hardbottom represents the less than 0.1 percent of total softbottom EFH in the Offshore Project Area. The managed species that would be laterally displaced during O&M would have access to ample, comparable EFH within and around the Offshore Project Area. Monitoring of the Block Island Wind Farm indicates that softbottom macrofaunal communities directly adjacent to WTGs have not exhibited declines in quality during O&M; polychaetes remain the dominant taxa in softbottom sediments within 98 to 295 ft (30 to 90 m) distance bands surrounding the monitored WTGs (Hutchison et al. 2020). Because changes to softbottom habitat are expected to be restricted to areas directly covered by Offshore Project Components, which represent a small fraction of the total softbottom EFH in the Offshore Project Area, effects of O&M on managed species are expected to be minor.

E.4.4.2 Long-term conversion of softbottom to artificial hardbottom habitat and introduction of vertical infrastructure to the water column

Under the maximum design scenario (Section E.3, Table E-6), approximately 204 ac (83 ha) of softbottom in the Offshore Project Area would be converted to hardbottom by foundations, scour protection, and Offshore Export Cable armoring. This area would provide new hardbottom habitat for a variety of structure-associated species.

Biogenic reefs would rapidly develop on underwater surfaces of WTG and Offshore Substation Foundations, scour protection, and cable protection as encrusting and attaching organisms emigrated from adjacent habitats or recruited from the plankton (Degraer et al. 2018) (e.g., algae, amphipods, anemones, anthozoans, barnacles, bryozoans, hydroids, mussels, sponges, tubeworms, tunicates [Steimle and Zetlin 2000; Steimle et al. 2002; Langhamer et al. 2009; Langhamer 2012; Causon and Gill 2018; ICF 2020]). These pioneer organisms would create secondary habitat for mobile fishes and invertebrates by increasing foraging and refuge opportunities (Causon and Gill 2018; ICF 2020). Monitoring at Block Island Wind Farm showed dense aggregations of mussels attached to some but not all the piled jacket foundations. Mussels and other epifauna were attached to the vertical structure from the water surface to the sea floor. The enriched organic sediment beneath the turbine was assumed to support the mussels, which in turn attracted mobile fauna such as sea stars (HDR 2020).

Foundation types vary in their potential to support habitat for benthic and demersal species. Monopile foundations provide smooth and mostly vertical walls for attachment. In contrast, the varied orientations of components of piled jacket foundations provide more complex habitat, including shaded undersides of horizontal elements, narrow crevices, and other sheltering opportunities (ICF 2020). Foundation types also vary in the extent to which they modify light levels, water motion, and sedimentation rates; variability in these features can increase the abundance and diversity of marine community assemblages (Bué et al. 2020). In the North Sea, physical complexity of jacket foundations supported more species and greater abundances than relatively simple monopile foundations (Causon and Gill 2018). Jacket foundation types are therefore expected to create a stronger artificial reef effect and support more diverse assemblages of fishes and invertebrates than monopiles. A 12-year study of colonization of an offshore renewable energy project reported additional habitat value of complex infrastructure features such as holes and ridges, especially for benthic crabs (Bender et al. 2020).

Studies of epifaunal communities on operational WTGs provide evidence of the potential reef effect of the Project. Monopile foundations in the North Sea accumulated 23 species within the first few months and 55 species within four years; associated scour protection accumulated 35 species within the same timeframe (Bouma and Lengkeek 2012). Monopiles of the Baltic Sea were colonized by red and green algae, hydroids, and sessile bivalves; after seven years of succession, assemblages on the foundations were similar to those on a nearby lighthouse (Andersson and Öhman 2010). Within four years, epifaunal communities on jacket foundation types in the North Sea included red and green algae, anemones, barnacles, mussels, sea stars, and urchins (Causon and Gill 2018). These findings are consistent with the observed epifaunal communities that have already been established on the CVOW Pilot Project foundations installed in 2020.

The timing of installation can influence the type of species that initially colonize new substrates because colonizers are recruited from whatever suitable species are in the plankton at the time. The Labrador Current carries ichthyoplankton from the north and the Gulf Stream carries different species from the south to create a dynamic planktonic larval assemblage in the Offshore Project Area. Furthermore, the quasi-decadal shift in the latitude of the Gulf Stream is reported to cause a corresponding northward shift of warm temperate species that follow bottom temperature isotherms (Davis et al. 2017). Because planktonic larval assemblages vary seasonally in the Offshore Project Area, initial colonization patterns of individual foundations and armoring material would reflect the season during which each foundation was installed (Krone et al. 2013, 2017). Over time, assemblages on all foundations would reach similar mature successional stages that reflect ambient conditions (e.g., water depth, temperature, currents).

The presence of Project infrastructure would not interfere with the dispersion of ichthyoplankton in the region. Monopiles would represent a relatively narrow physical intrusion into the benthic and pelagic habitats of the Lease Area. For ichthyoplankton, presence of hard substrate is one of several environmental indicators responsible for the initiation or delay of settlement; other signals include stage of larval development, temperature, prey availability, and chemical signature of conspecifics (Pineda et al. 2007; McManus et al. 2016). Operational WTGs in the North Sea have not exhibited the expected recruitment levels, perhaps due to one or more of these environmental indicators (Degraer et al. 2016). The introduction of foundations and scour protection in the Offshore Project Area would not negatively affect the regional abundances of any species with planktonic life forms.

Colonization of foundations may exhibit vertical zonation. In addition to generating novel hardbottom habitat, installation of WTGs introduces novel intertidal habitat at the sea surface. In the North Sea, the highest number of nonindigenous species (e.g., Pacific oyster [*Crassostrea gigas*], marine splash midge [*Telmatogeton japonicus*], barnacle [*Balanus perforates*] were found in this novel intertidal and splash zone (Glasby et al. 2007; De Mesel et al. 2015; Degraer et al. 2020). In some studies, monopile foundations have been colonized more heavily at the seafloor than at the sea surface, possibly because reef-building species rely on sediments suspended just above the seafloor to construct tubes (Kerckhof et al. 2010; Bouma and Lengkeek 2012). On all foundation types studied, red and green algae and barnacles were more common near the intertidal sea surface while sessile reef-forming blue mussels dominated the base (Andersson and Öhman 2010; Causon and Gill 2018). The solid bases of monopile foundations attract mobile fishes and invertebrates near the seafloor, perhaps because these structures provide some shelter from bottom currents and easy access to adjacent soft-bottom forage areas (Bouma and Lengkeek 2012; Krone et al. 2013; Causon and Gill 2018). In contrast, jacket foundations tend to attract mobile fishes and invertebrates throughout the water column, with less evidence of vertical zonation (ICF 2020). For example, steel jackets in the German Bight were dominated by adult crabs (*Cancer* spp.) at their base and larval edible crabs at upper levels (Krone et al. 2013, 2017). Vertical epifaunal zonation has not been observed on Block Island Wind Farm WTGs in the four years since its construction, suggesting that intermediary succession may persist for several years (Hutchison et al. 2020). Piled jacket foundations at Block Island Wind Farm were reported to be colonized by mussels, anemones, and sponges in the water column, and the *Astrangia poculata* coral near the sea floor. The tunicate *Didemnun vexillium*, a common invasive species, also occurs on the foundations (HDR 2020).

Enriched organic matter (i.e., littoral fall) and empty invertebrate shells accumulate beneath and immediately adjacent to all foundation types as the associated organisms grow, feed, and ultimately die (Goddard and Love 2010; Coates et al. 2014; Causon and Gill 2018; ICF 2020). The enriched area is typically favored by small mobile organisms seeking shelter in the discarded mollusk shells (e.g., juvenile black sea bass, red hake, scup, skate species) and organisms that can derive nutrients from the rain of detritus (e.g., larval fishes, burrowing amphipods, polychaetes, other forage infauna) (ICF 2020). The enriched area around offshore structures generally supports more species per unit area than flat softbottom habitat without structures (Coen and Grizzle 2007). In areas with limited bottom currents, decomposing organic matter can increase biological oxygen demand, resulting in anoxic areas at foundation bases (ICF 2020). Bottom currents in the Offshore Project Area are expected to maintain adequate oxygen to support marine life (see Section 4.1.2, Water Quality).

Benthic enrichment associated with littoral fall around operational oil and gas platforms in the Baltic Sea and North Sea was spatially limited, extending only 3 to 16 ft (1 to 5 m) from foundation bases (Wilhelmsson et al. 2006; Bergstrom et al. 2014). The spatial effects are especially notable at monopile foundations, where organic carbon enrichment decreased measurably with distance from the foundations, while grain size increased (Andersson and Öhman 2010; Bouma and Lengkeek 2012; Coates et al. 2014). The spatial patterns may be generated by accelerated water movement around the structures (i.e., wake effect), which causes turbulence and reduces current strength (ICF 2020). As current strength is reduced, pockets of substrate with smaller organically enriched sediment particles and greater abundance of larval recruits can form immediately down-current from the foundation bases; such enriched areas may subsequently attract mobile predators (Bouma and Lengkeek 2012; Coates et al. 2014; ICF 2020). Conversely, jacket foundations do not cause bottom currents to slow. Because water moves through rather than around the open structure, no low-flow pockets form, and spatial gradients are less apparent (Coates et al. 2014; Degraer et al. 2016). However, once jacket foundations are heavily colonized by epifauna, currents may behave more as they do when solid foundations are encountered (HDR 2020).

Increased productivity around WTG foundations may alter local distributional patterns of managed species (Rein et al. 2013; Degraer et al. 2016). Stomach contents of demersal fishes collected near operational wind farms in softbottom habitats in the Baltic and North Seas were characterized by hardbottom prey associated with the foundations (Andersson and Öhman 2010; Degraer et al. 2016). With the exception of the Fish Haven, and the existing CVOW Pilot Project monopile foundations, the Offshore Project Area presently offers little habitat for structure-associated species. Of the demersal species with EFH intersecting the Offshore Project Area, EFH source documents indicate that black sea bass, monkfish, red hake, scup, and spiny dogfish would benefit from the complex habitat offered by structured hardbottom. These species are known to associate with artificial structures (Table E-9; Appendix E-1).

The black sea bass exhibits particularly strong site fidelity to specific reefs and is known to aggregate around artificial reefs along the eastern seaboard from Massachusetts (Rousseau 2008; Barber et al. 2009; Harrison and Rousseau 2020) to Florida (Powers et al. 2003). Structure-associated managed species have been observed aggregating around artificial reefs and other infrastructure in Rhode Island (Wilber et al. 2022a; Hutchison et al. 2020), New York (NYSDEC 2020), New Jersey (Figley et al. 2001), Delaware (Steimle et al. 2002), Maryland (Loftus and Stone 2007; Cullen and Stevens 2017), North Carolina (Bangley and Rulifson 2014; Lemoine et al. 2019), South Carolina (Kolmos 2007), and elsewhere throughout the Mid-Atlantic Bight (Steimle and Zetlin 2000; Ross and Rhode 2016). These artificial reefs have also been frequented by Atlantic cod, bluefish, pollock, and other softbottom-dependent species (e.g., summer and winter flounder). Benefits of complex habitat provided by introduced WTGs may not extend to meso- and epipelagic species. While increased vertical mixing and subsequent transport of nutrients to the sea surface have been observed at WTGs in the North Sea, changes to primary production did not yield notable changes to the distribution of resident pelagic fishes (Floeter et al. 2017).

The positive effects of European wind farms on distributions of demersal fishes and invertebrates are well known, and limited observations of U.S. wind farms supports this finding. In a Biological Opinion for the Block Island Wind Farm, NOAA Fisheries concluded that increased prey associated with WTG structures would benefit Atlantic sturgeon transiting through the area (NOAA Fisheries 2015). Recent observations of the Block Island Wind Farm have noted aggregations of more than 100 black sea bass individuals per WTG, with additional sightings of scup, monkfish, bluefish, and smooth dogfish (Hutchison et al. 2020). In contrast, telemetry studies in the Maryland Wind Energy Area, where no infrastructure yet exists, reported low densities of black sea bass and other structure-associated species (Secor et al. 2020).

Two species of nonindigenous Indo-Pacific lionfish (*Pterois volitans* and *P. miles*) are associated with artificial reefs and offshore platforms throughout the Gulf of Mexico (Campbell et al. 2022), leading some researchers to predict that offshore wind infrastructure may support this species in the Atlantic Ocean as well. However, lionfish first colonized the natural hardbottom of the west Florida shelf, reportedly associating preferentially with sponges on hardbottom substrates, several years before moving into the western Gulf; lionfish have since been captured in all habitats except mud, silt, and clay (Campbell et al. 2022). Moreover, lionfish have already spread up the eastern seaboard as far north as New York despite the absence of major offshore infrastructure (USGS 2022). The successful range expansion of lionfish has been attributed to their lack of predators, rapid growth rates, broad prey base, nonspecific habitat use, large home ranges, and indeterminate fecundity (i.e., females contain developing eggs of various stages and can spawn repeatedly as each batch of eggs becomes mature) (Bacheler et al. 2022; Mouchlianitis et al. 2022; Green et al. 2021; Fogg et al. 2017). These and other features (such as the venomous spines) facilitate the establishment of lionfish throughout the Caribbean, Gulf of Mexico, and Western Atlantic Ocean. It is expected that lionfish will come to be associated with infrastructure in the Offshore Project Area in much the same ways reported elsewhere.

In the North Sea, the secondary habitat created by colonizing species on foundations and scour protection provide additional foraging opportunities for fishes and nurseries for crabs (Stenberg et al. 2015; Krone et al. 2017). In Belgium's offshore waters, increased foraging opportunities near foundations have been linked to increases in Atlantic cod and pout abundance and productivity (Reubens et al. 2014). In the Netherlands, abundances of sand eel were higher near foundations and scour protection than on surrounding softbottom sediments (Wilhelmsson et al. 2006; Bergstrom et al. 2013, 2014).

According to a recent meta-analysis of data from offshore wind farms in Europe, fishes occur at greater abundances within operational wind farm areas than at nearby reference locations (Methratta and Dardick 2019). It remains unclear whether artificial structures increase regional biomass, redistribute existing biomass, or have some effect on both processes (Powers et al. 2003; Brickhill et al. 2005; Rein et al. 2013, Smith et al. 2015). The incidence of fishing pressure also must be accounted for, as many European wind farms are closed to fishing vessels (Coates et al. 2016). At some wind farms in the North and Baltic Seas, no measurable differences in community abundances within and outside of wind farms were observed (Degraer et al. 2016; Langhamer et al. 2018). Conversely, a dual analysis of gut content and stable isotopes in benthopelagic and benthic fishes showed extensive foraging on organisms unique to offshore artificial infrastructure (Mavraki et al. 2021). In the U.S., neither the distribution, abundance, nor condition of individual fishes was reported to be altered by installation of WTGs at Block Island Wind Farm, despite predicted impacts to demersal fishes and American lobster communities (Wilber et al. 2018, 2022).

Offshore structures of all types (e.g., fixed, floating) attract many highly migratory fishes, including tunas (e.g., albacore, Atlantic bluefin, Atlantic skipjack, and Atlantic yellowfin tunas) and sharks (e.g., Atlantic angel, Atlantic sharpnose, blacktip, common thresher, dusky, sand tiger, sandbar, smoothhound, and tiger sharks) (see Attachment E-1). These highly migratory species also may use offshore structures as navigational landmarks (Taormina et al. 2018).

While foundations would introduce some habitat variability to the relatively uniform sandy substrate in the Lease Area, only a small fraction of the Offshore Project Area would be subject to a reef effect. The 205 monopile WTG foundations (with maximum 230 ft [70 m] diameter scour protection) and three piled jacket Offshore Substation foundations (with maximum 230 ft [70 m] diameter scour protection) would convert a maximum of 204 ac (83 ha) of softbottom to hardbottom under the maximum design scenario (see Table E-6). Foundations offering greater structural complexity (e.g., piled jackets) would support more complex attached species assemblages than smooth vertical foundation types (e.g., monopiles) (Wilhelmsson and Langhamer 2014; Bué et al. 2020).

Ultimately, effects of foundations on managed species and EFH in the Offshore Project Area may be adverse, beneficial, or mixed, depending on the species (NOAA Fisheries 2015; van der Stap et al. 2016). Effects on most managed benthic and pelagic organisms would be neutral or beneficial (Hooper et al. 2017). The conversion of softbottom to hardbottom around each foundation would reduce the amount of softbottom habitat in the Offshore Project Area for softbottom-reliant species (e.g., Atlantic sea scallop, Atlantic surfclam, clearnose skate [*Raja eglanteria*] and winter skate [*Leucoraja ocellata*], summer and windowpane flounders); however, softbottom habitat is not a limiting resource in the Mid-Atlantic Bight or in coastal Virginia. Structure-associated species (e.g., monkfish, red hake, black sea bass, scup, spiny dogfish [*Squalus acanthias*], tunas and sharks) may benefit from the Project because the foundations are expected to provide shelter and prey resources (Wilber et al. 2022b; HDR 2020; Hutchison et al. 2020). Influences of the Project on local distributions of fishes and invertebrates would be limited to the Offshore Project Area and no population-level impacts are expected.

E.5 SUMMARY OF EFFECTS TO EFH

The analyses presented in this EFHA and in the COP support Dominion Energy's determination of effects for managed species and EFH. Expected impacts for managed species with EFH intersecting the Offshore Project Area are detailed in Attachment E-2 and summarized briefly in this section. Effects on other NOAA Trust Resources (see Section E.2.4) would parallel those for managed species with similar habitat and prey requirements.

E.5.1 Summary of Effects on Water Column, Plankton, and Ichthyoplankton

Some EFH designated in the water column of the Offshore Project Area would temporarily be affected during construction and decommissioning of the Project. Potential stressors from these stages would include localized increases in turbidity from sediment plumes, inadvertent fuel releases from Project vessels and equipment, ichthyoplankton entrainment by cable installation equipment, and introduction of noise and vibration from impact pile driving. Water column EFH would not be subject to measurable O&M-related stressors.

During cable installation, equipment would move continuously through the installation corridor and pose a temporary entrainment threat to ichthyoplankton in any one location. Water would be drawn from the water column into the intake pumps of jetting tools, thus avoiding demersal eggs and larvae. The volume of water withdrawn by the pumps would be a small fraction of available pelagic habitat; mortality from entrainment would not be detectable relative to naturally high mortality of plankton. Therefore, the potential loss of ichthyoplankton to entrainment during construction would be temporary and localized in the Offshore Project Area.

During pile driving, noise and vibration introduced into the Offshore Project Area could result in behavioral changes, temporary or permanent threshold shifts, injury, or limited instances of mortality in managed species. Vulnerability to these impacts increases in species with swim bladders, particularly when the swim bladder is involved in hearing. However, mobile life stages of managed species vulnerable to impact pile driving are expected to reduce exposure to injurious noise by temporarily avoiding the area of impact. Given the limited spatial and temporal extent of Project-related pile driving, no population-level effect on managed fishes, squid, or bivalves is expected to occur.

E.5.2 Summary of Effects on Softbottom Substrate

A maximum of 204 ac (83 ha) of softbottom benthic habitat in the Offshore Project Area would be converted to hardbottom (WTG Foundations, Offshore Substation Foundations, scour protection) for the life of the Project (Table E-6). Short-term stressors to softbottom benthic EFH related to construction and decommissioning would include direct disturbance by construction equipment and potential burial, injury, or mortality of managed species. Bedforms such as sand waves, megaripples, and ripples would be temporarily disturbed and would reform within days to weeks under the influence of the same physical conditions that formed them initially. Long-term stressors to softbottom benthic EFH related to O&M would include the introduction of EMF in the benthic environment and the conversion of softbottom to hardbottom habitat.

Pre-lay grapnel runs and trench forming for Inter-Array and Offshore Export Cable installation would affect sessile life stages of managed species located directly in the path of construction. Mobile life stages of managed species would be expected to temporarily vacate the impacted area to avoid injurious interactions with construction equipment. Species that consume infaunal and epibenthic forage species would likely return rapidly after construction to scavenge organisms injured by the activity. Direct impacts to managed benthic and demersal species would be temporary and localized.

Long-term loss of softbottom habitat during O&M would be most likely to adversely affect managed species reliant on softbottom habitat for refuge and forage opportunities. These species would be directly impacted by the introduction of hardbottom substrate by being laterally displaced; they would also be indirectly impacted by the displacement of their preferred prey species. However, the area of softbottom habitat replaced by Offshore Project Components comprises less than 0.1 percent of total softbottom EFH in the Offshore Project Area. Monitoring of the Block Island Wind Farm indicates that softbottom macrofaunal communities directly adjacent to WTGs have not exhibited strong changes during O&M, implying that long-term changes to softbottom EFH would be restricted to areas directly covered by the Project (Hutchison et al. 2020).

E.5.3 Summary of Effects on Hardbottom Substrate

Hardbottom substrate (WTG Foundations, Offshore Substation Foundations, scour protection, cable protection) would be introduced in up to 204 ac (83 ha) of the Offshore Project Area for the life of the Project (Table E-6). Novel underwater surfaces would rapidly be colonized by encrusting and attaching organisms, which would create biogenic habitat for structure-associated species. Benthic areas surrounding WTG foundations would be enriched by littoral fall from these communities; discarded shells would serve as another form of hard substrate offering refuge for small mobile organisms. Certain managed species with EFH in the Offshore Project Area may benefit from the introduction of complex habitat and associated increased productivity, including both resident species and highly migratory sharks and tunas. While foundations would introduce some habitat variability to the relatively uniform softbottom substrates of the Lease Area, only a small fraction of the Offshore Project Area would be subject to reef effect. Influences of novel structure on local distributions of managed organisms would be limited to the Offshore Project Area and no population-level impacts are expected.

E.5.4 Avoidance, Minimization, and Mitigation Measures

Dominion Energy proposes to implement the following measures to avoid, minimize, and mitigate the potential impact-producing factors to managed species and EFH (Table E-11). Additional discussion of potential mitigation measures will be presented in the Long-term Monitoring Plan or as part of the EFH Conservation Recommendations that may result from the EFH Consultation process.

Table E-11. Project Impact-Producing Factors and Proposed Avoidance, Minimization, and Mitigation Measures

Project Stage	Location	Impact	Avoidance, Minimization, and Mitigation
Construction; Decommissioning	Offshore Project Area	Disturbance of softbottom EFH habitat Disturbance, injury, or mortality of benthic and pelagic organisms Change in water quality, including turbidity, sediment deposition, and chemical contamination Entrainment of plankton and ichthyoplankton	• Dominion would establish a horizontal buffer of at least 164 ft (50 m) around identified artificial reefs, shipwrecks, and other mapped hardbottom habitat in the Fish Haven area. No other hardbottom or sensitive habitat is known or expected to occur in the Offshore Project Area. Dominion Energy would further micro-site within the Offshore Export Cable Route Corridor to avoid softbottom EFH habitats where feasible to minimize the probability of adverse interactions with sensitive benthic resources;

Project Stage	Location	Impact	Avoidance, Minimization, and Mitigation
		Increase in underwater noise and vibration	• The release of non-toxic drilling muds during Trenchless Installation activities is possible but unlikely. Dominion Energy would develop and implement an Inadvertent Release Plan that would include pollution prevention measures and spill response procedures covered by the Stormwater Pollution Prevention Plan; and • Dominion Energy would commit to using a soft-start procedure and noise mitigation systems such as bubble curtain technologies to avoid or minimize impacts to managed species. During pile-driving activities, Dominion Energy will implement near-field and/or far-field noise mitigation systems to minimize underwater sound propagation. Examples of near-field noise mitigation systems include the Hydro Sound Damper, the Noise Mitigation Sleeve or the AdBm Noise Mitigation System. Dominion Energy is committed to the use of a double big bubble curtain for far field noise mitigation.
Operations and Maintenance	Offshore Project Area	Long-term conversion of softbottom to artificial hardbottom habitat and introduction of vertical infrastructure to the water column	• Dominion Energy does not expect the installation of hard structure to introduce nonindigenous species to the Project Area; however, existing species in the area may colonize or become associated with the structures once they are installed (e.g., lionfish). • As required for navigational safety, Dominion Energy would install artificial lights on all Project structures. These lights would be directed parallel to the sea surface to increase the visibility of structures to mariners; they would not be directed into the water; • Dominion Energy would develop and implement an Oil Spill Response Plan describing measures to avoid accidental spills and protocols to be implemented should a spill occur. Dominion Energy also would require all Project-related vessels to operate in accordance with laws regulating at-sea discharges of vessel-generated waste to minimize impacts to managed species; and • Dominion Energy would commit to burying Project-related cables wherever feasible to minimize EMF detectable by managed species.
		Habitat creation for nonindigenous species such as *Didemnun vexillium* (invasive tunicate)	
		Increase in shading and artificial lights	
		Change in water quality, including fuel and chemical spills	
		Introduction of Project-related electric and magnetic fields (EMF)	

Dominion Energy will continue discussion and engagement with the appropriate regulatory agencies and environmental non-governmental organizations throughout the life of the Project to develop an adaptive mitigation approach that provides flexible and protective mitigation measures. In addition to these specific measures, Dominion Energy and all Project-related vessels would abide by applicable laws and regulations, including but not limited to reducing marine debris, managing ballast water, preventing spills of fuels and other hazardous materials, and complying with vessel speed restrictions.

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ATTACHMENT E-1: PROFILES OF MANAGED SPECIES

CONSTRUCTION AND OPERATIONS PLAN

Coastal Virginia Offshore Wind Commercial Project

Appendix E, Attachment E-1
Profiles of Managed Species in the Offshore Project Area

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ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
EFH	Essential Fish Habitat
FMP	Fisheries Management Plan
ft	feet
HMS	Highly Migratory Species
Lease Area	Renewable Energy Lease Area OCS-A 0483
m	meters
MAFMC	Mid-Atlantic Fishery Management Council
NEFMC	New England Fishery Management Council
NOAA Fisheries	National Oceanographic and Atmospheric Administration National Marine Fisheries Service
Offshore Project Area	Project Components in Lease Area and Offshore Export Cable Route Corridor
ppt	parts per thousand
Project	Coastal Virginia Offshore Wind Commercial Project
U.S.	United States
YOY	young-of-year

E-1.1 MANAGED SPECIES IN THE OFFSHORE PROJECT AREA

The present Essential Fish Habitat (EFH) Assessment (EFHA) analyzes the potential effects of construction, operations and maintenance, and decommissioning of the Coastal Virginia Offshore Wind Commercial Project (Project) on managed fishery resources. Species with EFH in the Offshore Project Area were identified using the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NOAA Fisheries) EFH Mapper (2021), New England Fishery Management Council (NEFMC) Omnibus Amendment 2 (2017), Mid-Atlantic Fishery Management Council (MAFMC) Fisheries Management Plans, NOAA Fisheries Highly Migratory Species (HMS) Amendment 10 (2017), and NOAA Fisheries EFH source documents. Managed species with designated EFH intersecting the Offshore Project Area are listed in Table E-1-1.

Table E-1-1. Managed Species with Designated EFH in the Offshore Project Area

Common Name	Scientific Name	Essential Fish Habitat (EFH) Life Stages Designated within the Offshore Project Area
New England Fishery Management Council (NEFMC)		
Atlantic cod	Gadus morhua	Egg, Larva
Atlantic herring a/	Clupea harengus	Juvenile, Adult
Atlantic sea scallop	Placopecten magellanicus	ALL
clearnose skate	Raja eglanteria	Juvenile, Adult
monkfish b/	Lophius americanus	ALL
pollock	Pollachius virens	Larva
red hake	Urophycis chuss	Adult
windowpane flounder	Scophthalmus aquosus	ALL
winter skate	Leucoraja ocellata	Juvenile
witch flounder	Pseudopleuronectes americanus	Egg, Larva
yellowtail flounder	Limanda ferruginea	Larva
Mid-Atlantic Fishery Management Council (MAFMC)		
Atlantic butterfish	Peprilus triacanthus	ALL
Atlantic mackerel	Scomber scombrus	Egg, Juvenile, Adult
Atlantic surfclam	Spisula solidissima	Juvenile, Adult
black sea bass a/	Centropristis striata	Larva, Juvenile, Adult
bluefish a/	Pomatomus saltatrix	ALL
longfin inshore squid	Doryteuthis [Amerigo] pealeii	Egg, Juvenile, Adult
scup a/	Stenotomus chrysops	Juvenile, Adult
spiny dogfish a/ b/	Squalus acanthias	Sub-adult Female, Adult Female, Adult Male
summer flounder a/	Paralichthys dentatus	ALL
NOAA Fisheries—Highly Migratory Species (HMS)		
albacore tuna	Thunnus alalunga	Juvenile
Atlantic angel shark	Squatina dumeril	ALL
Atlantic bluefin tuna	Thunnus thynnus	Juvenile, Adult
Atlantic sharpnose shark	Rhizoprionodon terraenovae	Juvenile, Adult
Atlantic Skipjack tuna	Katsuwonus pelamis	Juvenile, Adult
Atlantic Yellowfin tuna	Thunnus albacares	Juvenile, Adult
blacktip shark	Carcharhinus limbatus	Juvenile, Adult
common thresher shark	Alopias vulpinus	ALL
dusky shark	Carcharhinus obscurus	ALL
sand tiger shark	Carcharias taurus	ALL
sandbar shark	Carcharhinus plumbeus	ALL
smoothhound shark complex (smooth dogfish)	Mustelus canis	ALL

Common Name	Scientific Name	Essential Fish Habitat (EFH) Life Stages Designated within the Offshore Project Area
tiger shark	Galeocerdo cuvier	Juvenile, Adult

Notes:
a/ Joint management with Atlantic States Marine Fisheries Commission
b/ Joint management by NEFMC and MAFMC

EFH is described in Section E-1.2, Managed Species in the Offshore Project Area for the 33 species with designated EFH for one or more life stages in the Offshore Project Area. For the purpose of this assessment, the Offshore Project Area includes the portions of the Project Components located in the designated Renewable Energy Lease Area OCS-A 0483 (Lease Area) and Offshore Export Cable Route Corridor (Figure E-1-1). The species-specific acreages of EFH within the Offshore Project Area were calculated using geographic information system tools that measure the intersection of EFH and Offshore Project Area shapefiles.

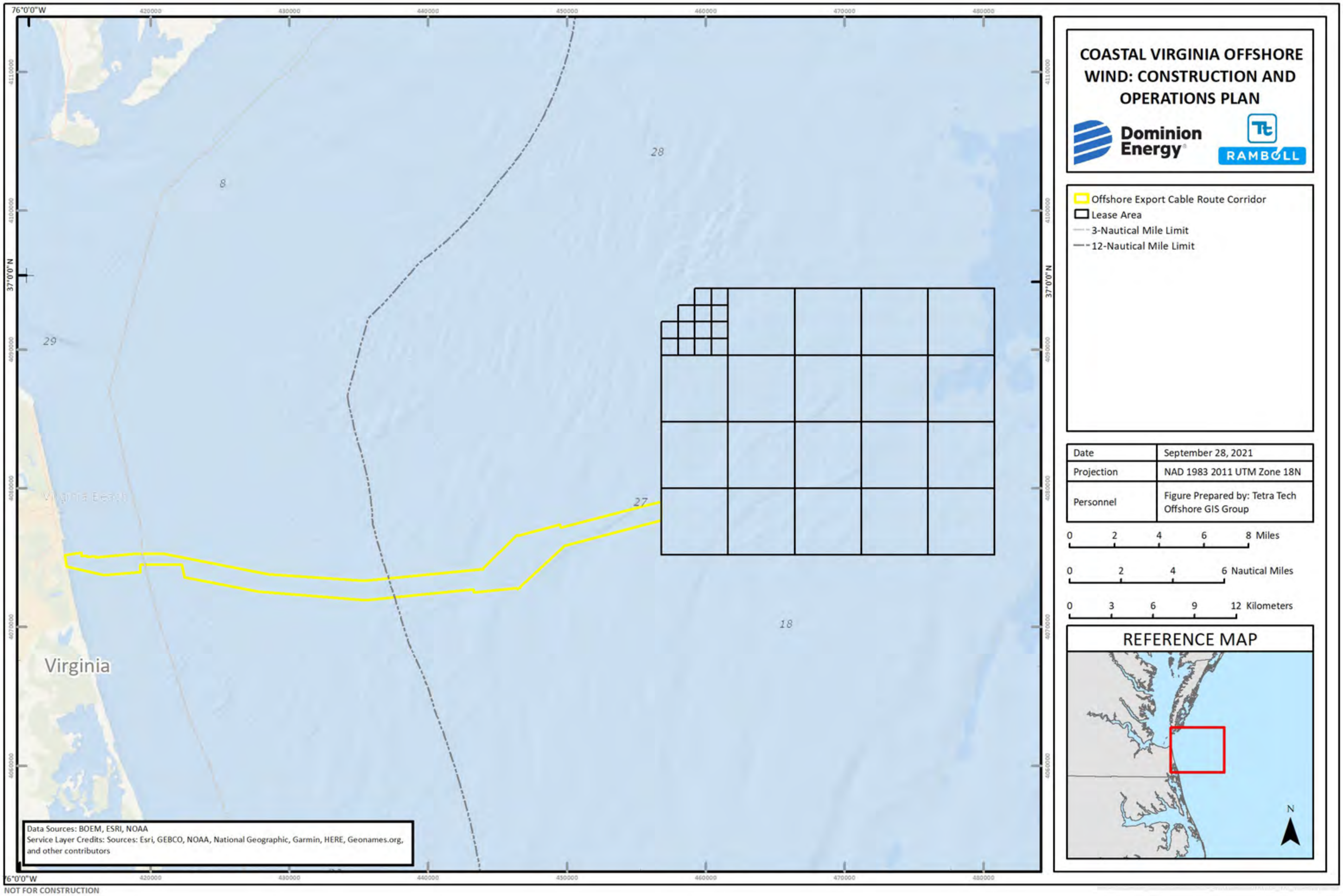

Figure E-1-1. CVOW Commercial Offshore Project Area Overview

E-1.2 PRESENCE OF EFH IN THE PROJECT AREA BY SPECIES AND LIFE STAGE

Managed species with EFH in the Offshore Project Area are described in the following sections. Species-specific EFH acreages are presented in tables and visualized in shapefiles intersecting the Offshore Project Area. All EFH portrayed in EFH Mapper shapefile downloads (NOAA Fisheries 2021) was assumed present, regardless of the geographic boundaries described in EFH source documents; therefore, the acreages presented in the following sections represent a conservative overestimate of functional EFH in the Offshore Project Area.

E-1.2.1 Atlantic Cod (*Gadus morhua*)

Atlantic cod egg EFH is designated in both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-2; Figure E-1-2). In the Mid-Atlantic Bight, Atlantic cod eggs are found in pelagic marine habitats and in the high salinity zones of regional bays and estuaries (NEFMC 2017). They typically occur in the upper 33 feet (ft; 10 meters [m]) of the water column, but spring rainfalls can locally reduce salinities and allow eggs to sink to lower depths (Fahay et al. 1999a; Lough 2004). Designated EFH for Atlantic cod eggs spans the fall to spring spawning season in the upper 230 feet (ft) (70 meters [m]) of the water column, where temperatures do not exceed 54 degrees Fahrenheit (°F; 12 degrees Celsius [°C]) and salinities are within 32 to 33 parts per thousand (ppt) (Fahay et al. 1999a; Lough 2004).

Table E-1-2. **Atlantic** Cod (*Gadus morhua*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Egg	0	1,659	1,652
Larva	50,842	5,021	0
Percent of Project Area Covered by EFH by Life Stage			
Egg	0.0%	11.7%	100.0%
Larva	45.1%	35.3%	0.0%
Percent of Total Species EFH Area Covered by Project Area			
Egg	0.000%	0.007%	0.007%
Larva	0.182%	0.018%	0.000%

Sources: Fahay et al. 1999a; Lough 2004; NEFMC 2017

Atlantic cod larva EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-2; Figure E-1-2). Atlantic cod larvae are found in pelagic marine habitats and in the high salinity zones of regional bays and estuaries (NEFMC 2017). Young larvae typically occur in the upper 246 ft (75 m) of the water column and descend as they age to depths of 689 ft (210 m); they migrate vertically in reaction to light (Fahay et al. 1999a; Lough 2004). Designated EFH for Atlantic cod larvae is in temperatures of 39 to 46°F (4 to 8°C) in winter and spring and 45 to 54°F (7 to 12°C) in summer and fall, where salinities are within 32 to 33 ppt (Fahay et al. 1999a; Lough 2004).

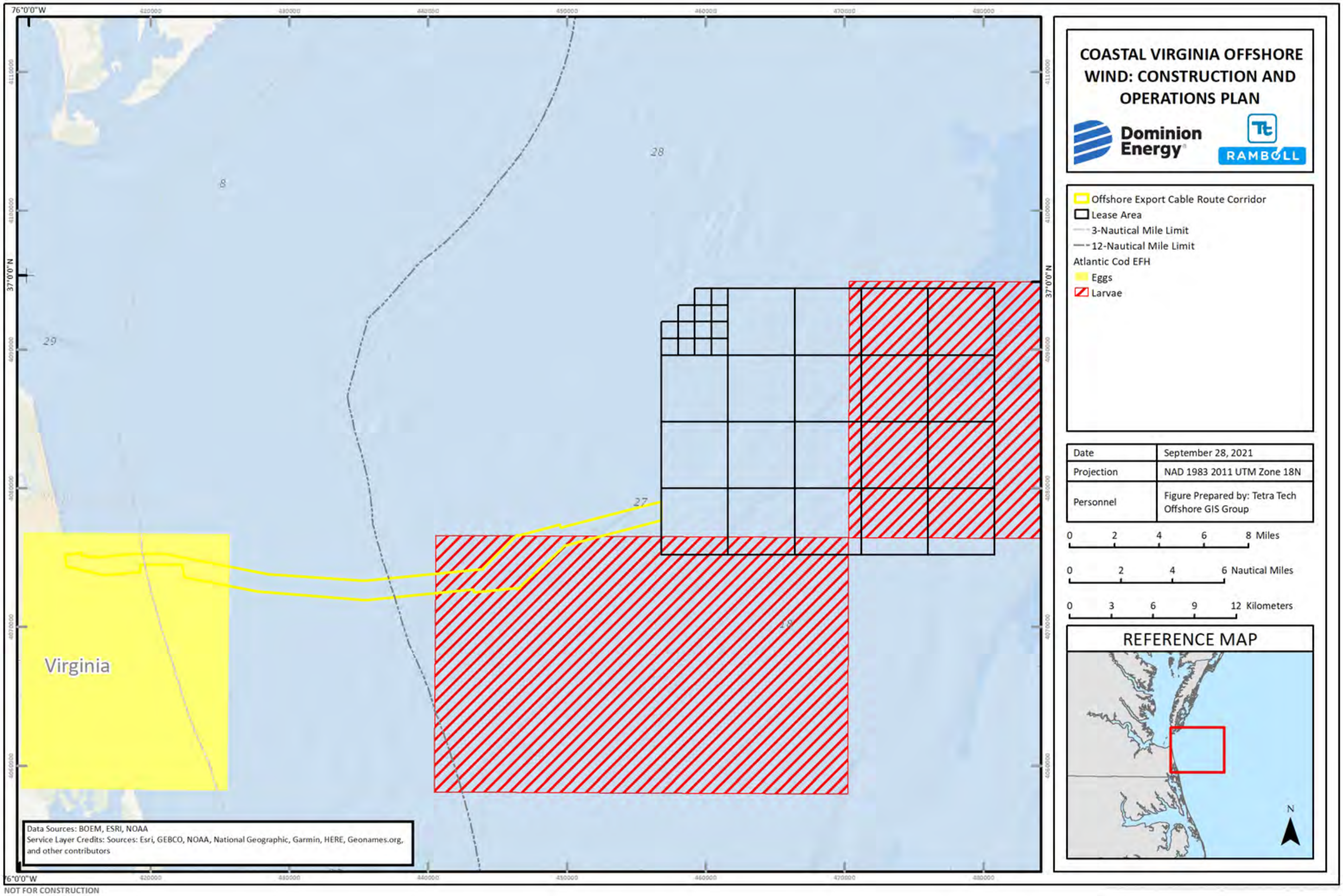

Figure E-1-2. Atlantic Cod (*Gadus morhua*) Designated EFH in the Offshore Project Area

No Atlantic cod juvenile or adult EFH is designated in the Offshore Project Area.

The Atlantic cod is managed as two stocks under the NEFSC Northeast Multispecies Fisheries Management Plan (FMP): the Gulf of Maine stock and the Georges Bank stock. Both fishery stocks are currently overfished and subject to overfishing (NOAA Fisheries 2019).

E-1.2.2 Atlantic Herring (*Clupea harengus*)

No Atlantic herring egg or larva EFH is designated in the Offshore Project Area.

Atlantic herring juvenile EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-3; Figure E-1-3). In the Mid-Atlantic Bight, Atlantic herring juveniles are found in intertidal and subtidal pelagic marine habitats and in the high salinity zones of regional bays and estuaries (NEFMC 2017). Juveniles exhibit diel vertical migrations; one- and two-year-old individuals form large schools to complete limited seasonal inshore-offshore migrations. Young-of-year (YOY) can tolerate low salinities but exhibit increasing preference for high salinities as they age (NEFMC 2017). They feed on up to 15 groups of zooplankton, including copepods, decapod larvae, barnacle larvae, cladocerans, and molluscan larvae (Stevenson and Scott 2005). Designated EFH for Atlantic herring juveniles is in the upper 984 ft (300 m) of the water column, where temperatures span 37 to 72°F (3 to 22°C) and salinities are within 28 to 32 ppt (Reid et al. 1999; Stevenson and Scott 2005; NEFMC 2017).

Table E-1-3. Atlantic Herring (*Clupea harengus*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Juvenile	112,799	12,575	0
Adult	112,799	14,234	1,652
Percent of Project Area Covered by EFH by Life Stage			
Juvenile	100.0%	88.3%	0.0%
Adult	100.0%	100.0%	100.0%
Percent of Total Species EFH Area Covered by Project Area			
Juvenile	0.189%	0.021%	0.000%
Adult	0.209%	0.026%	0.003%

Sources: Reid et al. 1999; Stevenson and Scott 2005; NEFMC 2017

Atlantic herring adult EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-3; Figure E-1-3). Atlantic herring adults are found in subtidal pelagic marine habitats and in the high salinity zones of regional bays and estuaries (NEFMC 2017). They exhibit diel vertical migrations and complete extensive seasonal migrations between northern spawning grounds in summer and fall and southern overwintering areas; though pelagic, they spawn on the seafloor on a variety of substrates in depths of 16 to 295 ft (5 to 90 m) (NEFMC 2017). Adults prefer well-mixed waters and transition zones between stratified and unstratified waters (Reid et al. 1999; Stevenson and Scott 2005). They feed primarily on euphausiids, chaetognaths, and copepods (Stevenson and Scott 2005). Designated EFH for Atlantic herring adults is in the upper 984 ft (300 m) of the water column, where temperatures span 39 to 45°F (4 to 7°C) in spring and 41 to 57°F (5 to 14°C) in summer and fall and salinities are within 27 to 35 ppt (Reid et al. 1999; Stevenson and Scott 2005).

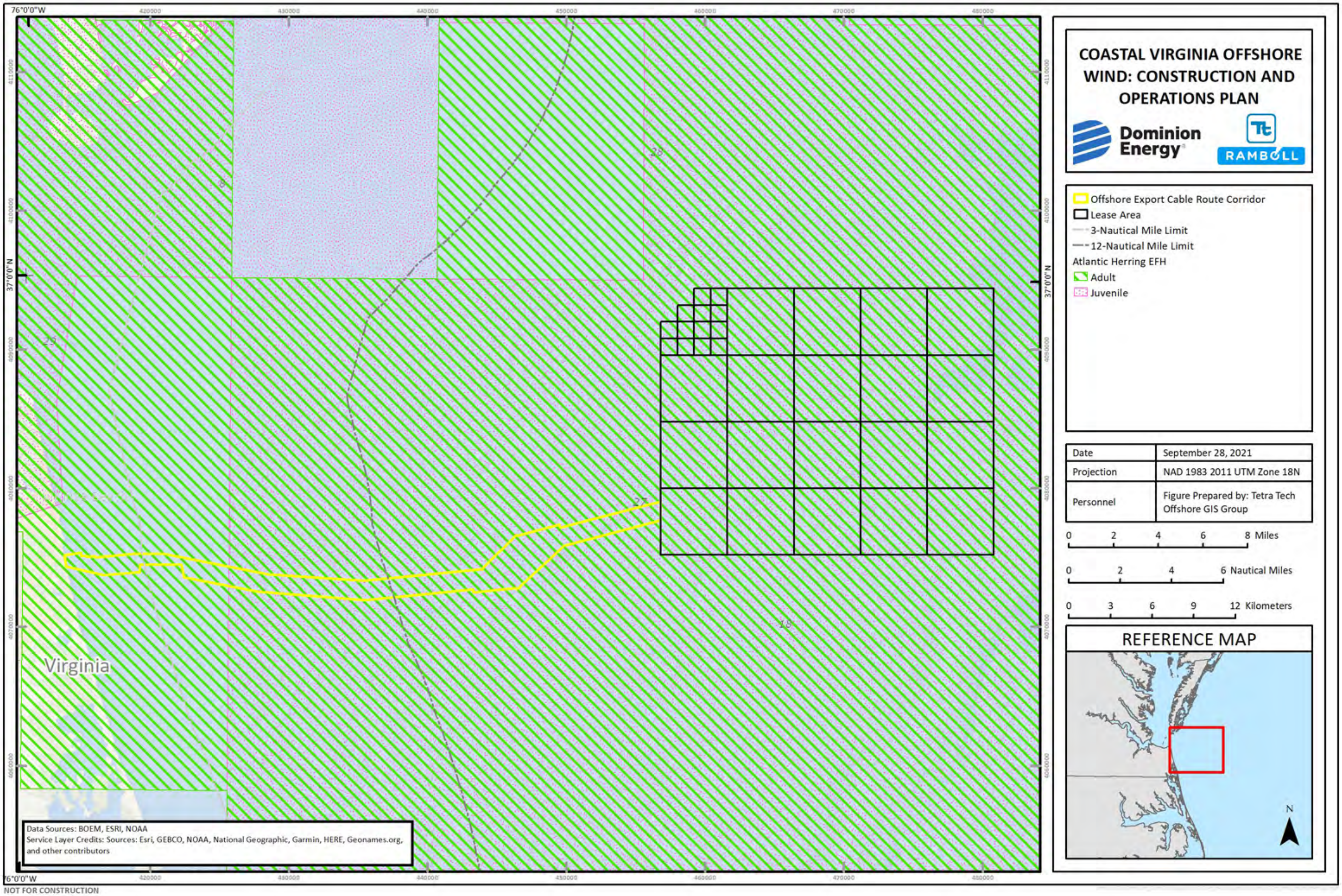

Figure E-1-3. Atlantic Herring (*Clupea harengus*) Designated EFH in the Offshore Project Area

The Atlantic herring is managed under the NEFMC Atlantic Herring FMP as a single stock: the Northwestern Atlantic Coast stock. The fishery stock is not currently overfished or subject to overfishing (NOAA Fisheries 2019).

E-1.2.3 Atlantic Sea Scallop (*Placopecten magellanicus*)

Atlantic sea scallop EFH for all life stages is designated in the Lease Area; there is no designated Atlantic sea scallop EFH in federal or state waters of the Offshore Export Cable Route Corridor (Table E-1-4; Figure E-1-4). They are suspension or filter feeders that feed primarily on phytoplankton, diatoms, microscopic animals, and detritus (Packer et al. 1999a). Feeding habits do not change markedly across life stages.

Table E-1-4. Atlantic Sea Scallop (*Placopecten magellanicus*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
ALL	46,601	0	0
Percent of Project Area Covered by EFH by Life Stage			
ALL	41.3%	0.0%	0.0%
Percent of Total Species EFH Area Covered by Project Area			
ALL	0.140%	0.000%	0.000%

Sources: Packer et al. 1999a; NEFMC 2017

In the Mid-Atlantic Bight, Atlantic sea scallop eggs are found in inshore benthic marine habitats and on the continental shelf in the vicinity of adult scallops (NEFMC 2017). Eggs remain on the seafloor for four to five weeks prior to developing into the first free-swimming larval stage. Designated EFH for Atlantic sea scallop eggs is on the seafloor in temperatures spanning 55 to 63°F (13 to 17°C) (Packer et al. 1999a).

Atlantic sea scallop larvae are found in pelagic marine habitats in inshore and offshore areas during their two planktonic stages (trochophore and veliger stages) (NEFMC 2017). Planktonic larvae exhibit diel vertical migrations and are carried by currents for more than a month before demersal spat settle on hard surfaces including gravel, pebbles, shells, macroalgae, and other organisms such as hydroids (NEFMC 2017). Spat attached to hardbottom have higher survival rates than spat settled on shifting sand. Designated EFH for Atlantic sea scallop larvae is in the upper 33 ft (10 m) of the water column during planktonic stages and on the seafloor as spat, where temperatures span 54 to 64°F (12 to 18°C) and salinities are within 16.9 to 30 ppt (Packer et al. 1999a).

Atlantic sea scallop juveniles are found in benthic marine habitats attached by byssal threads to gravel, pebble, cobble, and shells (NEFMC 2017). Older juveniles lose their byssal attachments and become active swimmers but remain demersal; they prefer habitats with low concentrations of suspended inorganic material for feeding purposes (Packer et al. 1999a; NEFMC 2017). Designated EFH for Atlantic sea scallop juveniles is in depths of 59 to 361 ft (18 to 110 m), where temperatures span 34 to 59°F (1.2 to 15°C) and salinities exceed 25 ppt (Packer et al. 1999a; NEFMC 2017).

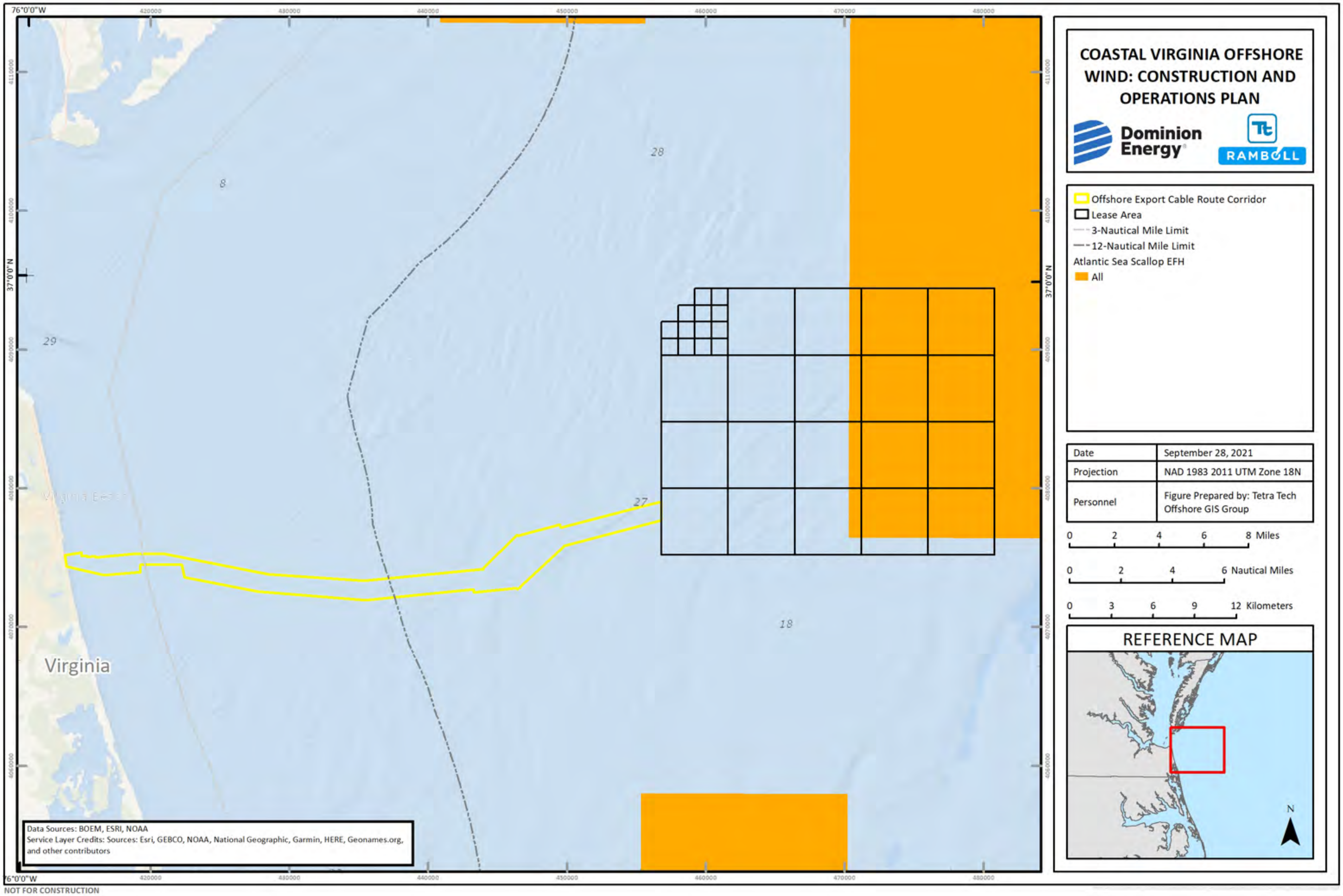

Figure E-1-4. Atlantic Sea Scallop (*Placopecten magellanicus*) Designated EFH in the Offshore Project Area

Atlantic sea scallop adults are found in benthic marine habitats on coarse sand and gravel substrates containing shell fragments, often aggregating in beds; oceanographic features may impact scallop bed duration by increasing larval retention or dispersion (NEFMC 2017). They prefer habitats with low concentrations of suspended inorganic material for feeding purposes (Packer et al. 1999a). Designated EFH for Atlantic sea scallop adults is in depths of 59 to 361 ft (18 to 110 m), where temperatures span 50 to 59°F (10 to 15°C) and salinities are within 32 to 33 ppt (Packer et al. 1999a; NEFMC 2017).

The Atlantic sea scallop is managed under the NEFMC Atlantic Sea Scallop FMP as a single stock: the Northwestern Atlantic Coast stock. The fishery stock is not currently overfished or subject to overfishing (NOAA Fisheries 2019).

E-1.2.4 Clearnose Skate (*Raja eglanteria*)

No clearnose skate egg EFH is designated in the Offshore Project Area; no larval stage exists for skates.

Clearnose skate juvenile EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-5; Figure E-1-5). In the Mid-Atlantic Bight, clearnose skate juveniles are found in subtidal benthic marine habitats in coastal and inner continental shelf waters and in the high salinity zones of regional bays and estuaries (NEFMC 2017). They prefer mud and sand but may also be found on gravel and hardbottom substrates (NEFMC 2017). Juveniles feed on polychaetes, amphipods, mantis and mysid shrimps, and a variety of small crabs, squids, and fishes (e.g., sole, weakfish, butterfish, scup) (Packer et al. 2003a). Designated EFH for clearnose skate juveniles is benthic habitats from the shoreline to depths of 984 ft (300 m) during spring and 262 ft (80 m) during fall, where temperatures span 39 to 70°F (4 to 21°C) in spring and 45 to 81°F (7 to 27°C) in fall and salinities are within 26 to 36 ppt (Packer et al. 2003a).

Table E-1-5. Clearnose Skate (*Raja eglanteria*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Juvenile	109,609	14,234	1,652
Adult	112,799	14,234	1,652
Percent of Project Area Covered by EFH by Life Stage			
Juvenile	97.2%	100.0%	100.0%
Adult	100.0%	100.0%	100.0%
Percent of Total Species EFH Area Covered by Project Area			
Juvenile	0.516%	0.067%	0.008%
Adult	0.682%	0.086%	0.010%

Sources: Packer et al. 2003a; NEFMC 2017

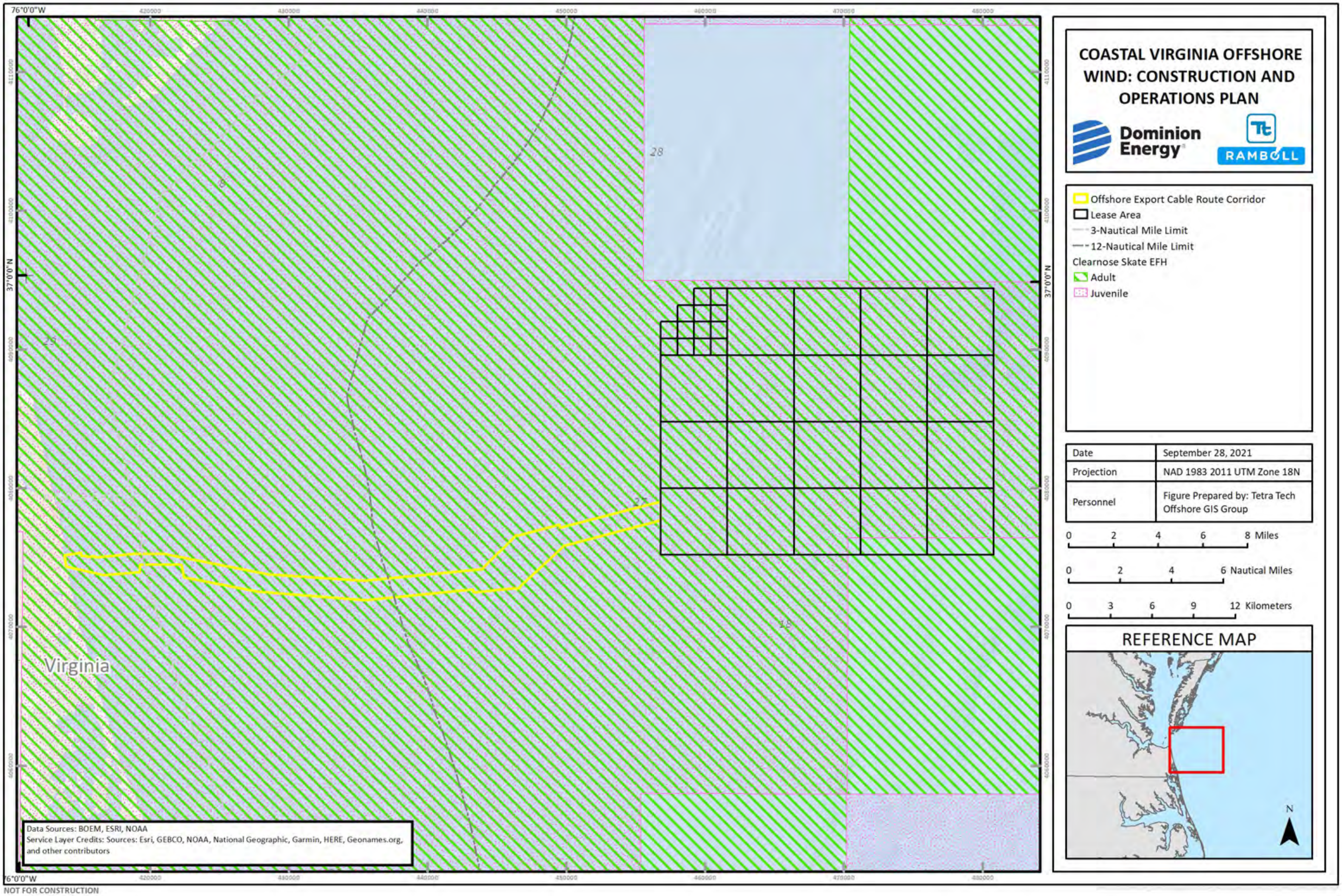

Figure E-1-5. Clearnose Skate (*Raja eglanteria*) Designated EFH in the Offshore Project Area

Clearnose skate adult EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-5; Figure E-1-5). Clearnose skate adults are found in subtidal benthic marine habitats in coastal and inner continental shelf waters and in the high salinity zones of regional bays and estuaries (NEFMC 2017). They prefer mud and sand but may also be found on gravel and hardbottom substrates (NEFMC 2017). Adults consume the same prey as juveniles. Designated EFH for clearnose skate adults is in benthic habitats from the shoreline to depths of 984 ft (300 m) during spring and 164 ft (50 m) during fall, where temperatures span 39 to 72°F (4 to 22°C) in spring and 50 to 77°F (10 to 25°C) in fall and salinities are within 26 to 36 ppt (Packer et al. 2003a).

The clearnose skate is managed under the NEFMC Northeast Skate Complex FMP as a single stock: the Southern New England/Mid-Atlantic stock. The fishery stock is not currently overfished or subject to overfishing (NOAA Fisheries 2019).

E-1.2.5 Monkfish (*Lophius americanus*)

Monkfish egg EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-6; Figure E-1-6). In the Mid-Atlantic Bight, monkfish eggs are shed in large, buoyant mucoidal egg veils that float on or near the surface in pelagic marine habitats of inshore areas and on the continental shelf and slope (NEFMC 2017). Designated EFH for monkfish eggs spans March to September from the surface to depths of 3,280 ft (1,000 m), where temperatures span 39 to 64°F (4 to 18°C) (Steimle et al. 1999a; MAFMC 2017; NEFMC 2017).

Table E-1-6. Monkfish (*Lophius americanus*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Egg/Larva	54,001	13,770	1,652
Juvenile	50,823	0	0
Adult	0	1,656	1,652
Percent of Project Area Covered by EFH by Life Stage			
Egg/Larva	47.9%	96.7%	100.0%
Juvenile	45.1%	0.0%	0.0%
Adult	0.0%	11.7%	100.0%
Percent of Total Species EFH Area Covered by Project Area			
Egg/Larva	0.100%	0.026%	0.003%
Juvenile	0.164%	0.000%	0.000%
Adult	0.000%	0.005%	0.005%

Sources: Steimle et al. 1999a; MAFMC 2017; NEFMC 2017

Monkfish larva EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-6; Figure E-1-6). Monkfish larvae are found in pelagic marine habitats in inshore areas and on the continental shelf and slope (NEFMC 2017). As with eggs, larvae occur over a wide depth range up to a maximum depth of 4,921 ft (1,500 m) (NEFMC 2017). They feed on zooplankton, including copepods, crustacean larvae, and chaetognaths (Steimle et al. 1999a). Designated EFH for monkfish larvae spans March to September from the surface to depths of 3,280 ft (1,000 m), where temperatures span 43 to 68°F (6 to 20°C) (Steimle et al. 1999a; MAFMC 2017; NEFMC 2017).

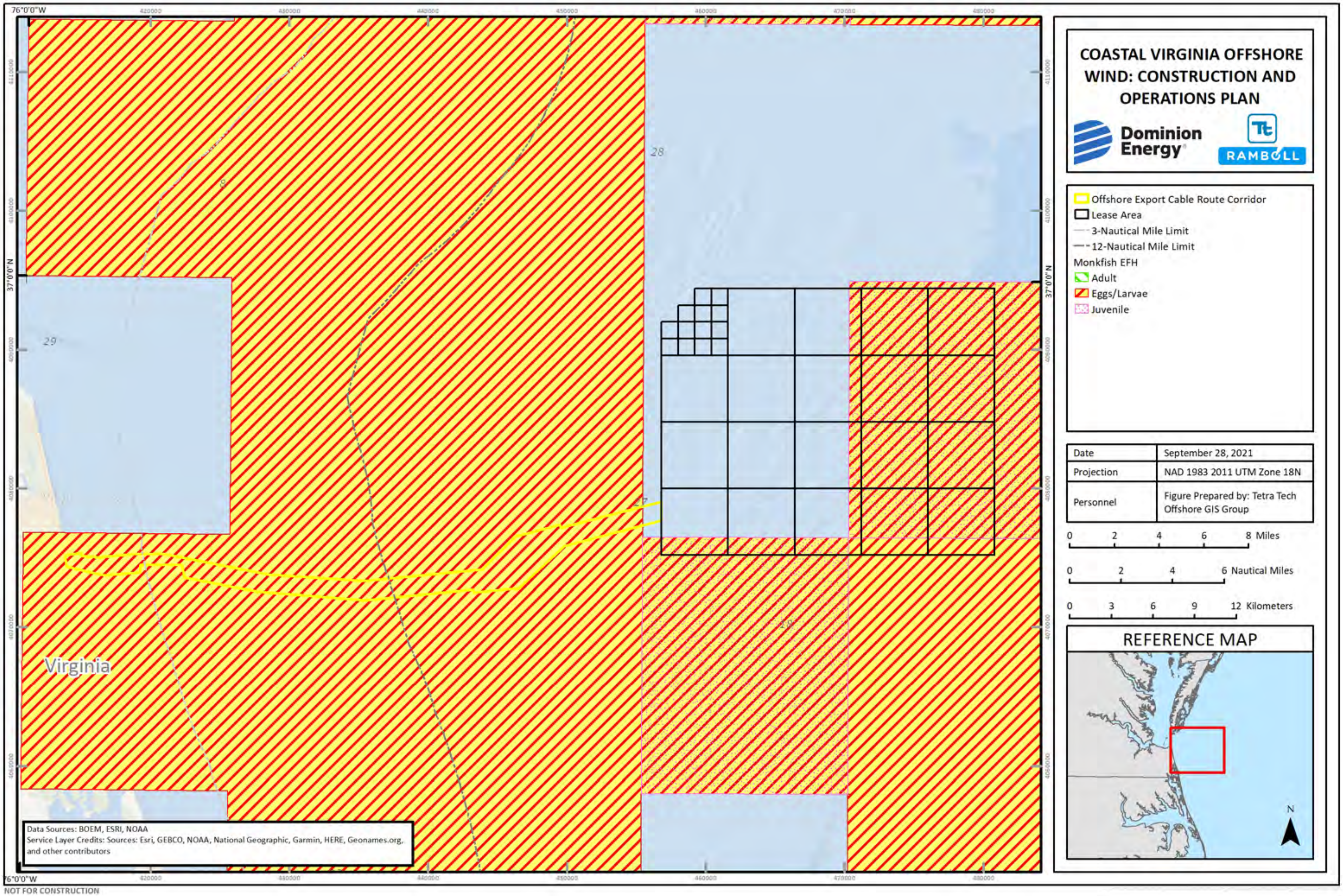

Figure E-1-6. Monkfish (*Lophius americanus*) Designated EFH in the Offshore Project Area

Monkfish juvenile EFH is designated in the Lease Area (Table E-1-6; Figure E-1-6). Monkfish juveniles are found in subtidal benthic marine habitats over a range of substrates, including soft mud, sand, gravel, pebbles, shell fragments, and structurally complex rock outcroppings with attached macroalgae (NEFMC 2017). They exhibit seasonal inshore-offshore migrations but most commonly occur on the outer shelf down to a maximum depth of 3,280 ft (1,000 m) (Steimle et al. 1999a; NEFMC 2017). Juveniles feed on small fishes (e.g., sand lance), red shrimp, and squid (Steimle et al. 1999a). Designated EFH for monkfish juveniles is in benthic habitats in depths of 66 to 1,312 ft (20 to 400 m), where temperatures span 36 to 75°F (2 to 24°C) and salinities are within 30 to 36 ppt (Steimle et al. 1999a).

Monkfish adult EFH is designated in both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-6; Figure E-1-6). Monkfish adults are found in subtidal benthic marine habitats over a range of substrates, including soft mud, sand, gravel, pebbles, and shell fragments (NEFMC 2017). They prefer soft sediments, forage at the edges of structurally complex rock outcroppings, and most commonly occur on the outer shelf down to a maximum depth of 3,280 ft (1,000 m) (NEFMC 2017). Adults are opportunistic feeders and consume a variety of benthic and pelagic crustaceans, squid, and fishes (Steimle et al. 1999a). Designated EFH for monkfish adults is in benthic habitats from the shoreline to depths of 2,625 ft (800 m), where temperatures span 32 to 75°F (0 to 24°C) and salinities are within 30 to 36 ppt (Steimle et al. 1999a).

The monkfish is co-managed by the NEFMC and MAFMC under the Monkfish FMP as two separate stocks: the Gulf of Maine/Northern Georges Bank stock and the Southern Georges Bank/Mid-Atlantic stock. Neither stock is currently overfished or subject to overfishing (NOAA Fisheries 2019).

E-1.2.6 Pollock (*Pollachius virens*)

No pollock egg, juvenile, or adult EFH is designated in the Offshore Project Area.

Pollock larva EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-7; Figure E-1-7). In the Mid-Atlantic Bight, pollock larvae are found in pelagic inshore and offshore marine habitats and in the high salinity zones of regional bays and estuaries (NEFMC 2017). The planktonic larval stage lasts approximately three to four months, during which time they are dispersed from spawning grounds by currents; youngest larvae are found nearest the surface (Cargnelli et al. 1999a). Young larvae feed primarily on larval copepods and shift their diets to adult copepods as they increase in size (Cargnelli et al. 1999a). Large larvae metamorphose into harbor pollock and migrate inshore to rocky subtidal and intertidal zones (Cargnelli et al. 1999a). Designated EFH for pollock larvae is in depths of 33 to 4,101 ft (10 to 1,250 m), where temperatures span 36 to 63°F (2 to 17°C) (Cargnelli et al. 1999a).

Table E-1-7. Pollock (*Pollachius virens*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Larva	7,387	5,032	0
Percent of Project Area Covered by EFH by Life Stage			
Larva	6.5%	35.4%	0.0%
Percent of Total Species EFH Area Covered by Project Area			
Larva	0.038%	0.026%	0.000%

Sources: Cargnelli et al. 1999a; NEFMC 2017

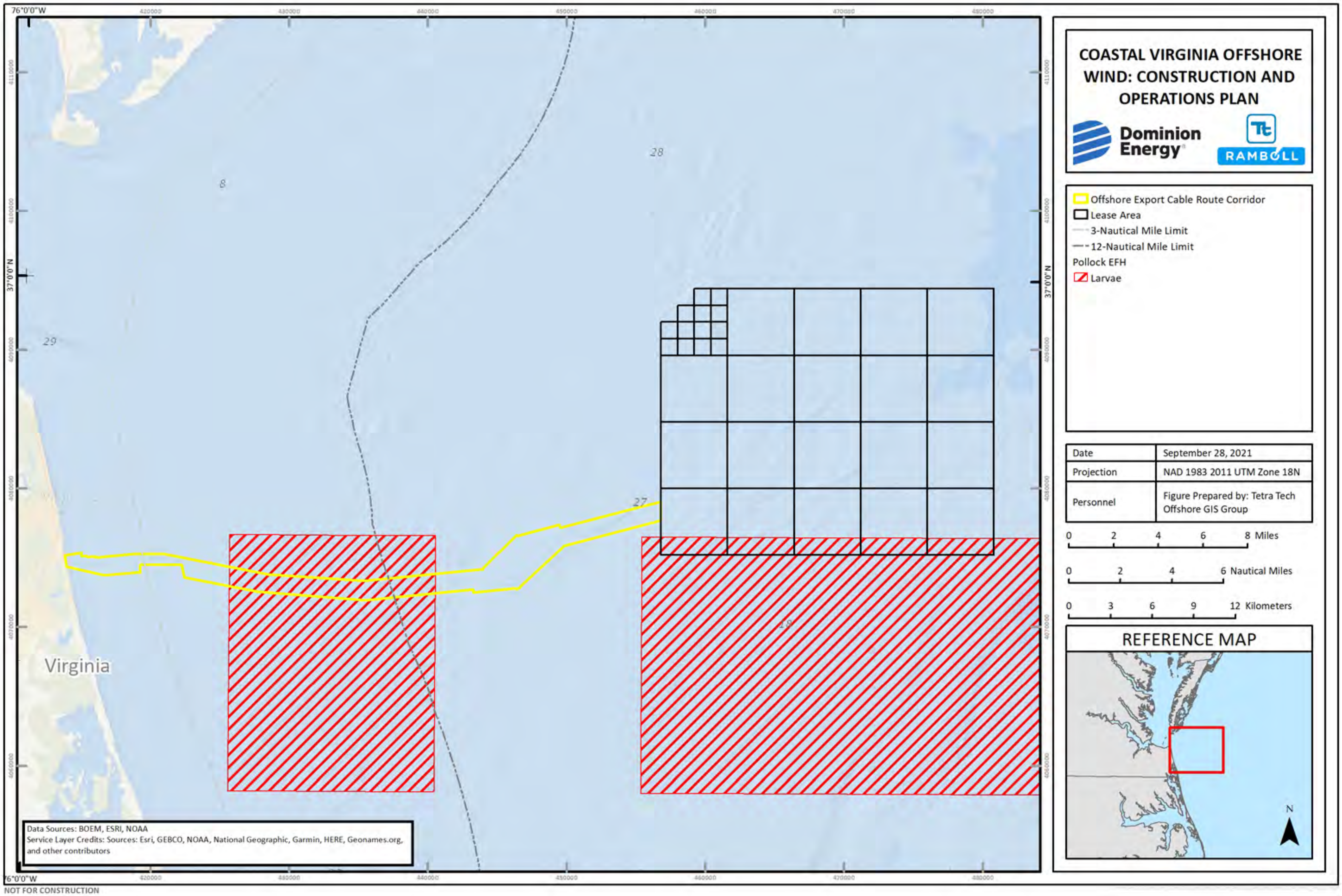

Figure E-1-7. Pollock (*Pollachius virens*) Designated EFH in the Offshore Project Area

The pollock is managed under the NEFMC Northeast Multispecies FMP as a single stock: the Gulf of Maine/Georges Bank stock. The fishery stock is not currently overfished or subject to overfishing (NOAA Fisheries 2019).

E-1.2.7 Red Hake (*Urophycis chuss*)

No red hake egg, larva, or juvenile EFH is designated in the Offshore Project Area.

Red hake adult EFH is designated in the Lease Area (Table E-1-8; Figure E-1-8). In the Mid-Atlantic Bight, red hake adults are found in benthic marine habitats on the outer continental shelf and slope and in high salinity zones of regional bays and estuaries (NEFMC 2017). Adults prefer depressions of soft mud and sand substrates, shell beds, and complex reef structure (NEFMC 2017). They exhibit seasonal migrations, preferring inshore waters in spring and fall and offshore waters in summer and winter. Adults feed on crustaceans and a variety of demersal and pelagic fishes and squids (Steimle et al. 1999b). Designated EFH for red hake adults is benthic habitat in depths of 16 to 2,461 ft (5 to 750 m), where temperatures span 36 to 72°F (2 to 22°C) and salinities exceed 20 ppt (Steimle et al. 1999b).

Table E-1-8. Red Hake (*Urophycis chuss*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Adult	7,504	0	0
Percent of Project Area Covered by EFH by Life Stage			
Adult	6.7%	0.0%	0.0%
Percent of Total Species EFH Area Covered by Project Area			
Adult	0.013%	0.000%	0.000%

Sources: Steimle et al. 1999b; NEFMC 2017

The red hake is managed under the NEFMC Northeast Multispecies FMP as a single stock: the Southern Georges Bank/Mid-Atlantic stock. The fishery stock is currently overfished and subject to overfishing (NOAA Fisheries 2019).

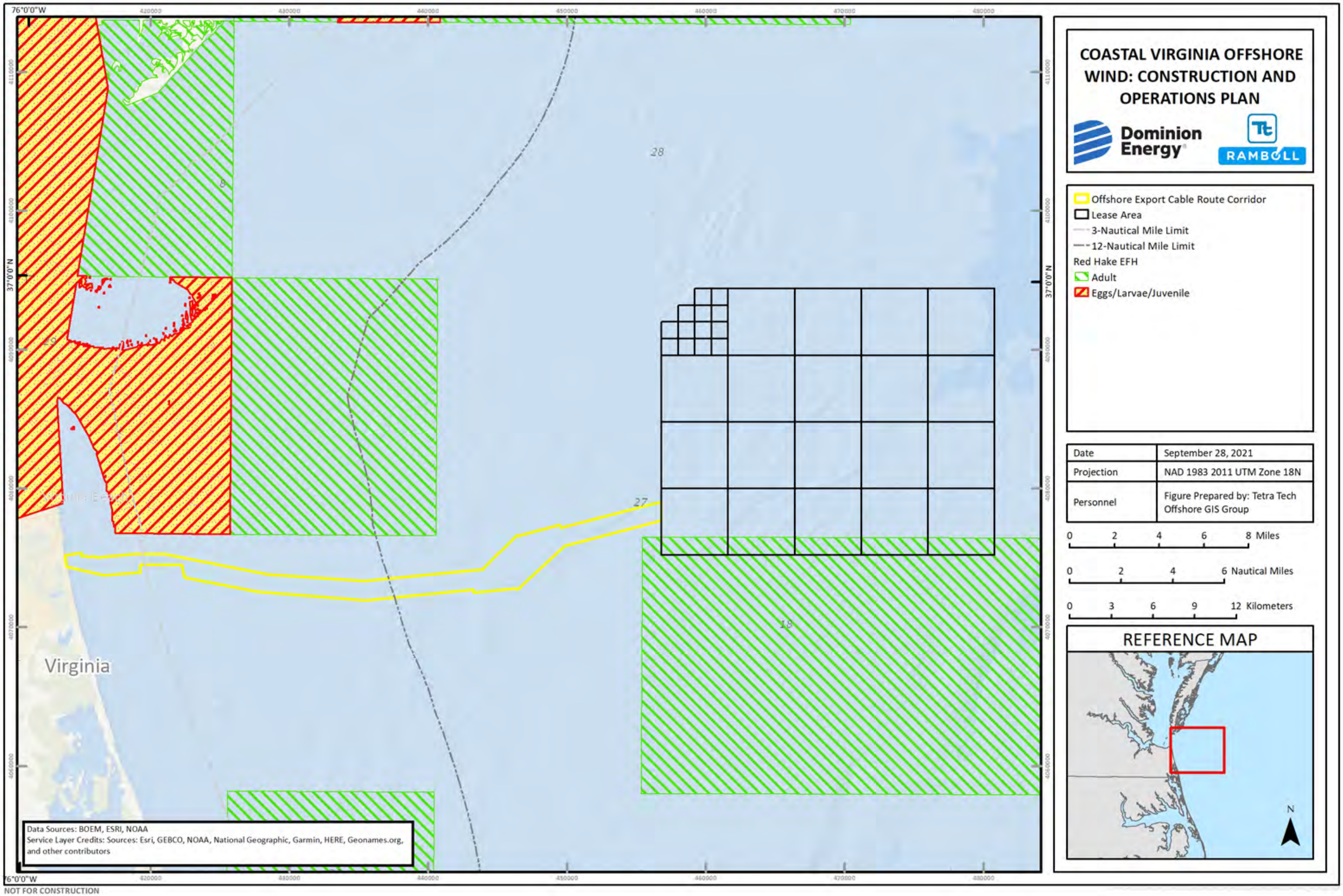

Figure E-1-8. Red Hake (*Urophycis chuss*) Designated EFH in the Offshore Project Area

E-1.2.8 Windowpane Flounder (*Scophthalmus aquosus*)

Windowpane flounder egg EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-9; Figure E-1-9). In the Mid-Atlantic Bight, windowpane flounder eggs are found in pelagic marine habitats and in mixed and high salinity zones of regional bays and estuaries (NEFMC 2017). Designated EFH for windowpane flounder eggs is pelagic habitat in the upper 230 ft (70 m) of the water column, where temperatures span 43 to 57°F (6 to 14°C) in spring, 50 to 61°F (10 to 16°C) in summer, and 57 to 68°F (14 to 20°C) in fall (Chang et al. 1999).

Table E-1-9. Windowpane flounder (*Scophthalmus aquosus*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Egg	50,823	13,770	1,652
Larva	109,623	7,565	0
Juvenile	108,587	14,234	1,652
Adult	111,403	12,575	0
Percent of Project Area Covered by EFH by Life Stage			
Egg	45.1%	97.7%	100.0%
Larva	97.2%	53.1%	0.0%
Juvenile	96.3%	100.0%	100.0%
Adult	98.8%	88.3%	0.0%
Percent of Total Species EFH Area Covered by Project Area			
Egg	0.234%	0.063%	0.008%
Larva	0.473%	0.033%	0.000%
Juvenile	0.276%	0.036%	0.004%
Adult	0.297%	0.034%	0.000%

Sources: Chang et al. 1999; NEFMC 2017

Windowpane flounder larva EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-9; Figure E-1-9). Windowpane flounder larvae are found in pelagic marine habitats and in mixed and high salinity zones of regional bays and estuaries; they consume planktonic prey (NEFMC 2017). Larvae descend to the seafloor upon reaching 0.4 inches (10 millimeters) in length; spring-spawned larvae settle in estuaries and on the shelf, while autumn-spawned larvae primarily settle on the shelf (Chang et al. 1999). Designated EFH for windowpane flounder larvae is pelagic habitat in the upper 230 ft (70 m) of the water column, where temperatures span 37 to 57°F (3 to 14°C) in spring, 50 to 63°F (10 to 17°C) in summer, and 55 to 66°F (13 to 19°C) in fall (Chang et al. 1999).

Windowpane flounder juvenile EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-9; Figure E-1-9). Windowpane flounder juveniles are found in intertidal and subtidal benthic habitats in estuarine, coastal marine, and continental shelf waters, including mixed and high salinity zones in regional bays and estuaries (NEFMC 2017). YOY prefer sand substrates, while older juveniles occur on both mud and sand substrates (NEFMC 2017). They feed on small crustaceans (e.g., mysid and decapod shrimps) and fish larvae (e.g., hakes, cod, and other windowpane flounders) (Chang et al. 1999). Designated EFH for windowpane flounder juveniles is benthic habitat in nearshore bays and estuaries from the shoreline to depths of 246 ft (75 m), where temperatures span 32 to 75°F (0 to 24°C) and salinities are within 15 to 33 ppt (Chang et al. 1999).

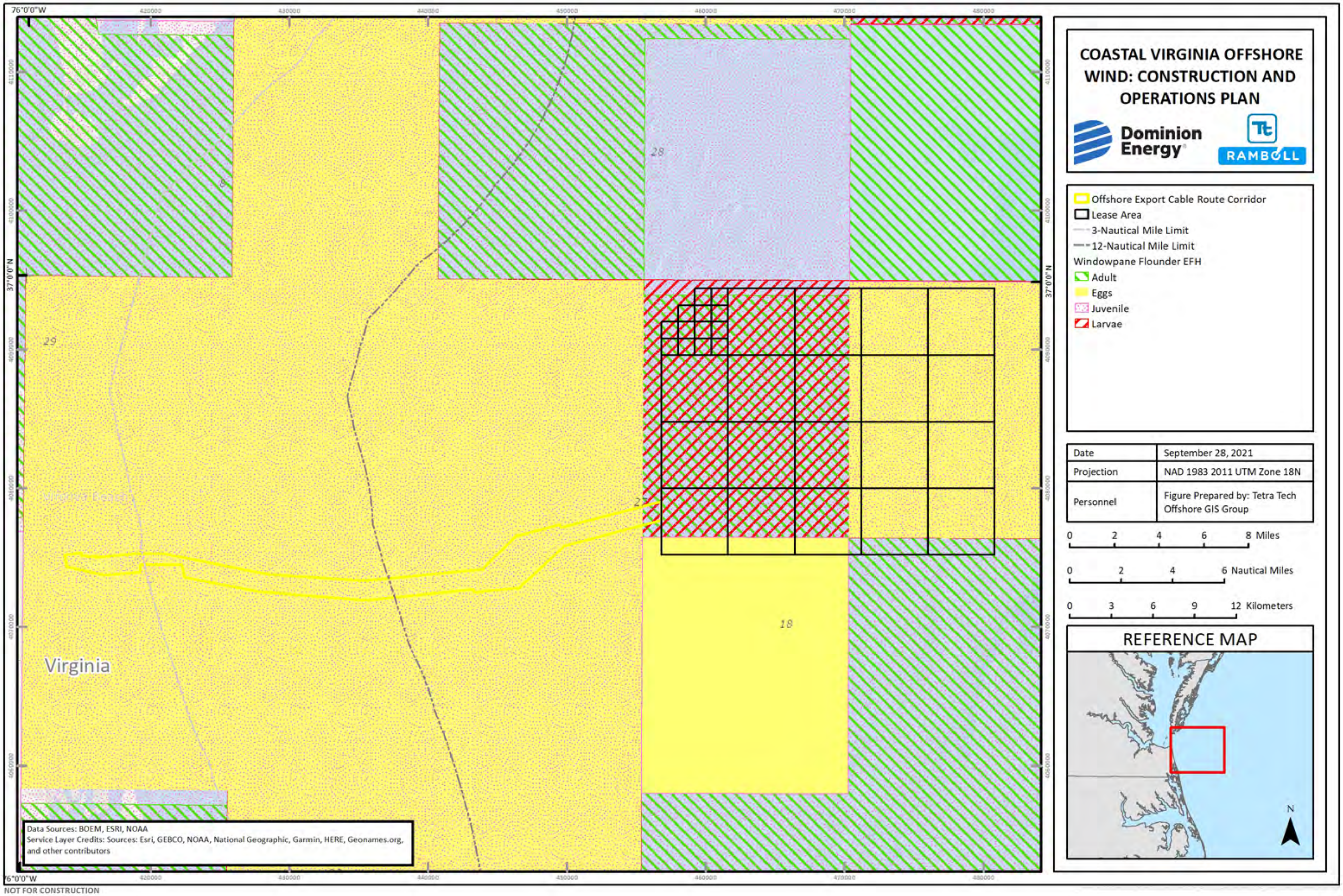

Figure E-1-9. Windowpane flounder (*Scophthalmus aquosus*) Designated EFH in the Offshore Project Area

Windowpane flounder adult EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-9; Figure E-1-9). Windowpane flounder adults are found in intertidal and subtidal benthic habitats in estuarine, coastal marine, and continental shelf waters, including mixed and high salinity zones in regional bays and estuaries (NEFMC 2017). Adults prefer mud and sand substrates (NEFMC 2017). They consume the same prey as juveniles. Designated EFH for windowpane flounder adults is benthic habitat in nearshore bays and estuaries from the shoreline to depths of 246 ft (75 m), where temperatures span 32 to 75°F (0 to 24°C) and salinities are within 15 to 33 ppt (Chang et al. 1999).

The windowpane flounder is managed under the NEFMC Northeast Multispecies FMP as two separate stocks: the Gulf of Maine/Georges Bank stock and the Southern New England/Mid-Atlantic stock. While the Southern New England/Mid-Atlantic stock is not overfished, the Gulf of Maine/Georges Bank stock is currently overfished; neither stock is subject to overfishing (NOAA Fisheries 2019).

E-1.2.9 Winter Skate (*Leucoraja ocellata*)

No winter skate egg or adult EFH is designated in the Offshore Project Area; there is no larval stage for skates.

Winter skate juvenile EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-10; Figure E-1-10). In the Mid-Atlantic Bight, winter skate juveniles are found in subtidal benthic marine habitats on the continental shelf and in the high salinity zones of regional bays and estuaries (NEFMC 2017). Juveniles reside in sediment depressions during the day (primarily on sand and gravel substrates, but occasionally on mud substrates) and are more active at night (Packer et al. 2003b; NEFMC 2017). They feed on polychaetes, amphipods, decapods, isopods, bivalves, and fishes (Packer et al. 2003b). Designated EFH for winter skate juveniles is benthic habitat from the shoreline to 1,217 ft (371 m), where temperatures span 30 to 66°F (-1.2 to 19°C) and salinities are within 28 to 35 ppt (Packer et al. 2003b).

Table E-1-10. Winter Skate (*Leucoraja ocellata*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Juvenile	46,611	2,068	0
Percent of Project Area Covered by EFH by Life Stage			
Juvenile	41.3%	14.5%	0.0%
Percent of Total Species EFH Area Covered by Project Area			
Juvenile	0.140%	0.006%	0.000%

Sources: Packer et al. 2003b; NEFMC 2017

The winter skate is managed under the NEFMC Northeast Skate Complex as a single stock: the Georges Bank/Southern New England stock. The fishery stock is not currently overfished or subject to overfishing (NOAA Fisheries 2019).

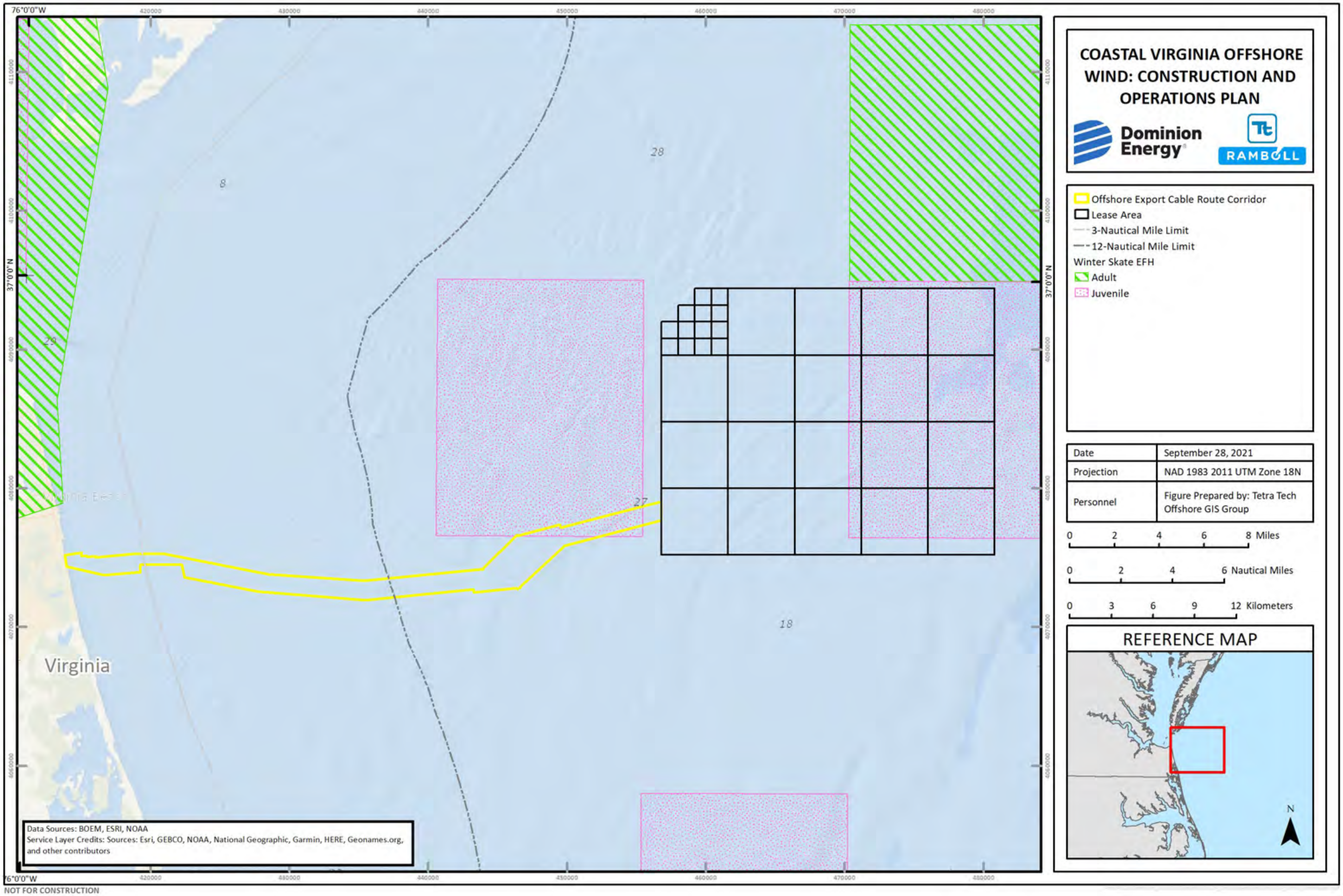

Figure E-1-10. Winter Skate (*Leucoraja ocellata*) Designated EFH in the Offshore Project Area

E-1.2.10 Witch Flounder (*Glyptocephalus cynoglossus*)

Witch flounder egg EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-11; Figure E-1-11). In the Mid-Atlantic Bight, witch flounder eggs are found in pelagic marine habitats on the continental shelf (NEFMC 2017). They are buoyant and often occur near the surface above deep waters but have been found at depths of 16,404 ft (5,000 m). Designated EFH for witch flounder eggs spans March to October in depths of 33 to 558 ft (10 to 170 m), where temperatures range from 39 to 63°F (4 to 17°C) and salinities are high (Cargnelli et al. 1999b).

Table E-1-11. Witch Flounder (*Glyptocephalus cynoglossus*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Egg	50,823	8,759	1,652
Larva	105,324	464	0
Percent of Project Area Covered by EFH by Life Stage			
Egg	45.1%	61.5%	100.0%
Larva	93.4%	3.3%	0.0%
Percent of Total Species EFH Area Covered by Project Area			
Egg	0.369%	0.064%	0.012%
Larva	0.617%	0.003%	0.000%

Sources: Cargnelli et al. 1999b; NEFMC 2017

Witch flounder larva EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-11; Figure E-1-11). Witch flounder larvae are found in pelagic marine habitats on the continental shelf; they feed on planktonic prey (NEFMC 2017). Larvae undergo extended planktonic stages from four months to one year, during which time smaller larvae are found near the surface and sink to lower depths as they increase in size (Cargnelli et al. 1999b). Designated EFH for witch flounder larvae is in the upper 820 ft (250 m) of the water column, where temperatures span 39 to 61°F (4 to 16°C) and salinities are high (Cargnelli et al. 1999b).

No witch flounder juvenile or adult EFH is designated in the Offshore Project Area.

The witch flounder is managed by the NEFMC Northeast Multispecies FMP as a single stock: the Northwestern Atlantic Coast stock. The fishery stock is overfished but is not currently subject to overfishing (NOAA Fisheries 2019).

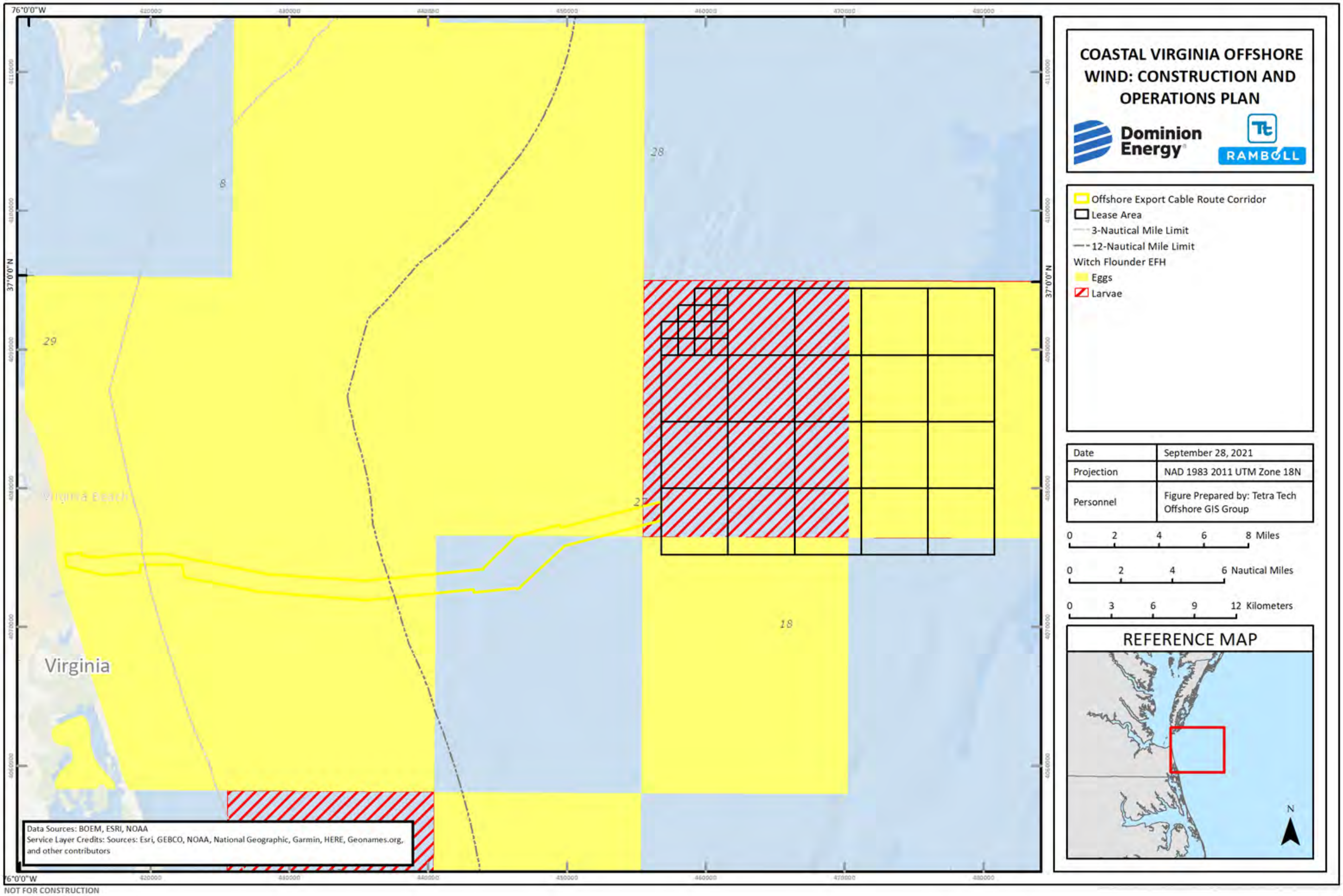

Figure E-1-11. Witch Flounder (*Glyptocephalus cynoglossus*) Designated EFH in the Offshore Project Area

E-1.2.11 Yellowtail Flounder (*Limanda ferruginea*)

No yellowtail flounder egg, juvenile, or adult EFH is designated in the Offshore Project Area.

Yellowtail flounder larva EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-12; Figure E-1-12). In the Mid-Atlantic Bight, yellowtail flounder larvae are found in coastal and continental shelf pelagic marine habitats and in the high salinity zones of regional bays and estuaries; they feed on planktonic prey (NEFMC 2017). Larvae complete diel migrations and exhibit a vertical abundance peak at 33 ft (10 m) at night and 66 ft (20 m) during daytime (Johnson et al. 1999). They are planktonic until they reach approximately 0.5 to 0.7 inches (12 to 16 millimeters) in length, at which point they descend to the seafloor and metamorphose into juveniles (Johnson et al. 1999). Designated EFH for yellowtail flounder larvae is in depths of 33 to 2,460 ft (10 to 1,250 m), where temperatures span 41 to 63°F (5 to 17°C) and salinities are within 32 to 34 ppt (Johnson et al. 1999).

Table E-1-12. Yellowtail Flounder (*Limanda ferruginea*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Larva	4,211	2,068	0
Percent of Project Area Covered by EFH by Life Stage			
Larva	3.7%	14.5%	0.0%
Percent of Total Species EFH Area Covered by Project Area			
Larva	0.022%	0.011%	0.000%

Sources: Johnson et al. 1999; NEFMC 2017

The yellowtail flounder is managed under the NEFMC Northeast Multispecies FMP as two separate stocks: the Cape Cod/Gulf of Maine stock and the Southern New England/Mid-Atlantic stock. The Southern New England/Mid-Atlantic stock is overfished, and the Cape Cod/Gulf of Maine stock is rebuilding; neither stock is currently subject to overfishing (NOAA Fisheries 2019).

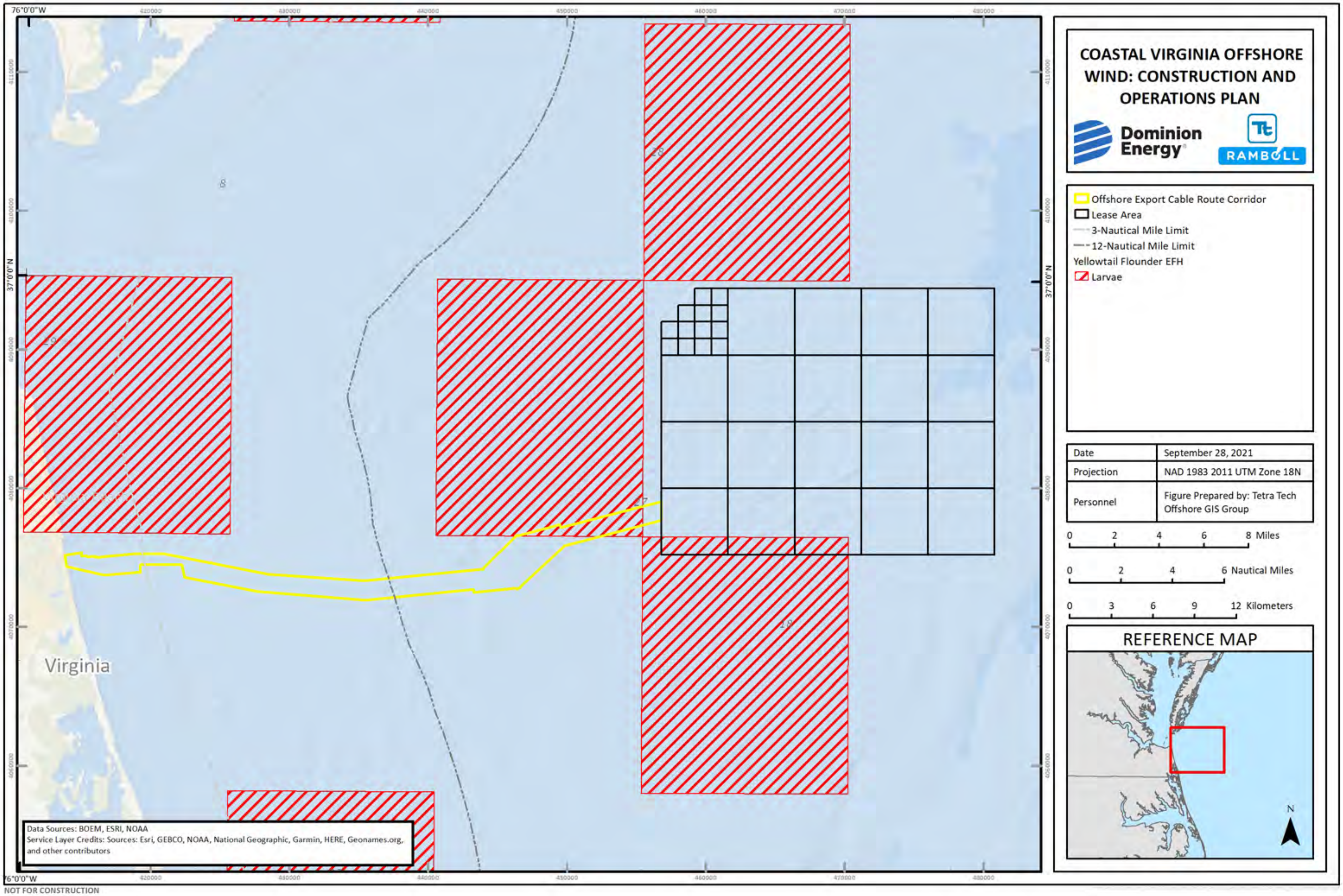

Figure E-1-12. Yellowtail Flounder (*Limanda ferruginea*) Designated EFH in the Offshore Project Area

E-1.2.12 Atlantic Butterfish (*Peprilus triacanthus*)

Atlantic butterfish egg EFH is designated in federal waters of the Offshore Export Cable Route Corridor (Table E-1-13; Figure E-1-13). In the Mid-Atlantic Bight, Atlantic butterfish eggs are found in pelagic marine habitats on the continental shelf and slope and in the high salinity zones of inshore estuaries and embayments (MAFMC 2011). Designated EFH for Atlantic butterfish eggs is in the upper 656 ft (200 m) of the water column over depths of 4,921 ft (1,500 m), where temperatures span 43 to 79°F (6 to 26°C) and salinities are within 25 to 33 ppt (Cross et al. 1999; MAFMC 2011).

Table E-1-13. Atlantic Butterfish (*Peprilus triacanthus*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Egg	0	2,066	0
Larva	49,785	0	0
Juvenile	109,618	14,234	1,646
Adult	4,216	6,691	1,646
Percent of Project Area Covered by EFH by Life Stage			
Egg	0.0%	14.5%	0.0%
Larva	44.1%	0.0%	0.0%
Juvenile	97.2%	100.0%	99.6%
Adult	3.7%	47.0%	99.6%
Percent of Total Species EFH Area Covered by Project Area			
Egg	0.000%	0.011%	0.000%
Larva	0.213%	0.000%	0.000%
Juvenile	0.278%	0.036%	0.004%
Adult	0.010%	0.015%	0.004%

Sources: Cross et al. 1999; MAFMC 2011

Atlantic butterfish larva EFH is designated in the Lease Area (Table E-1-13; Figure E-1-13). Atlantic butterfish larvae are found in pelagic marine habitats on the continental shelf and in the high salinity zones of inshore estuaries and embayments; they feed on planktonic prey (MAFMC 2011). Larvae exhibit diel migrations, occurring in deeper waters during day and migrating to surface waters at night (Cross et al. 1999). Designated EFH for Atlantic butterfish larvae is in the upper 656 ft (200 m) of the water column over depths of 5,741 ft (1,750 m), where temperatures span 45 to 79°F (7 to 26°C) and salinities are within 6 to 38 ppt (Cross et al. 1999; MAFMC 2011).

Atlantic butterfish juvenile EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-13; Figure E-1-13). Atlantic butterfish juveniles are found in pelagic marine habitats in the inner and outer continental shelf and in the high salinity zones of inshore estuaries and embayments (MAFMC 2011). They are common in inshore areas, including the surf zone, and larger individuals are found over sandy and muddy substrates (Cross et al. 1999). Juveniles tolerate a wide range of temperatures and salinities. They feed primarily on pelagic prey including thaliaceans, mollusks, crustaceans, coelenterates, polychaetes, small fishes, and ctenophores (Cross et al. 1999). Designated EFH for Atlantic butterfish juveniles is in depths of 33 to 1,083 ft (10 to 330 m), where temperatures span 45 to 86°F (7 to 30°C) and salinities are within 3 to 37 ppt (Cross et al. 1999; MAFMC 2011).

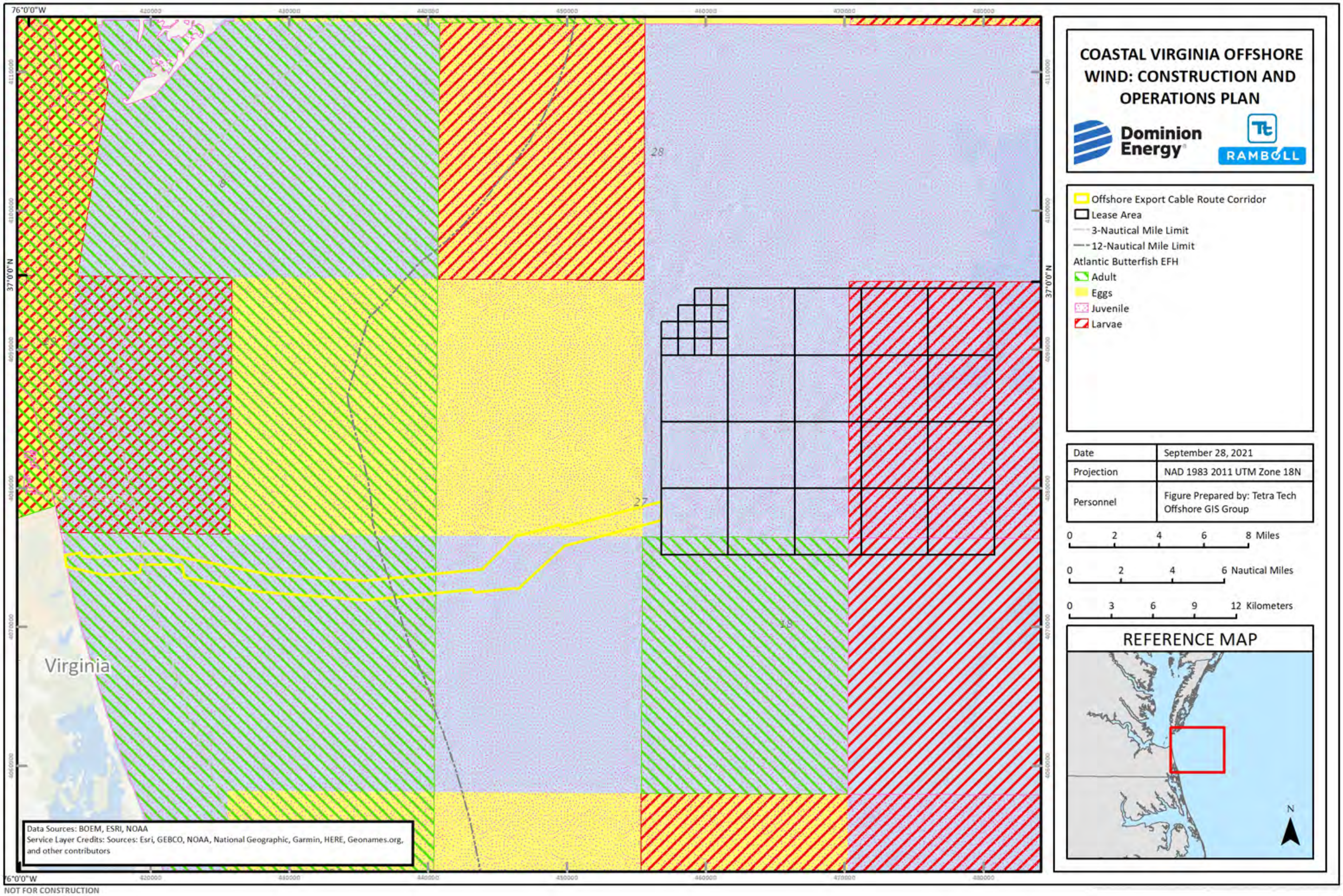

Figure E-1-13. Atlantic Butterfish (*Peprilus triacanthus*) Designated EFH in the Offshore Project Area

Atlantic butterfish adult EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-13; Figure E-1-13). Atlantic butterfish adults are found in pelagic marine habitats on the inner and outer continental shelf and in the high salinity zones of inshore estuaries and embayments (MAFMC 2011). As with juveniles, adults are eurythermal and euryhaline and primarily consume pelagic prey. Designated EFH for Atlantic butterfish adults is from surface waters to depths of 1,378 ft (420 m), where temperatures span 41 to 82°F (5 to 28°C) and salinities are within 4 to 33 ppt (Cross et al. 1999; MAFMC 2011).

The Atlantic butterfish is managed under the MAFMC Atlantic Mackerel, Squid, and Butterfish FMP as a single stock: the Gulf of Maine/Cape Hatteras stock. The fishery stock is not currently overfished or subject to overfishing (NOAA Fisheries 2019).

E-1.2.13 Atlantic Mackerel (*Scomber scombrus*)

Atlantic mackerel egg EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-14; Figure E-1-14). In the Mid-Atlantic Bight, Atlantic mackerel eggs are found in pelagic marine habitats on the continental shelf and in the high salinity zones of inshore estuaries and embayments (MAFMC 2011). Eggs exhibit seasonal variations in depth and generally occur in depths of 33 to 98 ft (10 to 30 m) in April, 98 to 164 ft (30 to 50 m) in May, and 98 to 230 ft (30 to 70 m) in June through August. Designated EFH for Atlantic mackerel eggs is in depths of 33 to 1,066 ft (10 to 325 m), where temperatures span 41 to 73°F (5 to 23°C) in salinities within 25 to 34 ppt (Studholme et al. 1999).

Table E-1-14. Atlantic Mackerel (*Scomber scombrus*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Egg	58,798	464	0
Juvenile	112,799	7,562	0
Adult	112,799	14,234	1,646
Percent of Project Area Covered by EFH by Life Stage			
Egg	52.1%	3.3%	0.0%
Juvenile	100.0%	53.1%	0.0%
Adult	100.0%	100.0%	99.6%
Percent of Total Species EFH Area Covered by Project Area			
Egg	0.353%	0.003%	0.000%
Juvenile	0.356%	0.024%	0.000%
Adult	0.373%	0.047%	0.005%

Sources: Studholme et al. 1999; MAFMC 2011

No Atlantic mackerel larva EFH is designated in the Offshore Project Area.

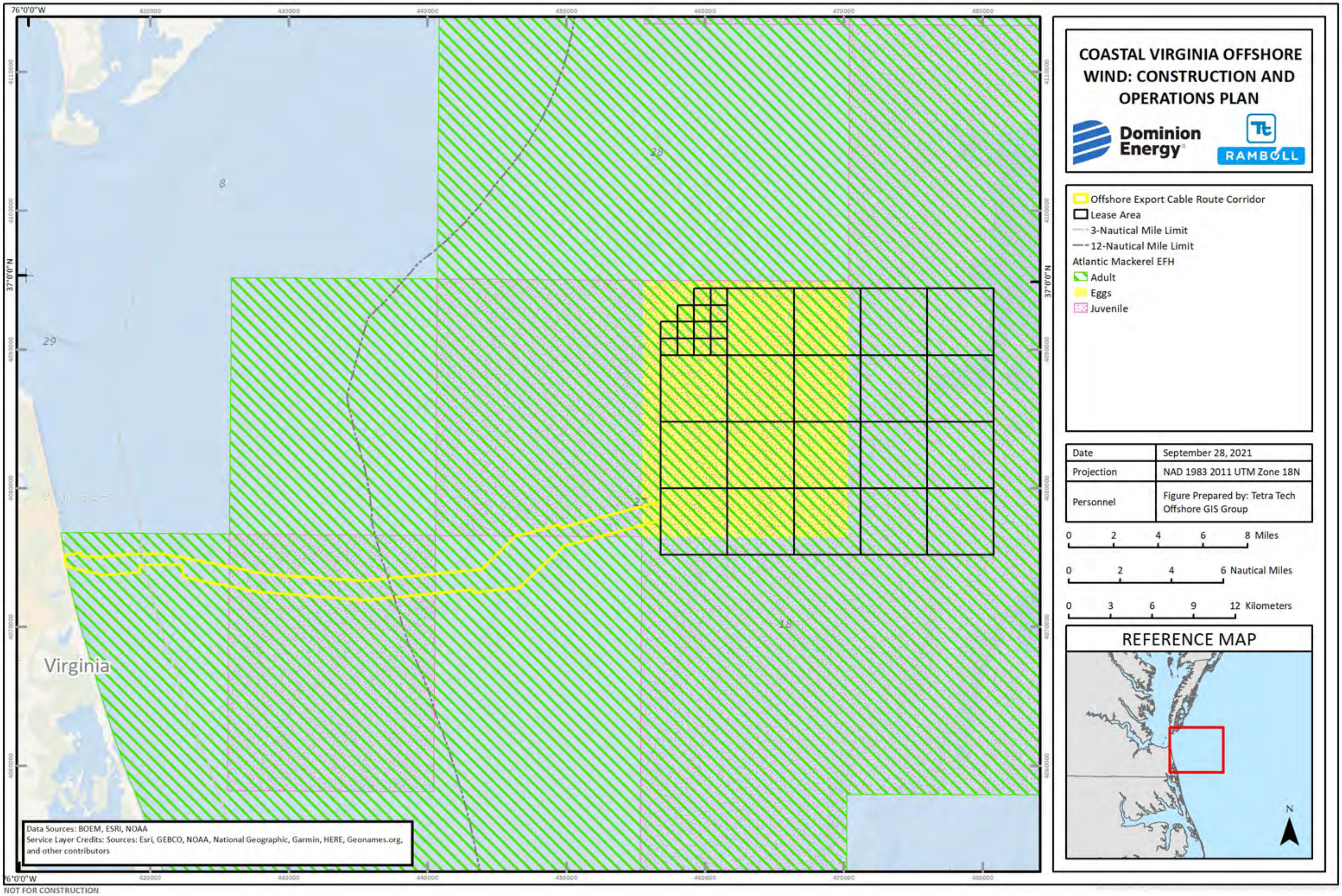

Figure E-1-14. Atlantic Mackerel (*Scomber scombrus*) Designated EFH in the Offshore Project Area

Atlantic mackerel juvenile EFH is designated in the Lease Area and federal of the Offshore Export Cable Route Corridor (Table E-1-14; Figure E-1-14). Atlantic mackerel juveniles are found in pelagic marine habitats on the continental shelf and in the high salinity zones of inshore estuaries and embayments (MAFMC 2011). Juveniles exhibit seasonal variations in depth and generally occur in depths of 66 to 131 ft (20 to 40 m) in fall, 164 to 230 ft (50 to 70 m) in winter, 98 to 295 ft (30 to 90 m) in spring, and 66 to 164 ft (20 to 50 m) in summer (Studholme et al. 1999). They are opportunistic feeders that primarily consume small crustaceans including copepods, amphipods, mysid shrimp, and decapod larvae (Studholme et al. 1999). Designated EFH for Atlantic mackerel juveniles is from surface waters to depths of 1,050 ft (320 m), where temperatures span 39 to 72°F (4 to 22°C) and salinities exceed 25 ppt (Studholme et al. 1999).

Atlantic mackerel adult EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-14; Figure E-1-14). Atlantic mackerel adults are found in pelagic marine habitats on the continental shelf and in the high salinity zones of inshore estuaries and embayments (MAFMC 2011). Adults exhibit seasonal variations in depth and generally occur in depths of 197 to 262 ft (60 to 80 m) in fall, 66 to 98 ft (20 to 30 m) in winter, 197 to 558 ft (60 to 170 m) in spring, and 164 to 230 ft (50 to 70 m) in winter (Studholme et al. 1999). Larger fish are often found at greater depths than smaller adults; distributions may be correlated with prey availability, downwelling events, and onshore advection of warm surface water (Studholme et al. 1999). Adults consume the same general prey as juveniles but consume a wider assortment of organisms and larger prey items (Studholme et al. 1999). Designated EFH for Atlantic mackerel adults in from surface waters to depths of 1,247 ft (380 m), where temperatures span 41 to 61°F (5 to 16°C) and salinities exceed 25 ppt (Studholme et al. 1999).

The Atlantic mackerel is managed under the MAFMC Atlantic Mackerel, Squid, and Butterfish FMP as a single stock: the Gulf of Maine/Cape Hatteras stock. The fishery stock is currently overfished and subject to overfishing (NOAA Fisheries 2019).

E-1.2.14 Atlantic Surfclam (*Spisula solidissima*)

No Atlantic surfclam egg or larva EFH is designated in the Offshore Project Area.

Atlantic surfclam juvenile EFH stages is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-15; Figure E-1-15). In the Mid-Atlantic Bight, Atlantic surfclam juveniles are found in benthic marine habitats throughout the substrate to a depth of 3 ft (1 m) below the water/sediment interface (MAFMC 2017). Planktonic larvae metamorphose to juveniles within 18 to 35 days. Juveniles are planktivorous siphon feeders that consume a variety of diatoms and ciliates (Cargnelli et al. 1999c). Designated EFH for Atlantic surfclam juveniles is benthic habitat in depths of 26 to 217 ft (8 to 66 m), where temperatures span 36 to 86°F (2 to 30°C) and salinities exceed 14 ppt (Cargnelli et al. 1999c).

Table E-1-15. Atlantic Surfclam (*Spisula solidissima*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Juvenile	112,799	12,575	0

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
Adult	112,799	5,477	0
Percent of Project Area Covered by EFH by Life Stage			
Juvenile	100.0%	88.3%	0.0%
Adult	100.0%	38.5%	0.0%
Percent of Total Species EFH Area Covered by Project Area			
Juvenile	0.684%	0.076%	0.000%
Adult	0.838%	0.041%	0.000%

Sources: Cargnelli et al. 1999c; MAFMC 2017

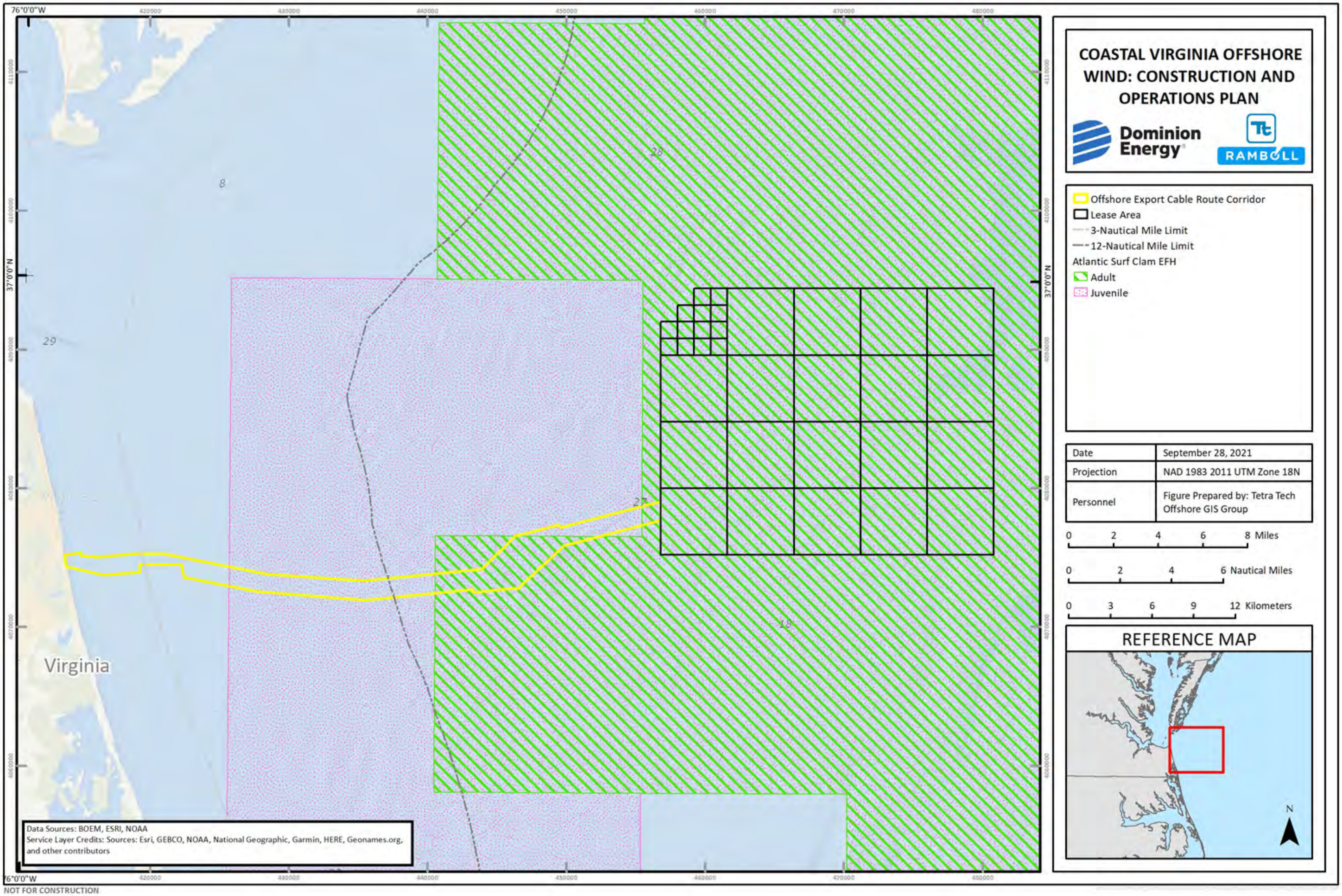

Figure E-1-15. Atlantic Surfclam (*Spisula solidissima*) Designated EFH in the Offshore Project Area

Atlantic surfclam adults are found in benthic marine habitats throughout the substrate to a depth of 3 ft (1 m) below the water/sediment interface (MAFMC 2017). They consume the same planktivorous prey as juveniles. Designated EFH for Atlantic surfclam juveniles is benthic habitat in depths of 26 to 217 ft (8 to 66 m), where temperatures span 36 to 86°F (2 to 30°C) and salinities exceed 14 ppt (Cargnelli et al. 1999c).

The Atlantic surfclam is managed under the MAFMC Atlantic Surfclam and Ocean Quahog FMP as a single stock: the Mid-Atlantic Coast stock. The fishery stock is not currently overfished or subject to overfishing (NOAA Fisheries 2019).

E-1.2.15 Black Sea Bass (*Centropristis striata*)

No black sea bass egg EFH is designated in the Offshore Project Area.

Black sea bass larva EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-16; Figure E-1-16). In the Mid-Atlantic Bight, black sea bass larvae are found in pelagic marine habitat over the continental shelf and in the mixed to high salinity zones of regional estuaries (MAFMC 1998a). They primarily feed on decapods (Drohan et al. 2007). Larvae typically transform into juveniles in nearshore habitats. Designated EFH for black sea bass larvae is in the upper 328 ft (100 m) of the water column over depths of 6,562 ft (2,000 m), where temperatures span 52 to 79°F (11 to 26°C) and salinities are within 30 to 35 ppt (Steimle et al. 1999c; Drohan et al. 2007; MAFMC 2017).

Table E-1-16. Black Sea Bass (*Centropristis striata*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Larva	54,001	7,098	0
Juvenile	112,799	14,234	1,652
Adult	112,799	14,234	1,652
Percent of Project Area Covered by EFH by Life Stage			
Larva	47.9%	49.9%	0.0%
Juvenile	100.0%	100.0%	100.0%
Adult	100.0%	100.0%	100.0%
Percent of Total Species EFH Area Covered by Project Area			
Larva	0.679%	0.089%	0.000%
Juvenile	0.405%	0.051%	0.006%
Adult	0.428%	0.054%	0.006%

Sources: MAFMC 1998a; Steimle et al. 1999c; Drohan et al. 2007; MAFMC 2017

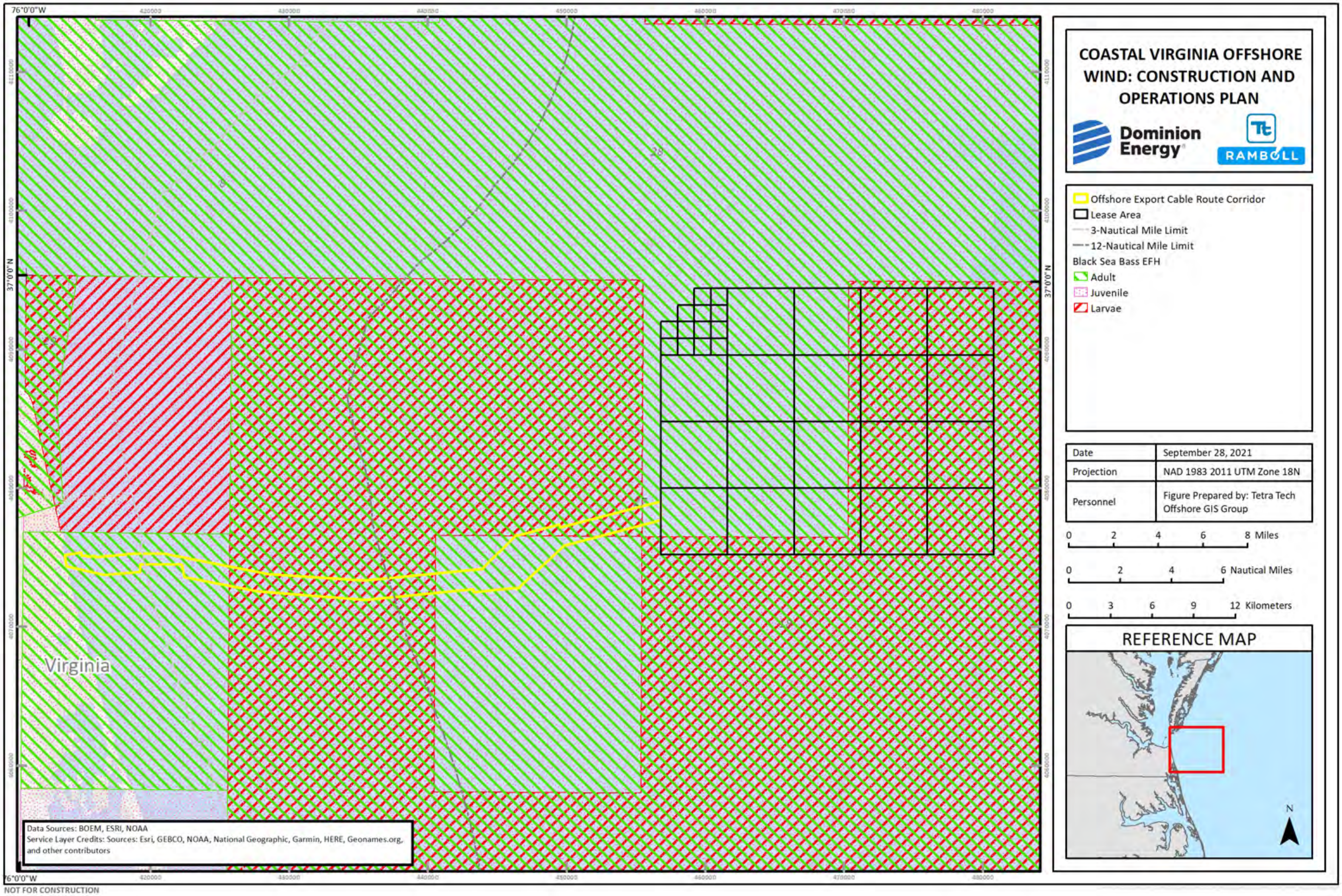

Figure E-1-16. Black Sea Bass (*Centropristis striata*) Designated EFH in the Offshore Project Area

Black sea bass adult EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-16; Figure E-1-16). Black sea bass adults are found in benthic marine habitats over the continental shelf and in the mixed and high salinity zones of regional estuaries (MAFMC 1998a). Adults generally summer in estuaries and coastal waters in depths of 125 ft (38 m) and overwinter offshore in deeper waters (MAFMC 1998a). They are generalist carnivores that feed on a variety of infaunal and epibenthic invertebrates, especially crustaceans, small fishes, and squid (Drohan et al. 2007). They exhibit high site fidelity and preference for structurally complex substrates, sand with shell hash, and artificial reefs (MAFMC 2017). Designated EFH for black sea bass adults is 66 to 1,312 ft (20 to 400 m), where temperatures span 43 to 81°F (6 to 27°C) and salinities are within 30 to 36 ppt (MAFMC 1998a; Drohan et al. 2007; MAFMC 2017).

The black sea bass is managed under the MAFMC Summer Flounder, Scup, and Black Sea Bass FMP as a single stock: the Mid-Atlantic Coast stock. The fishery stock is not currently overfished or subject to overfishing (NOAA Fisheries 2019).

E-1.2.16 Bluefish (*Pomatomus saltatrix*)

Bluefish egg EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-17; Figure E-1-17). In the Mid-Atlantic Bight, bluefish eggs are found in pelagic marine habitats over the continental shelf (MAFMC 1998b). Surface currents transport eggs south and offshore (Shephard and Packer 2006). The prolonged bluefish spawning season is attributed to at least three separate cohorts of bluefish that spawn independently in spring, summer, and fall. Designated EFH for bluefish eggs is in depths of 98 to 230 ft (30 to 70 m), where temperatures span 64 to 72°F (18 to 22°C) and salinities exceed 26 ppt (Fahay et al. 1999b; Shepherd and Packer 2006).

Table E-1-17. Bluefish (*Pomatomus saltatrix*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Egg	50,823	2,068	0
Larva	54,000	2,068	0
Juvenile	58,798	14,234	1,646
Adult	0	13,770	1,646
Percent of Project Area Covered by EFH by Life Stage			
Egg	45.1%	14.5%	0.0%
Larva	47.9%	14.5%	0.0%
Juvenile	52.1%	100.0%	99.6%
Adult	0.0%	96.7%	99.6%
Percent of Total Species EFH Area Covered by Project Area			
Egg	0.170%	0.007%	0.000%
Larva	0.065%	0.002%	0.000%
Juvenile	0.059%	0.014%	0.002%
Adult	0.000%	0.010%	0.001%

Sources: MAFMC 1998b; Fahay et al. 1999b; Shepherd and Packer 2006; MAFMC 2017

Bluefish larva EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-17; Figure E-1-17). Bluefish larvae are found in pelagic marine habitats over the continental shelf (MAFMC 1998b). Individuals from the spring cohort associate strongly with surface waters, while those from the summer cohort exhibit diel migrations from surface waters at night to below depths of 13 ft (4 m) during the day (Fahay et al. 1999b; Shepherd and Packer 2006). Young larvae primarily consume copepods and shift their diets to fish as they age (Shepherd and Packer 2006). Designated EFH for bluefish larvae spans May to September in depths of 98 to 230 ft (30 to 70 m), where temperatures span 64 to 79°F (18 to 26°C) and salinities are within 30 to 35 ppt (Fahay et al. 1999b; Shepherd and Packer 2006).

Bluefish juvenile EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-17; Figure E-1-17). Bluefish juveniles are found in pelagic marine habitats over the continental shelf and in the mixed and high salinity zones of regional estuaries (MAFMC 1998b). They move shoreward with growth and enter estuarine nurseries (Fahay et al. 1999b; Shepherd and Packer 2006). Individuals from the summer cohort exhibit diel distributions from the shoreline during the day to open bay or channel waters at night (Fahay et al. 1999b; Shepherd and Packer 2006). Juveniles are opportunistic feeders that consume whatever taxa are locally abundant, including fish, crustaceans, and polychaetes (Shepherd and Packer 2006). Designated EFH for bluefish juveniles is in surface waters to mid-shelf depths, where temperatures span 59 to 86°F (15 to 30°C) and salinities are within 23 to 36 ppt (Fahay et al. 1999b; Shepherd and Packer 2006; MAFMC 2017).

Bluefish adult EFH is designated in both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-17; Figure E-1-17). Bluefish adults are found in pelagic marine habitats over the continental shelf and in the mixed and high salinity zones of regional estuaries (MAFMC 1998b). They are highly migratory and their distribution varies seasonally and according to the size of the individuals comprising the schools (MAFMC 1998b). Like juveniles, adults are opportunistic feeders and consume a large variety of fishes, crustaceans, and polychaetes (Shepherd and Packer 2006). Designated EFH for bluefish adults is in surface waters to mid-shelf depths, where temperatures span 57 to 86°F (14 to 30°C) and salinities are within 32 to 33 ppt (Fahay et al. 1999b; Shepherd and Packer 2006; MAFMC 2017).

The bluefish is managed under the MAFMC Bluefish FMP as a single stock: the Atlantic Coast stock. The fishery stock is currently overfished but is not subject to overfishing (NOAA Fisheries 2019).

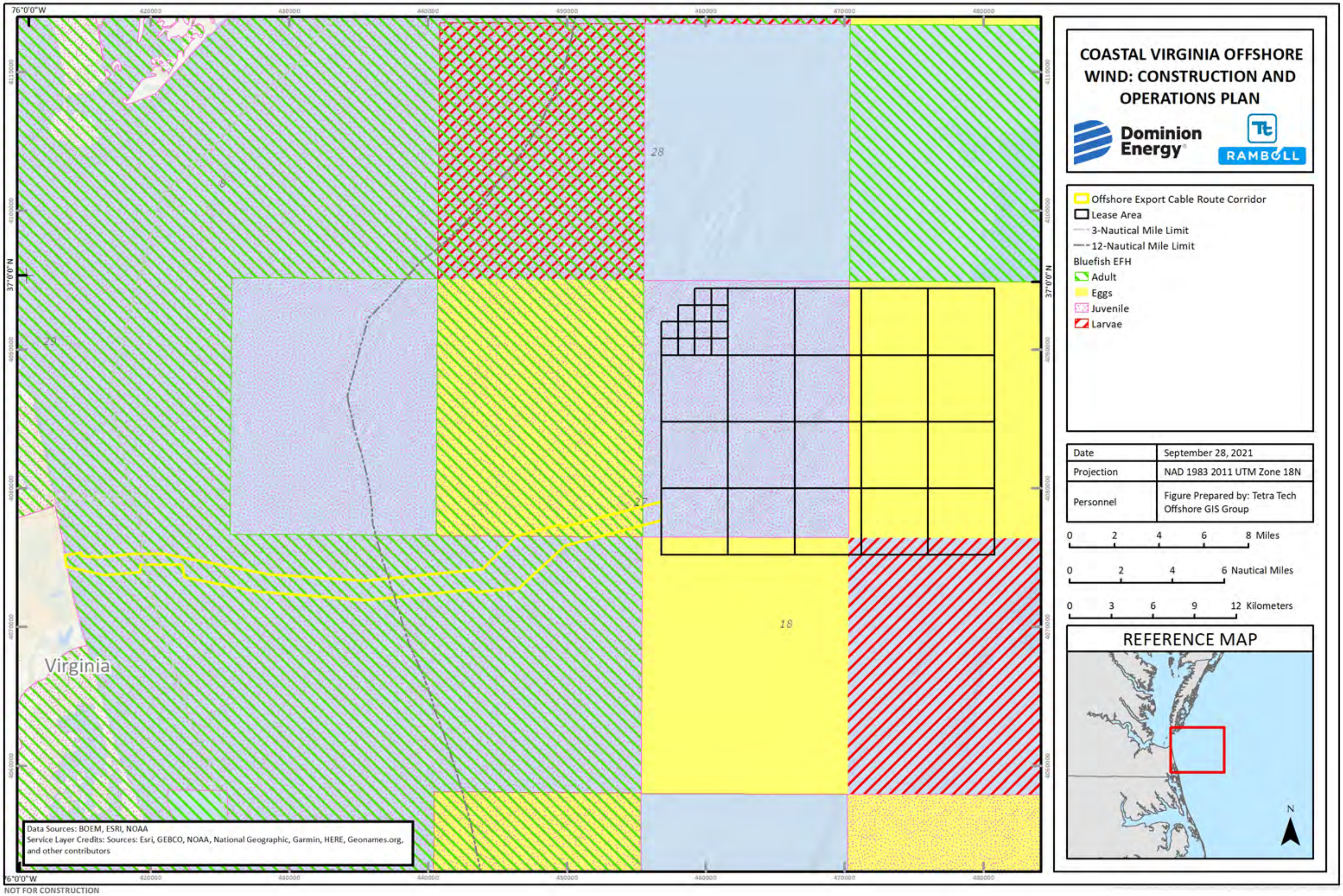

Figure E-1-17. Bluefish (*Pomatomus saltatrix*) Designated EFH in the Offshore Project Area

E-1.2.17 Longfin Inshore Squid (*Doryteuthis [Amerigo] pealeii*)

Longfin inshore squid egg EFH is designated in both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-18; Figure E-1-18). In the Mid-Atlantic Bight, longfin inshore squid eggs are found in inshore and offshore benthic marine habitats (MAFMC 2011). Egg masses, or "mops," are anchored to hand substrates, including shells, rocks, boulders, submerged aquatic vegetation, sand, and mud (MAFMC 2011). Designated EFH for longfin inshore squid eggs is in benthic habitat from the shoreline to depths of 164 ft (50 m), where temperatures span 50 to 73°F (10 to 23°C) and salinities are within 30 to 32 ppt (Cargnelli et al. 1999d; Jacobson 2005).

No longfin inshore squid larva EFH is designated in the Offshore Project Area.

Longfin inshore squid juvenile EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-18; Figure E-1-18). Juveniles and subadults (pre-recruits) are found in pelagic marine habitats in coastal inshore waters in spring through fall and offshore continental shelf waters in winter (Cargnelli et al. 1999d; Jacobson 2005). Juveniles exhibit diel migrations from the surface at night to greater depths during the day (Cargnelli et al. 1999d; Jacobson 2005). Their prey varies with size; small juveniles consume euphausiids and arrow worms, while larger juveniles consume small crabs, polychaetes, and shrimp (Jacobson 2005). Designated EFH for longfin inshore squid juveniles and subadults is the upper 33 ft (10 m) of pelagic habitat over depths of 164 to 328 ft (50 to 100 m), where temperatures span 50 to 79°F (10 to 26°C) and salinities are within 28 to 37 ppt (Cargnelli et al. 1999d; Jacobson 2005; MAFMC 2011).

Table E-1-18. Longfin Inshore Squid (*Doryteuthis [Amerigo] pealeii*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Egg	0	6,691	1,646
Juvenile	109,616	5,478	0
Adult	109,616	5,478	0
Percent of Project Area Covered by EFH by Life Stage			
Egg	0%	47.0%	99.6%
Juvenile	97.2%	38.5%	0.0%
Adult	97.2%	38.5%	0.0%
Percent of Total Species EFH Area Covered by Project Area			
Egg	0.000%	0.052%	0.013%
Juvenile	0.338%	0.019%	0.000%
Adult	0.339%	0.017%	0.000%

Sources: Cargnelli et al. 1999d; Jacobson 2005; MAFMC 2011

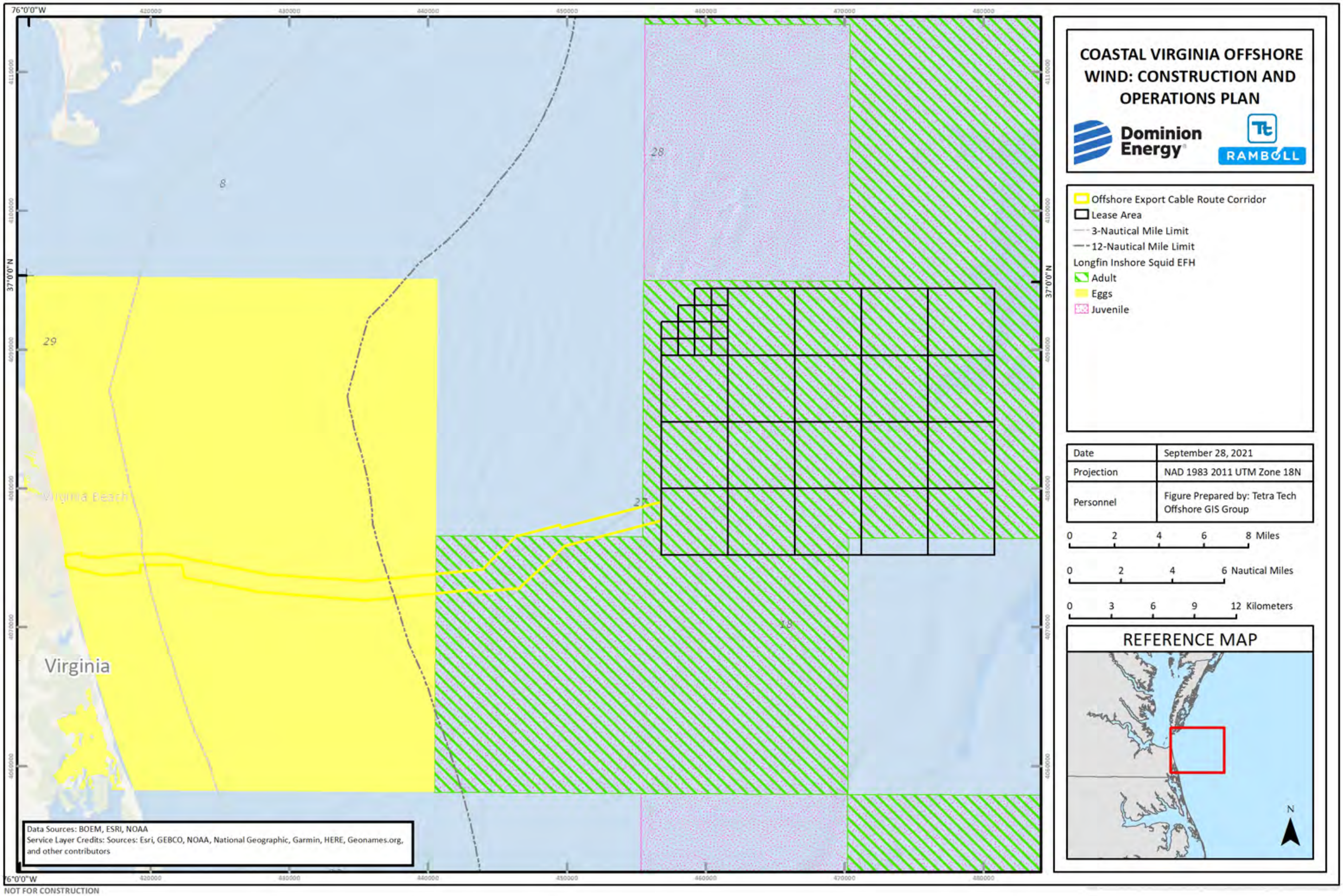

Figure E-1-18. Longfin Inshore Squid (*Doryteuthis [Amerigo] pealeii*) Designated EFH in the Offshore Project Area

Longfin inshore squid adult EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-18; Figure E-1-18). Adults (recruits) are found in pelagic marine habitats in inshore and offshore continental shelf waters and in the high salinity zones of regional embayments (MAFMC 2011). They migrate offshore in the fall and overwinter in warmer waters along the edge of the shelf; they exhibit diel vertical migrations from the surface at night to greater depths during the day (MAFMC 2011). Prey varies with individual size; small adults consume larval and juvenile fish and squid, while larger adults consume adult fish (e.g., hakes, mackerel, herring, anchovies, menhaden, weakfish) and squid (Jacobson 2005). Designated EFH for longfin inshore squid adults is in surface waters to depths of 591 ft (180 m) during spring and summer and depths of 1,312 ft (400 m) during fall and winter, where temperatures span 46 to 61°F (8 to 16°C) and salinities are within 24 to 37 ppt (Cargnelli et al. 1999d; Jacobson 2005; MAFMC 2011).

The longfin inshore squid is managed under the MAFMC Atlantic Mackerel, Squid, and Butterfish FMP as a single stock: the Georges Bank/Cape Hatteras stock. The fishery stock is not currently subject to overfishing, but the stock status remains unknown (NOAA Fisheries 2019).

E-1.2.18 Scup (*Stenotomus chrysops*)

No scup egg or larva EFH is designated in the Offshore Project Area.

Scup juvenile EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-19; Figure E-1-19). In the Mid-Atlantic Bight, scup juveniles are found in intertidal and subtidal benthic marine habitats over the continental shelf and in the mixed and high salinity zones of regional estuaries (MAFMC 1998a). Juveniles exhibit seasonal changes in distribution from inshore waters in summer and nearshore waters in fall to offshore waters in winter and spring (Steimle et al. 1999d). In inshore waters, juveniles associate with a variety of substrates, including mud, sand, mussel, and eelgrass beds; in offshore waters, juveniles are found over a variety of sand substrates (Steimle et al. 1999d). They feed on polychaetes, epibenthic amphipods and other small crustaceans, mollusks, and fish eggs and larvae (Steimle et al. 1999d). Designated EFH for scup juveniles is from the shoreline to depths of 125 ft (38 m), where temperatures span 45 to 81°F (7 to 27°C) and salinities exceed 15 ppt (MAFMC 1998a; Steimle et al. 1999d).

Table E-1-19. Scup (*Stenotomus chrysops*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Juvenile	112,799	14,234	1,652
Adult	112,799	14,234	1,652
Percent of Project Area Covered by EFH by Life Stage			
Juvenile	100.0%	100.0%	100.0%
Adult	100.0%	100.0%	100.0%
Percent of Total Species EFH Area Covered by Project Area			
Juvenile	0.353%	0.045%	0.005%
Adult	0.328%	0.041%	0.005%

Sources: MAFMC 1998a; Steimle et al. 1999d

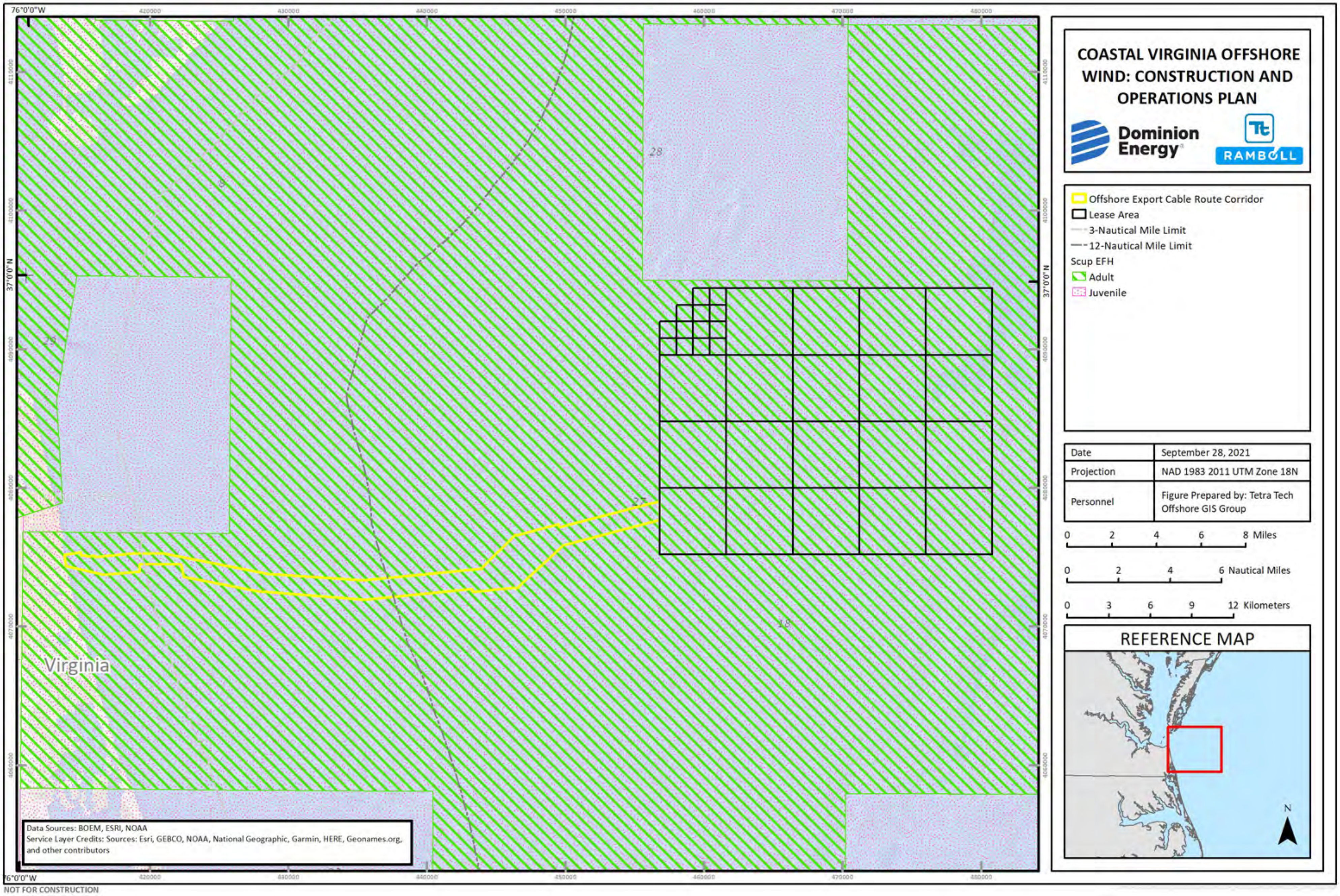

Figure E-1-19. Scup (*Stenotomus chrysops*) Designated EFH in the Offshore Project Area

Scup adult EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-19; Figure E-1-19).

Scup adults are found in intertidal and subtidal benthic marine habitats over the continental shelf and in the mixed and high salinity zones of regional estuaries (MAFMC 1998a). Adults generally overwinter offshore and move inshore during summer, during which time they associate with a variety of substrates, including fine to silty sand, mud, mussel beds, rocks, and artificial reefs (Steimle et al. 1999d). They feed on polychaetes, mollusks, small squid, detritus, insect larvae, hydroids, sand dollars, and small fish (Steimle et al. 1999d). Designated EFH for scup adults is in depths of 7 to 125 ft (2 to 38 m) during summer and 125 to 607 ft (38 to 185 m) during winter, where temperatures span 45 to 77°F (7 to 25°C) and salinities are within 20 to 31 ppt (Steimle et al. 1999d).

The scup is managed under the MAFMC Summer Flounder, Scup, and Black Sea Bass FMP as a single stock: the Atlantic Coast stock. The fishery stock is not currently overfished or subject to overfishing (NOAA Fisheries 2019).

E-1.2.19 Spiny Dogfish (*Squalus acanthias*)

No spiny dogfish neonate, juvenile, or sub-adult male EFH is designated in the Offshore Project Area.

Spiny dogfish sub-adult female EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-20; Figure E-1-20). In the Mid-Atlantic Bight, sub-adult females are often more widely distributed than sub-adult males and are found in epibenthic and pelagic marine habitats, primarily on the outer continental shelf (MAFMC 2014). They feed on a variety of fish, squid, and ctenophores (Stehlik 2007). Designated EFH for spiny dogfish sub-adult females is over a wide depth range in temperatures spanning 45 to 59°F (7 to 15°C) and salinities within 32 to 35 ppt (MAFMC 2014).

Table E-1-20. Spiny Dogfish (*Squalus acanthias*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Sub-Adult Female	112,799	14,234	1,652
Adult Female	112,799	12,575	0
Adult Male	58,805	7,155	1,652
Percent of Project Area Covered by EFH by Life Stage			
Sub-Adult Female	100.0%	100.0%	100.0%
Adult Female	100.0%	88.3%	0.0%
Adult Male	52.1%	50.3%	100.0%
Percent of Total Species EFH Area Covered by Project Area			
Sub-Adult Female	0.271%	0.034%	0.004%
Adult Female	0.321%	0.036%	0.000%
Adult Male	0.161%	0.020%	0.005%

Sources: McMillan and Morse 1999; Stehlik 2007; MAFMC 2014

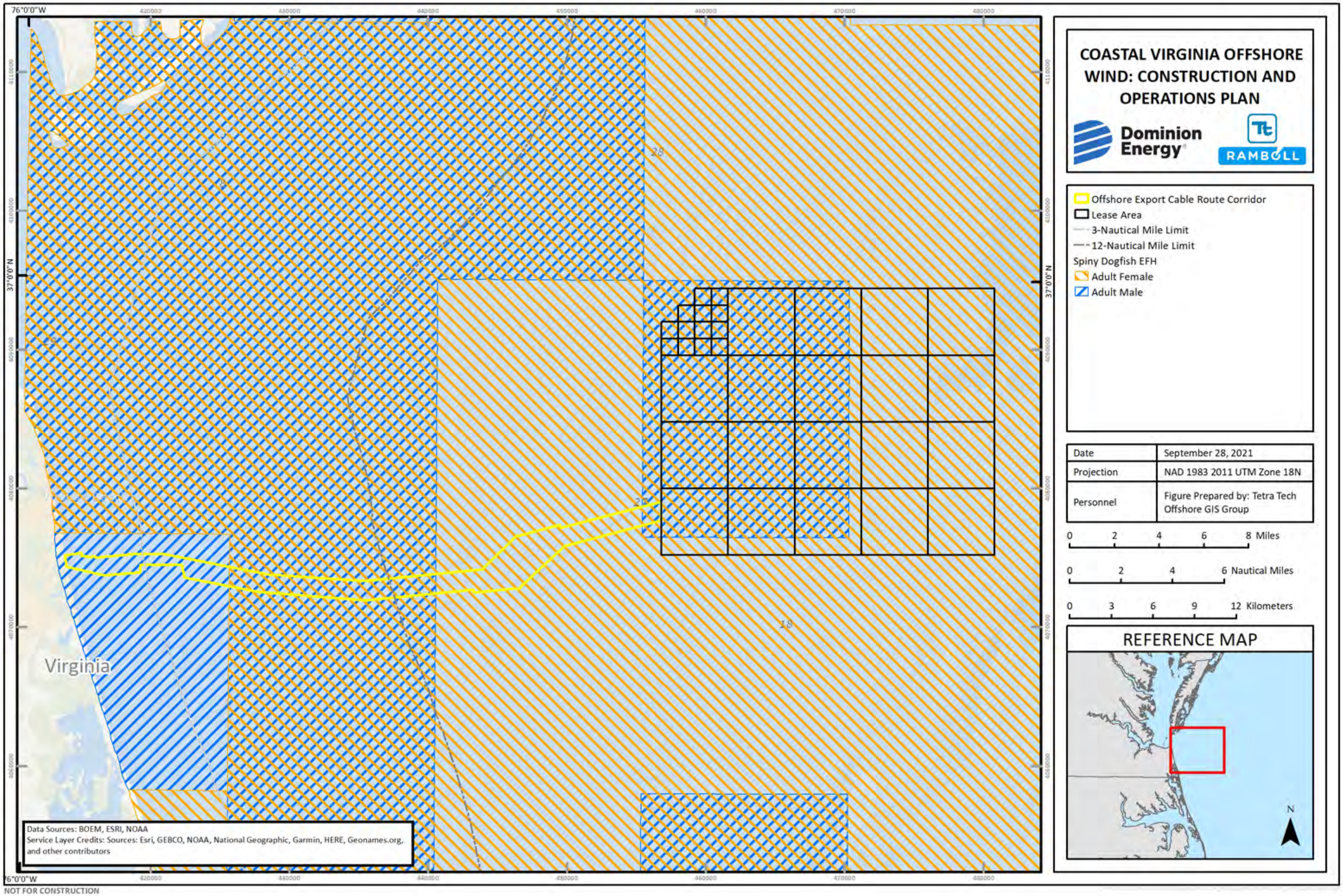

Figure E-1-20. Spiny Dogfish (*Squalus acanthias*) Designated EFH in the Offshore Project Area

Spiny dogfish adult male and female EFH is designated in the Lease Area and federal of the Offshore Export Cable Route Corridor; adult male EFH is also designated in state waters of the Offshore Export Cable Route Corridor (Table E-1-20; Figure E-1-20). Spiny dogfish adults are found in epibenthic and pelagic marine habitats (MAFMC 2014). They are widely distributed in winter and spring, but few remain in the Mid-Atlantic Bight in summer and fall when temperatures exceed 59°F (15°C) (MAFMC 2014). They consume the same prey as sub-adults, though the size of their prey increases as they age (Stehlik 2007). Designated EFH for spiny dogfish adults is in depths of 82 to 1,194 ft (25 to 364 m), where temperatures span 45 to 59°F (7 to 15°C) and salinities are within 30 to 35 ppt (McMillan and Morse 1999; Stehlik 2007; MAFMC 2014).

The spiny dogfish is co-managed by the NEFMC and MAFMC under the Spiny Dogfish FMP as a single stock: the Atlantic Coast stock. The fishery stock is not currently overfished or subject to overfishing (NOAA Fisheries 2019).

E-1.2.20 Summer Flounder (*Paralichthys dentatus*)

Summer flounder EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-21; Figure E-1-21). In the Mid-Atlantic Bight, summer flounder eggs are found in pelagic marine habitats over the continental shelf (MAFMC 1998a). Designated EFH for summer flounder eggs is in depths of 30 to 360 ft (9 to 110 m), where temperatures span 48 to 73°F (9 to 23°C) and salinities are within 22 to 33 ppt (Packer et al. 1999b).

Summer flounder larva EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-21; Figure E-1-21). Summer flounder larvae are found in pelagic marine habitats over the continental shelf and in the mixed and high salinity zones of regional estuaries; they primarily feed on copepods (MAFMC 1998a; Packer et al. 1999b). Larvae are most abundant nearshore and exhibit a seasonal shift from the northern Mid-Atlantic Bight from September through February to the southern Mid-Atlantic Bight from November to May (MAFMC 1998a). Designated EFH for summer flounder larvae is in depths of 30 to 230 ft (9 to 70 m), where temperatures span 32 to 73°F (0 to 23°C) and salinities are within 10 to 30 ppt (Packer et al. 1999b).

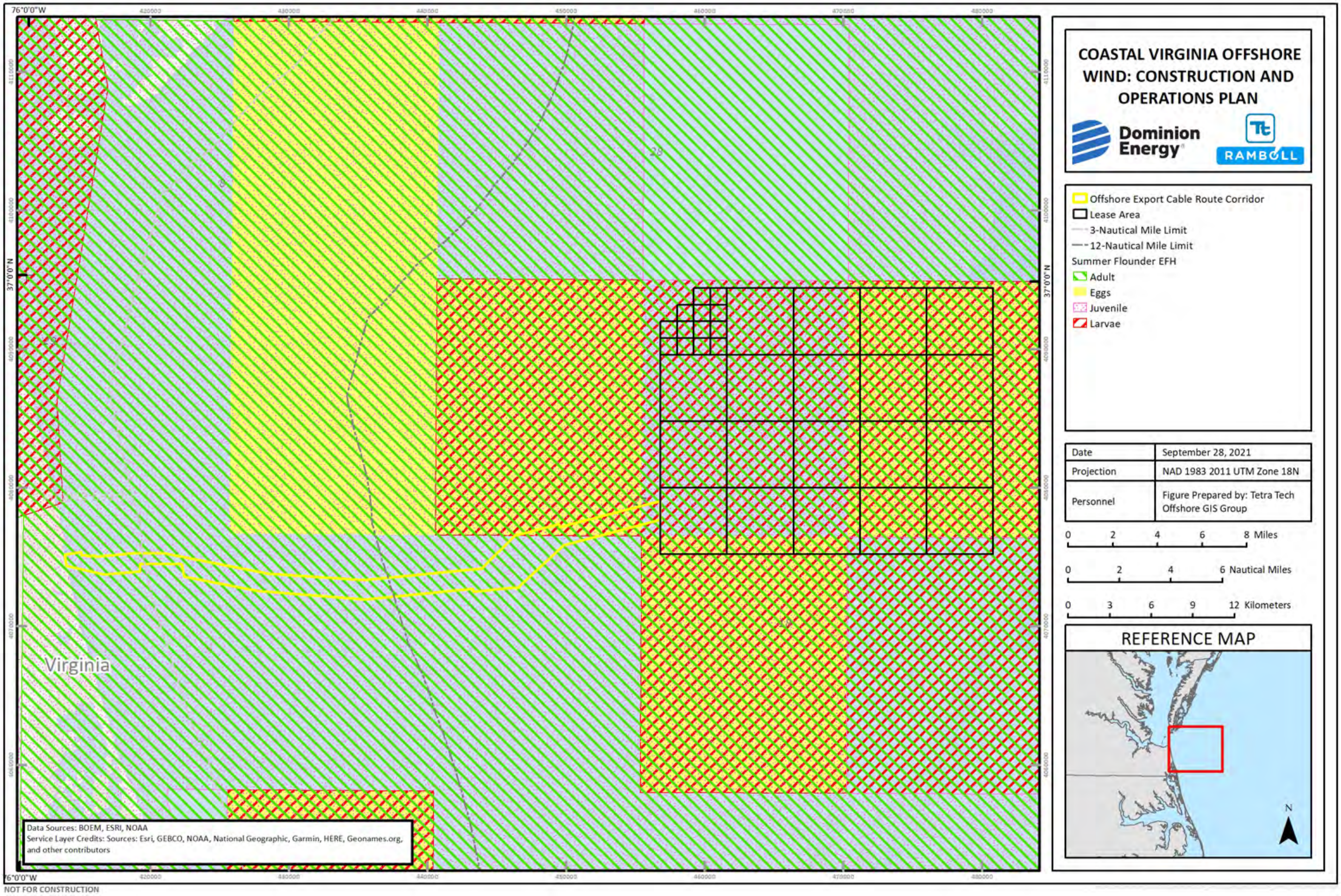

Figure E-1-21. Summer Flounder (*Paralichthys dentatus*) Designated EFH in the Offshore Project Area

Table E-1-21. Summer Flounder (*Paralichthys dentatus*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Egg	50,823	2,068	0
Larva	112,799	2,530	0
Juvenile	109,621	14,234	1,652
Adult	112,799	14,234	1,652
Percent of Project Area Covered by EFH by Life Stage			
Egg	45.1%	14.5%	0.0%
Larva	100.0%	17.8%	0.0%
Juvenile	97.2%	100.0%	100.0%
Adult	100.0%	100.0%	100.0%
Percent of Total Species EFH Area Covered by Project Area			
Egg	0.598%	0.024%	0.000%
Larva	0.244%	0.005%	0.000%
Juvenile	0.193%	0.025%	0.003%
Adult	0.156%	0.020%	0.002%

Sources: MAFMC 1998a; Packer et al. 1999b

Summer flounder juvenile EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-21; Figure E-1-21). Summer flounder juveniles are found in benthic marine habitats over the continental shelf and in the mixed and high salinity zones of regional estuaries (MAFMC 1998a). Juveniles generally use estuaries as nursery habitat, including salt marsh creeks, seagrass beds, mudflats, and sands of open bay areas (MAFMC 1998a). They are opportunistic feeders that consume polychaetes, infaunal invertebrates, bivalve siphons, and small fish (Packer et al. 1999b). Designated EFH for summer flounder juveniles is benthic habitat from the shoreline to depths of 500 ft (152 m), where temperatures span 37 to 81°F (3 to 27°C) and salinities are within 18 to 35 ppt (Packer et al. 1999b).

Summer flounder adult EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-21; Figure E-1-21). Summer flounder adults are found in benthic marine habitats over the continental shelf and in the mixed and high salinity zones of regional estuaries (MAFMC 1998a). Adults generally inhabit shallow coastal and estuarine waters during warmer months and move offshore to outer continental shelf substrates in colder months (MAFMC 1998a). Like juveniles, they are opportunistic feeders that consume a variety of fish (e.g., flounders, anchovies, hakes, scup, bluefish, weakfish) and invertebrates (e.g., crabs, squids, shrimps, bivalves, gastropods, worms, sand dollars) (Packer et al. 1999b). Designated EFH for summer flounder adults is benthic habitat from the shoreline to 500 ft (152 m), where temperatures span 36 to 81°F (2 to 27°C) (Packer et al. 1999b).

The summer flounder is managed under the MAFMC Summer Flounder, Scup, and Black Sea Bass FMP as a single stock: the Mid-Atlantic Coast stock. The fishery stock is not currently overfished or subject to overfishing (NOAA Fisheries 2019).

E-1.2.21 Albacore Tuna (*Thunnus alalonga*)

No albacore tuna egg, larva, or adult EFH is designated in the Offshore Project Area. Albacore tuna juvenile EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-22; Figure E-1-22).

Table E-1-22. Albacore Tuna (*Thunnus alalonga*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Juvenile	112,799	14,234	1,652
Percent of Project Area Covered by EFH by Life Stage			
Juvenile	100.0%	100.0%	100.0%
Percent of Total Species EFH Area Covered by Project Area			
Juvenile	0.090%	0.011%	0.001%

Sources: NOAA Fisheries 2017

The albacore tuna is a highly migratory, temperate, epipelagic species with a poorly known life history. In the Atlantic Ocean, the species ranges from between 40°N to 40°S (NOAA Fisheries 2017). Individuals aggregate in schools (often containing multiple species of tuna) according to size; schools comprised of the largest individuals complete the longest journeys. The albacore tuna is generally found in surface waters in temperatures ranging from 61 to 66°F (16 to 19°C), but individuals may dive into waters as cold as 48°F (9°C) (NOAA Fisheries 2017). Juveniles (up to five years old) and adults conduct feeding migrations throughout the central Atlantic during winter and northeastern Atlantic during summer and fall (NOAA Fisheries 2017). They forage opportunistically in epipelagic to upper mesopelagic waters and consume medium-sized fish and cephalopods (NOAA Fisheries 2017). Designated EFH for albacore tuna juveniles and adults is offshore, pelagic habitats of the Atlantic Ocean from the outer edge of the United States (U.S.) Exclusive Economic Zone through Georges Bank and south to Cape Hatteras, North Carolina (NOAA Fisheries 2017).

The albacore tuna is managed on the Atlantic Coast of the U.S. by NOAA's HMS Management Division under the Consolidated HMS FMP as a single stock: the North Atlantic stock. The fishery stock is not currently overfished or subject to overfishing (NOAA Fisheries 2019).

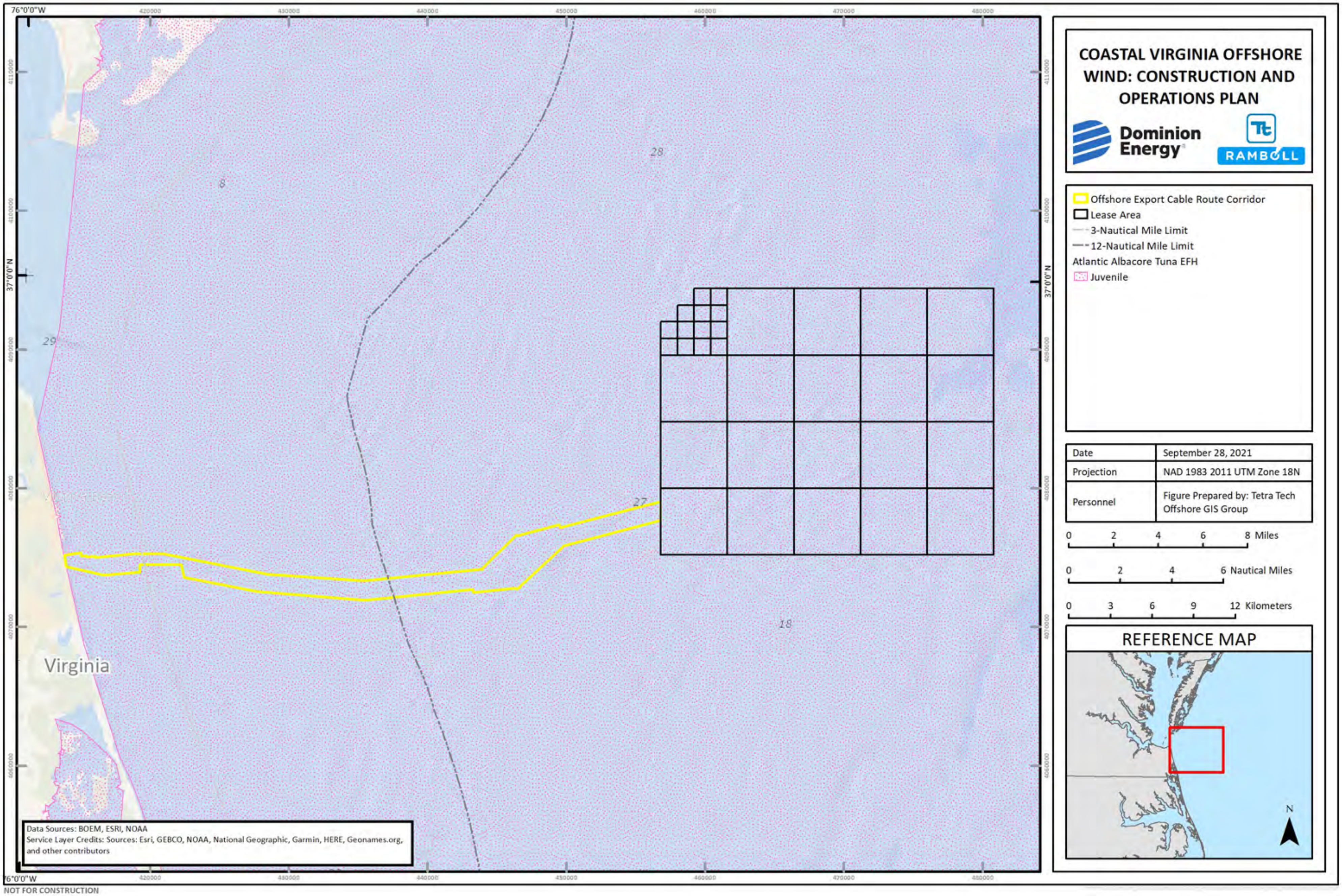

Figure E-1-22. Albacore Tuna (*Thunnus alalonga*) Designated EFH in the Offshore Project Area

E-1.2.22 Atlantic Angel Shark (*Squatina dumeril*)

Atlantic angel shark EFH for all life stages is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-23; Figure E-1-23).

Table E-1-23. Atlantic Angel Shark (*Squatina dumeril*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
ALL	112,799	14,234	1,652
Percent of Project Area Covered by EFH by Life Stage			
ALL	100.0%	100.0%	100.0%
Percent of Total Species EFH Area Covered by Project Area			
ALL	0.239%	0.030%	0.004%

Sources: NOAA Fisheries 2017

The Atlantic angel shark is a highly migratory species found in benthic marine habitats in coastal waters of the U.S. from Massachusetts to the Florida Keys, Gulf of Mexico, and Caribbean (NOAA Fisheries 2017). They conduct seasonal migrations from shallow to deep waters and consume teleost fishes, cephalopods, crustaceans, and portunid crabs (NOAA Fisheries 2017). Designated EFH for all life stages of the Atlantic angel shark in the Atlantic Ocean includes benthic habitats on the continental shelf from Cape May, New Jersey to Cape Lookout, North Carolina (NOAA Fisheries 2017).

The Atlantic angel shark is managed on the Atlantic Coast of the U.S. by NOAA's HMS Management Division under the Consolidated HMS FMP. Fishing for the Atlantic angel shark is prohibited in U.S. waters (NOAA Fisheries 2017).

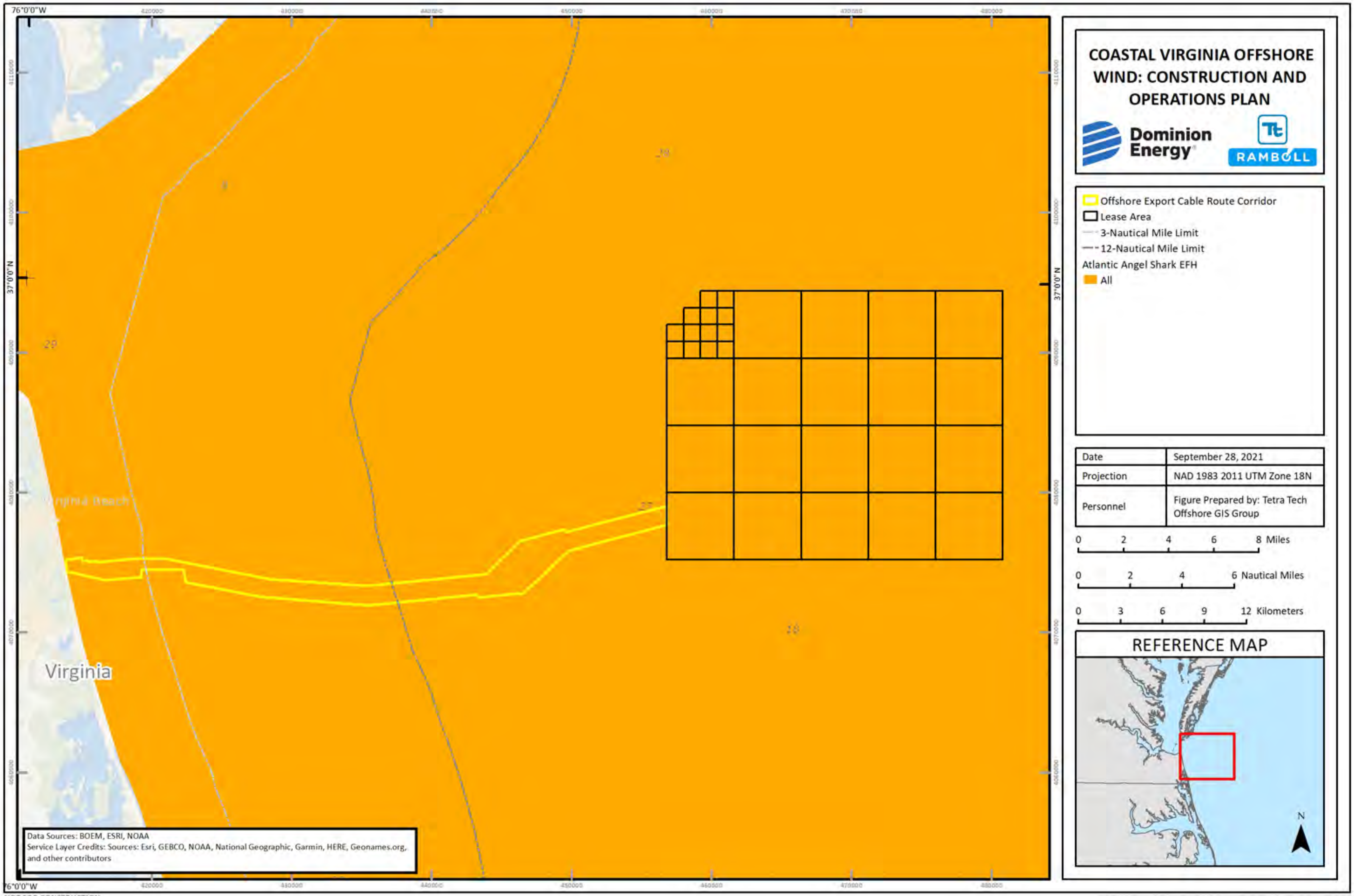

Figure E-1-23. Atlantic Angel Shark (*Squatina dumeril*) Designated EFH in the Offshore Project Area

E-1.2.23 Atlantic Bluefin Tuna (*Thunnus thynnus*)

No Atlantic bluefin tuna egg or larva EFH is designated in the Offshore Project Area. Atlantic bluefin tuna juvenile and adult EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-24; Figure E-1-24).

Table E-1-24. Atlantic Bluefin Tuna (*Thunnus thynnus*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Juvenile	112,799	14,234	1,652
Adult	112,799	14,234	1,652
Percent of Project Area Covered by EFH by Life Stage			
Juvenile	100.0%	100.0%	100.0%
Adult	100.0%	100.0%	100.0%
Percent of Total Species EFH Area Covered by Project Area			
Juvenile	0.318%	0.040%	0.005%
Adult	0.058%	0.007%	0.001%

Sources: NOAA Fisheries 2017

The Atlantic bluefin tuna is a highly migratory species that historically ranged from the equator to 45°N in the Western Atlantic Ocean; warming sea temperatures have allowed a range expansion as far north as 60°N (NOAA Fisheries 2017). The species spawns from April to June in the Gulf of Mexico, Bahamas, and Florida Straits; there is also evidence of spawning behavior and larval presence in the Slope Sea of the Mid-Atlantic Bight. Larvae are typically found at depths of 6,000 ft (1,829 m) and within narrow temperature and salinity ranges of approximately 79°F (26°C) and 36 ppt, respectively (NOAA Fisheries 2017). YOY begin migrations in June to juvenile habitats over the continental shelf near 34°N and 41°W and shift with age to nursery areas between Cape Hatteras, North Carolina, and Cape Cod, Massachusetts. Individuals conduct seasonal migrations in pursuit of forage species off the eastern U.S. and Canadian coasts from June through March (NOAA Fisheries 2017). Though the species is generally epipelagic in the open ocean, some individuals migrate inshore during the summer in pursuit of prey (e.g., herring, mackerel, and squid). Juveniles feed primarily on zooplanktivorous fishes and crustaceans, while adults opportunistically prey on schooling fish, cephalopods, and benthic invertebrates (NOAA Fisheries 2017). Designated EFH for juveniles is in coastal and pelagic habitats from shore to the continental shelf break, where depths span 66 to 328 ft (20 to 100 m) and temperatures range from 39 to 79°F (4 to 26°C). Designated EFH for adults in the Mid-Atlantic Bight is in coastal and offshore pelagic habitat from southern New England to Onslow Bay, North Carolina (NOAA Fisheries 2017).

The Atlantic bluefin tuna is managed on the Atlantic Coast of the U.S. by NOAA's HMS Management Division under the Consolidated HMS FMP as a single stock: the Western Atlantic stock. The fishery stock is not currently subject to overfishing, but the stock status remains unknown (NOAA Fisheries 2019).

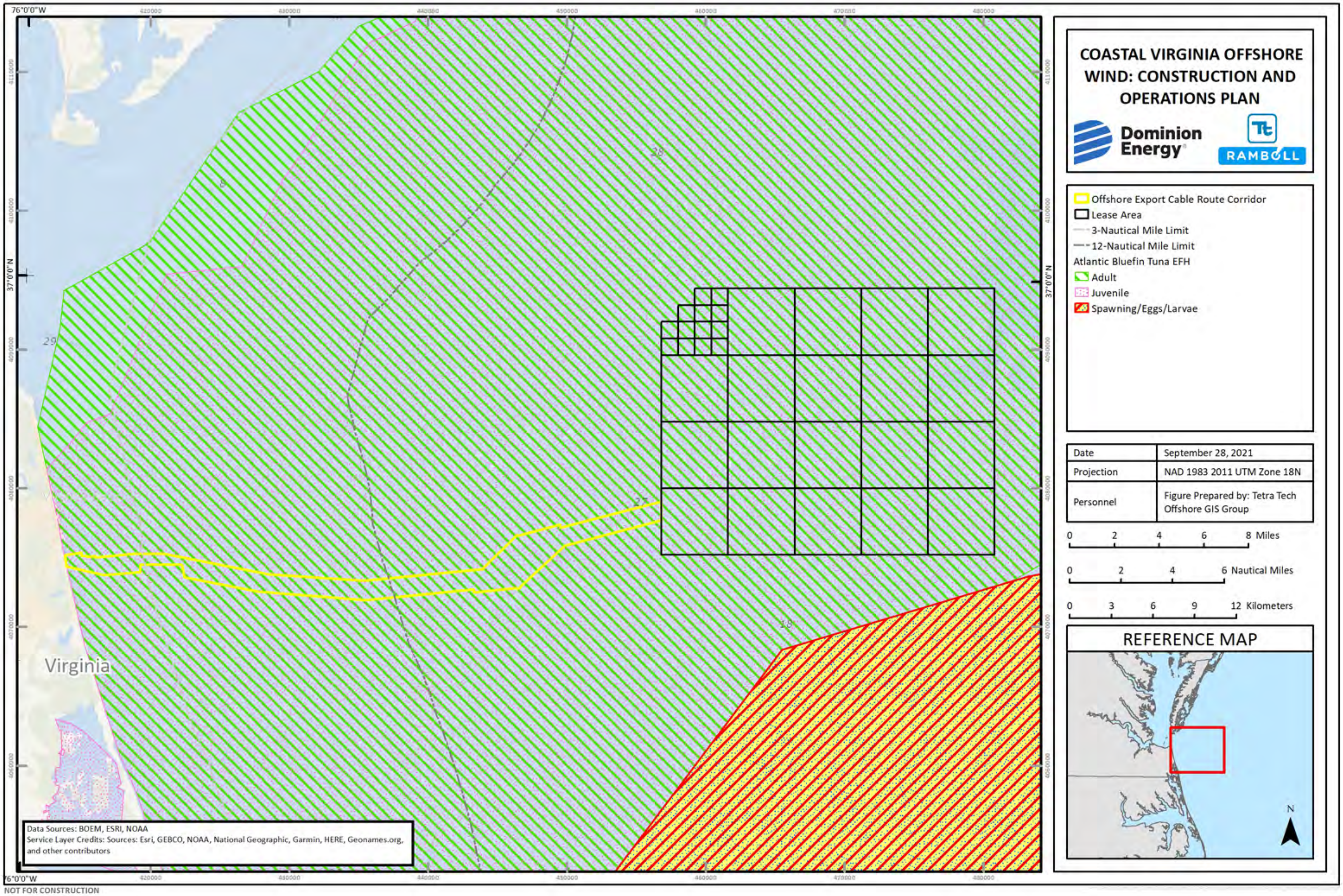

Figure E-1-24. Atlantic Bluefin Tuna (*Thunnus thynnus*) Designated EFH in the Offshore Project Area

E-1.2.24 Atlantic Sharpnose Shark (*Rhizoprionodon terraenovae*)

No Atlantic sharpnose shark neonate EFH is designated in the Offshore Project Area. Atlantic sharpnose shark juvenile and adult EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-25; Figure E-1-25).

Table E-1-25. Atlantic Sharpnose Shark (*Rhizoprionodon terraenovae*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Juvenile	0	3,648	1,652
Adult	112,799	14,234	1,652
Percent of Project Area Covered by EFH by Life Stage			
Juvenile	0.0%	25.6%	100.0%
Adult	100.0%	100.0%	100.0%
Percent of Total Species EFH Area Covered by Project Area			
Juvenile	0.000%	0.013%	0.006%
Adult	0.351%	0.044%	0.005%

Sources: NOAA Fisheries 2017

The Atlantic sharpnose shark is an abundant summer migrant off coastal Virginia and the Chesapeake Bay. Designated EFH for neonates and YOY is in estuarine, inshore, and nearshore nursery habitats from the shoreline to maximum depths of 43 ft (13 m), where temperatures span 64 to 89°F (18 to 31°C) and salinities are within 21 to 37 ppt (NOAA Fisheries 2017). Designated EFH for juveniles is in estuarine, inshore, and nearshore waters with an offshore depth extent of 591 ft (180 m), where temperatures span 63 to 91°F (17 to 33°C) and salinities are within 21 to 37 ppt. Juveniles and adults primarily feed on teleost fishes (NOAA Fisheries 2017). Designated EFH for adults is in inshore and nearshore waters with an offshore depth extent of 591 ft (180 m). Both juveniles and adults exhibit seasonal summer distributions in the northern portion of the species' Atlantic stock range (NOAA Fisheries 2017).

The Atlantic sharpnose shark is managed on the Atlantic Coast of the U.S. by NOAA's HMS Management Division under the Consolidated HMS FMP as two separate stocks: the Atlantic stock and the Gulf of Mexico stock. Neither stock is currently overfished or subject to overfishing (NOAA Fisheries 2019).

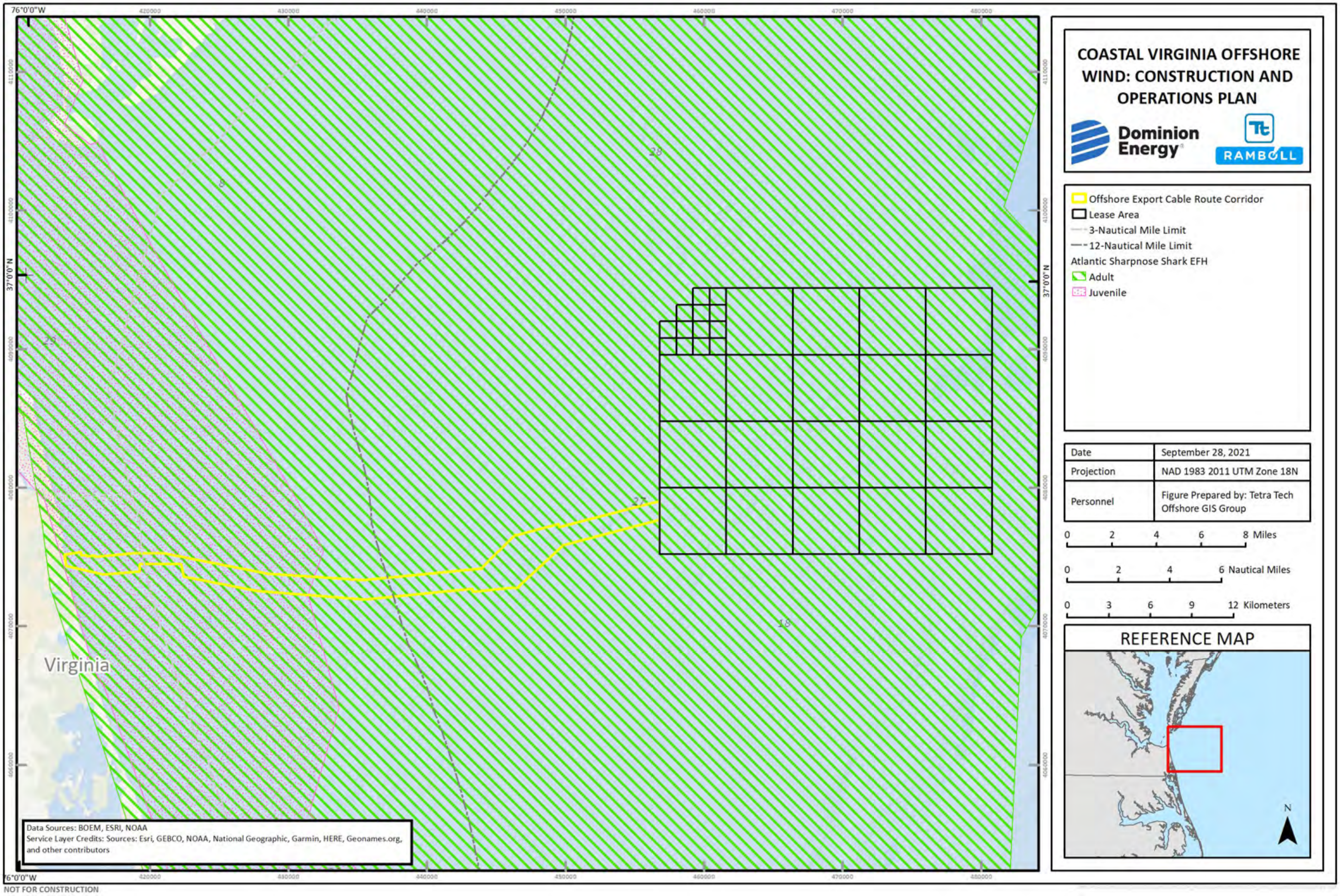

Figure E-1-25. Atlantic Sharpnose Shark (*Rhizoprionodon terraenovae*) Designated EFH in the Offshore Project Area

E-1.2.25 Atlantic Skipjack Tuna (*Katsuwonus pelamis*)

No Atlantic skipjack tuna egg or larva EFH is designated in the Offshore Project Area. Atlantic skipjack tuna juvenile EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-26; Figure E-1-26). Atlantic skipjack tuna adult EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-26; Figure E-1-26).

Table E-1-26. Atlantic Skipjack Tuna (*Katsuwonus pelamis*) Designated EFH in the Offshore Project Area

Action Area		Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Juvenile	112,799	3,119	0
Adult	112,799	14,234	1,652
Percent of Project Area Covered by EFH by Life Stage			
Juvenile	100.0%	21,9%	0.0%
Adult	100.0%	100.0%	99.647%
Percent of Total Species EFH Area Covered by Project Area			
Juvenile	0.056%	0.002%	0.000%
Adult	0.071%	0.009%	0.001%

Sources: NOAA Fisheries 2017

The Atlantic skipjack tuna is a highly migratory, epipelagic species present in tropical and warm-temperate waters from Newfoundland to Brazil (NOAA Fisheries 2017). While the species resides in surface waters, individuals may dive to depths of 853 ft (260 m) during the day. Schools of Atlantic skipjack tuna are associated with convergences, hydrographic discontinuities, birds, drifting objects, whales, sharks, and other tuna species. Both juveniles and adults opportunistically feed on fishes, cephalopods, and crustaceans; their prey often include *Sargassum*-associated species (NOAA Fisheries 2017). Designated EFH for juveniles is in coastal pelagic habitats from Massachusetts to South Carolina and in offshore pelagic habitats seaward of the continental shelf break in depths greater than 66 ft (20 m). Designated EFH for adults is in coastal and offshore pelagic habitats from Massachusetts to Cape Lookout, North Carolina. The optimal temperature range for the species is 68 to 88°F (20 to 13°C) (NOAA Fisheries 2017).

The Atlantic skipjack tuna is managed on the Atlantic Coast of the U.S. by NOAA's HMS Management Division under the Consolidated HMS FMP as a single stock: the Western Atlantic stock. The fishery stock is not currently overfished or subject to overfishing (NOAA Fisheries 2019).

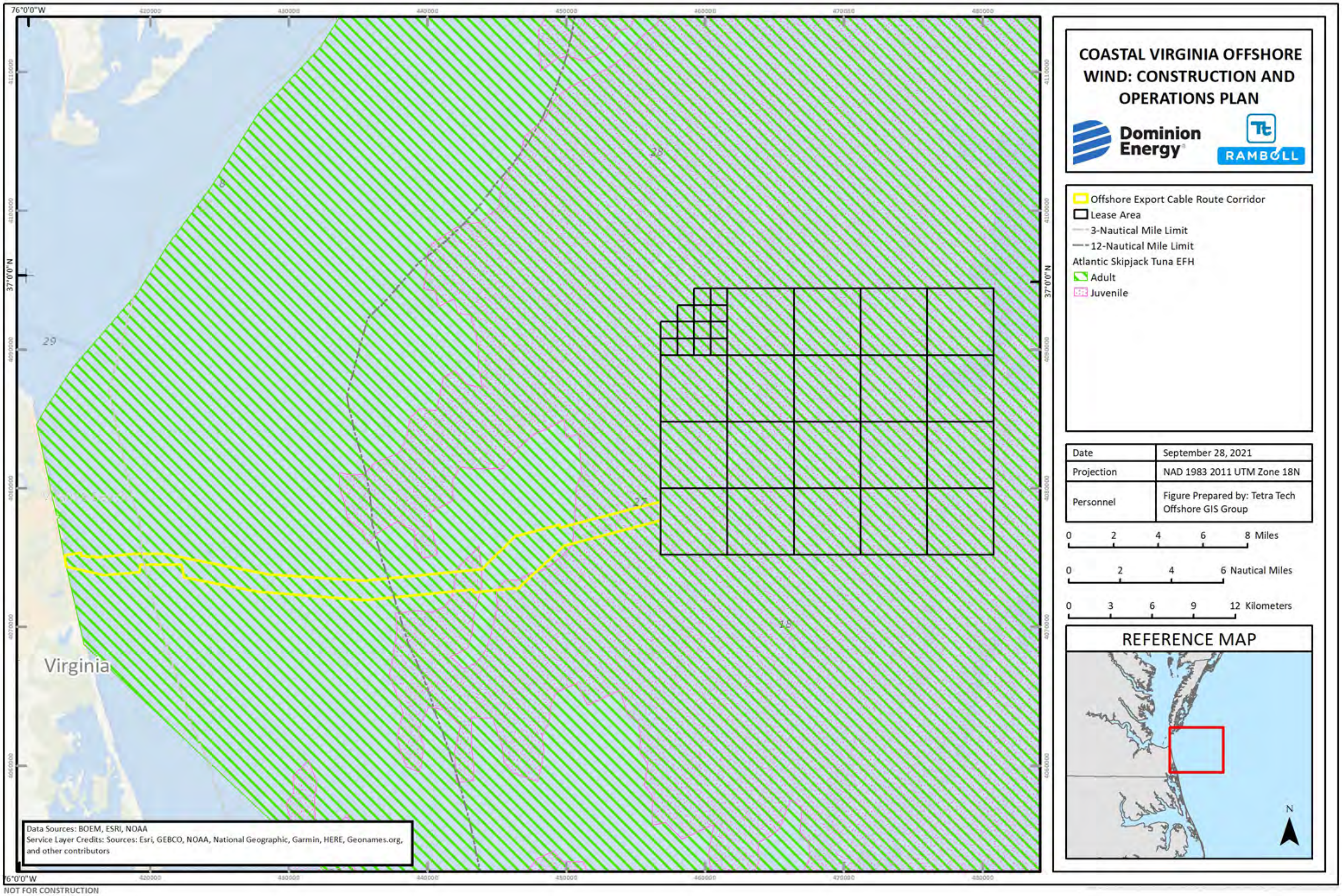

Figure E-1-26. Atlantic Skipjack Tuna (*Katsuwonus pelamis*) Designated EFH in the Offshore Project Area

E-1.2.26 Atlantic Yellowfin Tuna (*Thunnus albacares*)

No Atlantic yellowfin egg or larva EFH is designated in the Offshore Project Area. Atlantic yellowfin tuna juvenile EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-27; Figure E-1-27). Atlantic yellowfin tuna adult EFH is designated in the Lease Area (Table E-1-27; Figure E-1-27).

Table E-1-27. Atlantic Yellowfin Tuna (*Thunnus albacares*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Juvenile	112,799	14,234	1,652
Adult	19,690	0	0
Percent of Project Area Covered by EFH by Life Stage			
Juvenile	100.0%	100.0%	100.0%
Adult	17.5%	0.0%	0.0%
Percent of Total Species EFH Area Covered by Project Area			
Juvenile	0.062%	0.008%	0.001%
Adult	0.015%	0.000%	0.000%

Sources: NOAA Fisheries 2017

The Atlantic yellowfin tuna is a highly migratory, epipelagic species found in tropical and temperate waters between 45°N and 40°S (NOAA Fisheries 2017). Juveniles aggregate at the surface in mixed schools of skipjack and bigeye tuna, while larger adults extend their ranges into deeper waters and higher latitudes; vertical distribution has been associated with thermocline depth. Both juveniles and adults opportunistically feed on fishes, cephalopods, and crustaceans; their prey often include *Sargassum*-associated species (NOAA Fisheries 2017). Designated EFH for juveniles is in coastal and offshore pelagic habitats between Cape Cod, Massachusetts, and Florida and seaward of the continental shelf break. Designated EFH for adults is in coastal and offshore pelagic habitats from Cape Cod to North Carolina and seaward of the continental shelf break; adults are generally confined to the upper 328 ft (100 m) of the water column (NOAA Fisheries 2017).

The Atlantic yellowfin tuna is managed on the Atlantic Coast of the U.S. by NOAA's HMS Management Division under the Consolidated HMS FMP as a single stock: the Atlantic stock. The fishery stock is not currently overfished or subject to overfishing (NOAA Fisheries 2019).

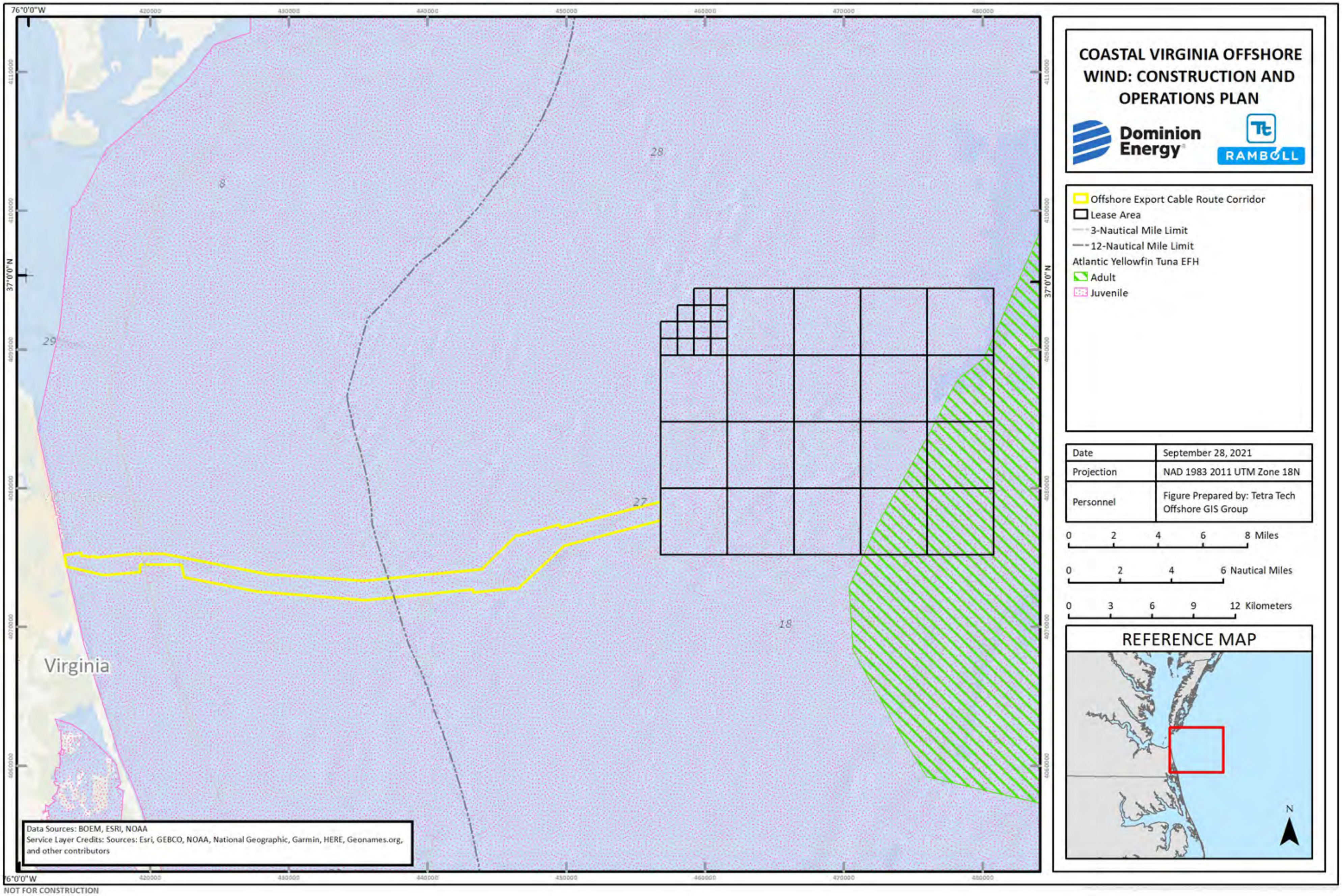

Figure E-1-27. Atlantic Yellowfin Tuna (*Thunnus albacares*) Designated EFH in the Offshore Project Area

E-1.2.27 Blacktip Shark (*Carcharhinus limbatus*)

No blacktip shark neonate EFH is designated in the Offshore Project Area. Blacktip shark juvenile and adult EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-28; Figure E-1-28).

Table E-1-28. Blacktip Shark (*Carcharhinus limbatus*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**13,800**	**1,832**
EFH Acreage in Project Area by Life Stage			
Juvenile/Adult	83,974	14,234	1,647
Percent of Project Area Covered by EFH by Life Stage			
Juvenile/Adult	74.4%	100.0%	99.6%
Percent of Total Species EFH Area Covered by Project Area			
Juvenile/Adult	0.514%	0.087%	0.010%

Sources: NOAA Fisheries 2017

The blacktip shark is a highly migratory, circumtropical species present in shallow coastal waters and offshore surface waters of the continental shelf (NOAA Fisheries 2017). The species prefers warmer temperatures, mid to deep waters, and salinities exceeding 30 ppt over silt, sand, mud, and seagrass habitats; juveniles and adults are also found over shell, sand, and rocky habitats. They feed primarily on fishes, cephalopods, and crustaceans (NOAA Fisheries 2017). Designated EFH for juveniles and adults is in estuarine and coastal areas from Virginia to Florida in depths of 3 to 30 ft (1 to 9 m), where temperatures span 66 to 91°F (20 to 32°C) and salinities are within 22 to 35 ppt (though some juveniles have been found in salinities as low as 7 ppt) (NOAA Fisheries 2017).

The blacktip shark is managed on the Atlantic Coast of the U.S. by NOAA's HMS Management Division under the Consolidated HMS FMP as two separate stocks: the Atlantic stock and the Gulf of Mexico stock. The Gulf of Mexico stock is not currently overfished or subject to overfishing; the status of the Atlantic stock remains unknown (NOAA Fisheries 2019).

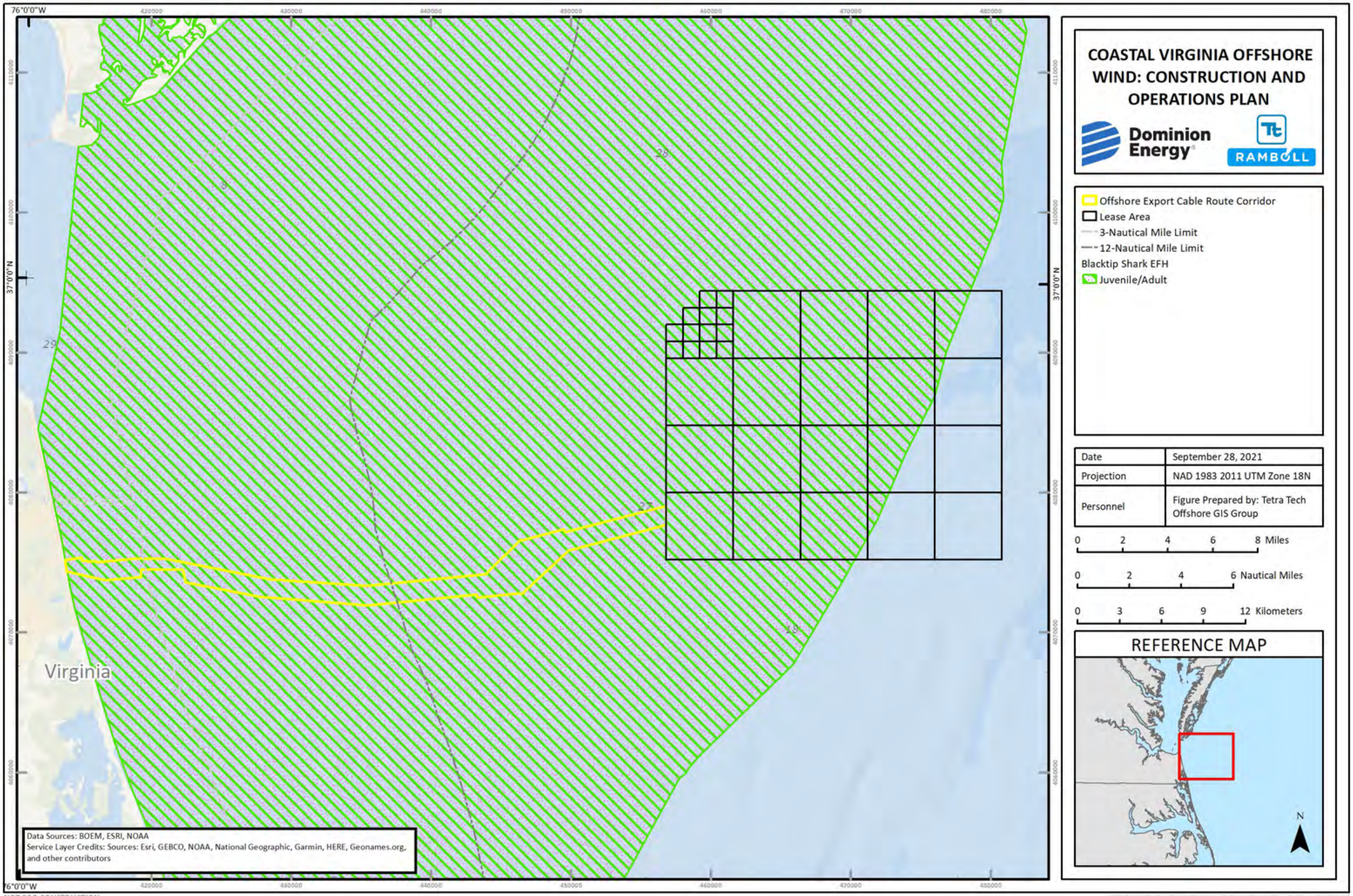

Figure E-1-28. Blacktip Shark (*Carcharhinus limbatus*) Designated EFH in the Offshore Project Area

E-1.2.28 Common Thresher Shark (*Alopias vulpinus*)

Common thresher shark EFH for all life stages is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-29; Figure E-1-29).

Table E-1-29. Common Thresher Shark (*Alopias vulpinus*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
ALL	112,799	14,234	1,647
Percent of Project Area Covered by EFH by Life Stage			
ALL	100.0%	100.0%	99.6%
Percent of Total Species EFH Area Covered by Project Area			
ALL	0.234%	0.030%	0.003%

Sources: NOAA Fisheries 2017

The common thresher shark is a highly migratory species common to warm and temperate coastal and oceanic waters (NOAA Fisheries 2017). It is more abundant in nearshore pelagic habitats and exhibits north-south seasonal migrations, particularly in offshore and cold inshore waters during summer months. The species feeds on invertebrates (e.g., squid and pelagic crabs) and small fishes (e.g., anchovies, sardines, hakes, mackerels) (NOAA Fisheries 2017). Designated EFH for all life stages of the common thresher shark is in the Atlantic Ocean from Georges Bank to Cape Lookout, North Carolina in depths of 16 to 43 ft (5 to 13 m), where temperatures span 64 to 70°F (18 to 21°C) (NOAA Fisheries 2017).

The common thresher shark is managed on the Atlantic Coast of the U.S. by NOAA's HMS Management Division under the Consolidated HMS FMP as a single stock. The stock status remains unknown (NOAA Fisheries 2019).

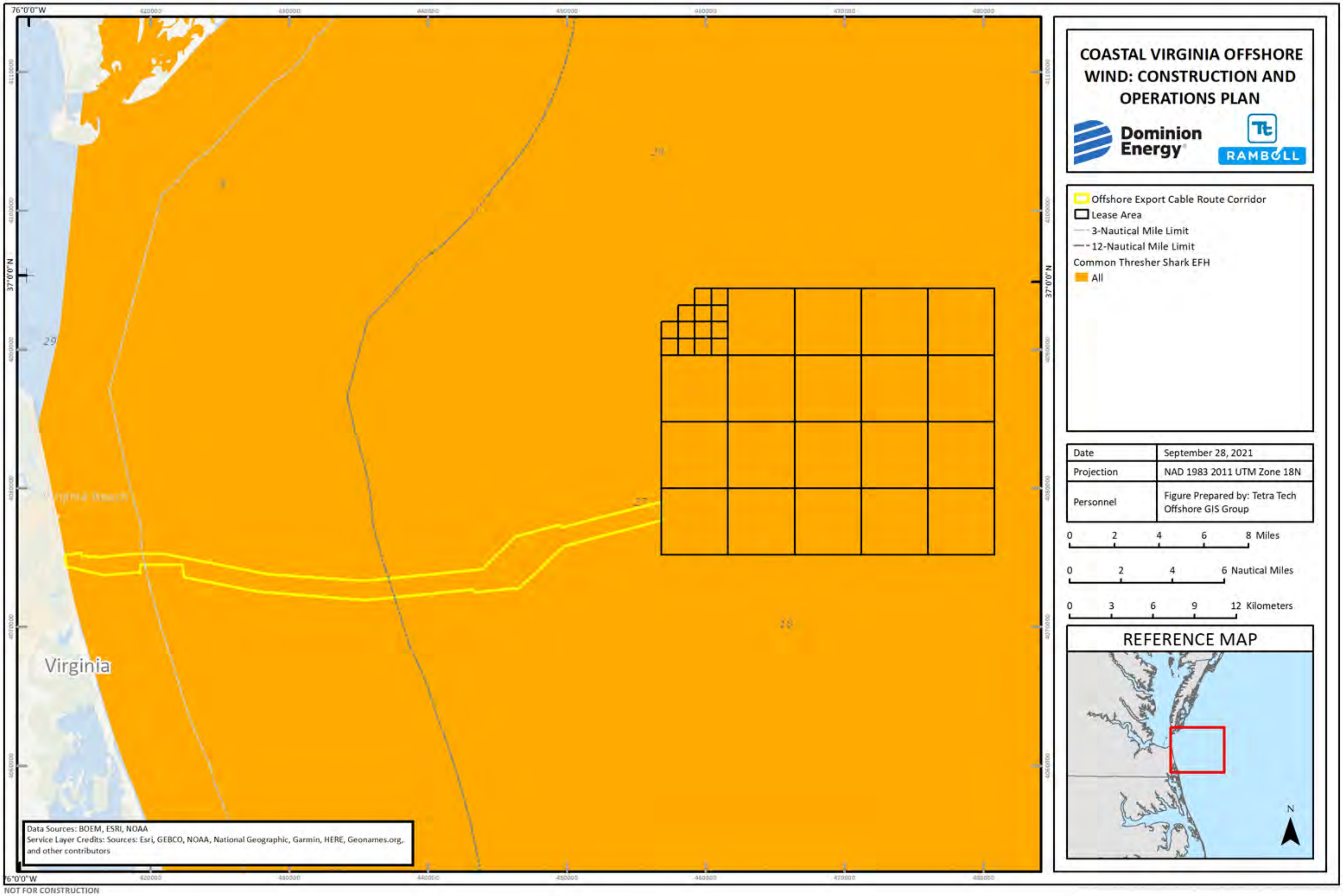

Figure E-1-29. Common Thresher Shark (*Alopias vulpinus*) Designated EFH in the Offshore Project Area

E-1.2.29 Dusky Shark (*Carcharhinus obscurus*)

Dusky shark neonate EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-30; Figure E-1-30). Dusky shark juvenile and adult EFH is designated in the Lease Area and federal waters of the Offshore Export Cable Route Corridor (Table E-1-30; Figure E-1-30).

Table E-1-30. Dusky Shark (*Carcharhinus obscurus*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**13,800**	**1,832**
EFH Acreage in Project Area by Life Stage			
Neonate	112,799	14,234	1,644
Juvenile/Adult	112,799	3,119	0
Percent of Project Area Covered by EFH by Life Stage			
Neonate	100.0%	100.0%	99.5%
Juvenile/Adult	100.0%	21.9%	0.0%
Percent of Total Species EFH Area Covered by Project Area			
Neonate	0.604%	0.076%	0.009%
Juvenile/Adult	0.112%	0.003%	0.000%

Sources: NOAA Fisheries 2017

The dusky shark is a highly migratory species found in warm and temperate continental shelf waters from inshore habitats to the outer continental shelf; it makes seasonal north-south migrations (NOAA Fisheries 2017). They are generalist predators and feed on demersal fishes (e.g., flounders, skates), pelagic fishes (e.g., sardines, tunas), and cephalopods (NOAA Fisheries 2017). Designated EFH for dusky shark neonates and YOY is in offshore pelagic habitats of New England to Cape Lookout, North Carolina, in depths of 13 to 197 ft (4 to 60 m), where temperatures span 64 to 72°F (18 to 22°C) and salinities are within 25 to 35 ppt. Designated EFH for juveniles and adults is in coastal and pelagic habitats inshore of the continental shelf break in depths of 66 to 656 ft (20 to 200 m), where temperatures span 68 to 75°F (20 to 24°C). Adults are generally found deeper than juveniles in depths of 6,562 ft (2,000 m) (NOAA Fisheries 2017).

The dusky shark is managed on the Atlantic Coast of the U.S. by NOAA's HMS Management Division under the Consolidated HMS FMP as a single stock: the Atlantic and Gulf of Mexico stock. The fishery stock is currently overfished and subject to overfishing (NOAA Fisheries 2019).

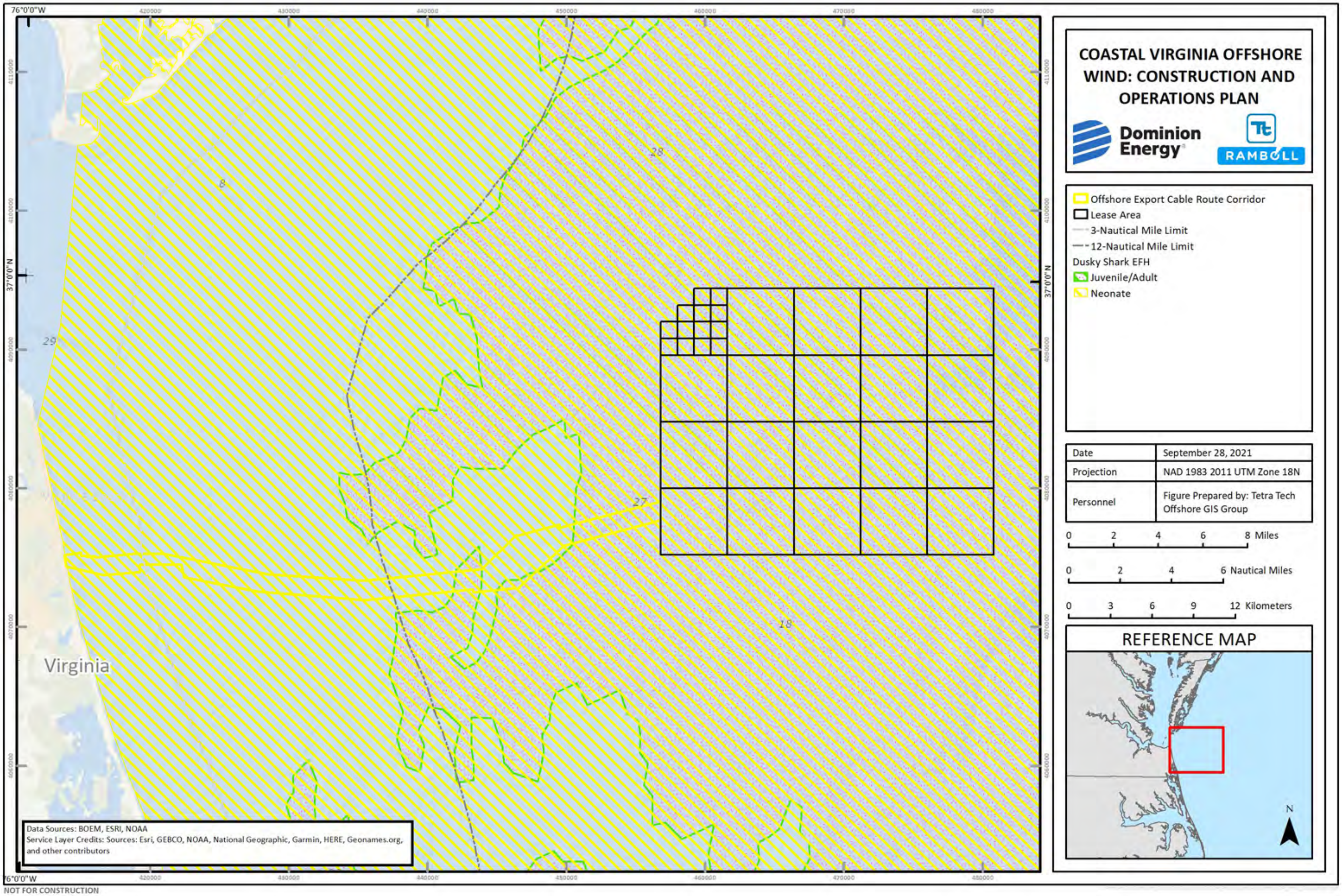

Figure E-1-30. Dusky Shark (*Carcharhinus obscurus*) Designated EFH in the Offshore Project Area

E-1.2.30 Sand Tiger Shark (*Carcharhinus taurus*)

Sand tiger shark EFH for all life stages is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-31; Figure E-1-31).

Table E-1-31. Sand Tiger Shark (*Carcharhinus taurus*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Neonate/Juvenile	94,517	14,234	1,652
Adult	112,799	14,234	1,652
Percent of Project Area Covered by EFH by Life Stage			
Neonate/Juvenile	83.8%	100.0%	100.0%
Adult	100.0%	100.0%	100.0%
Percent of Total Species EFH Area Covered by Project Area			
Neonate/Juvenile	0.283%	0.043%	0.005%
Adult	0.395%	0.050%	0.006%

Sources: NOAA Fisheries 2017

The sand tiger shark is a highly migratory species found in tropical and warm temperate coastal waters (NOAA Fisheries 2017). The species exhibits seasonal migrations from northern summer habitats to southern overwintering habitats; individuals may segregate by sex, with males exhibiting stricter north-south migrations and females exhibiting greater inshore-offshore seasonal movements. In North America, adults give birth to two pups in March and April, likely in the southern part of their range. Neonates migrate northward to rear in estuaries and coastal sounds in the Mid-Atlantic Bight. They feed on a variety of fishes (e.g., hakes, herring), crabs, and cephalopods (NOAA Fisheries 2017). Designated EFH for sand tiger shark neonates, YOY, and juveniles extends from Massachusetts to Florida in nearshore habitats and coastal sounds; they exhibit habitat preferences for mud, rocky substrates, and complex natural or artificial reef structures in depths of 26 to 46 ft (8 to 14 m), where temperatures span 66 to 81°F (19 to 27°C) and salinities are within 30 to 31 ppt. Designated EFH for adults is in shallow coastal waters from Florida to Delaware Bay (typically in 13 ft [4 m]) in temperatures spanning 63 to 73°F (17 and 23°C) (NOAA Fisheries 2017).

The sand tiger shark is managed on the Atlantic Coast of the U.S. by NOAA's HMS Management Division under the Consolidated HMS FMP. Fishing for the sand tiger shark is prohibited in U.S. waters (NOAA Fisheries 2017).

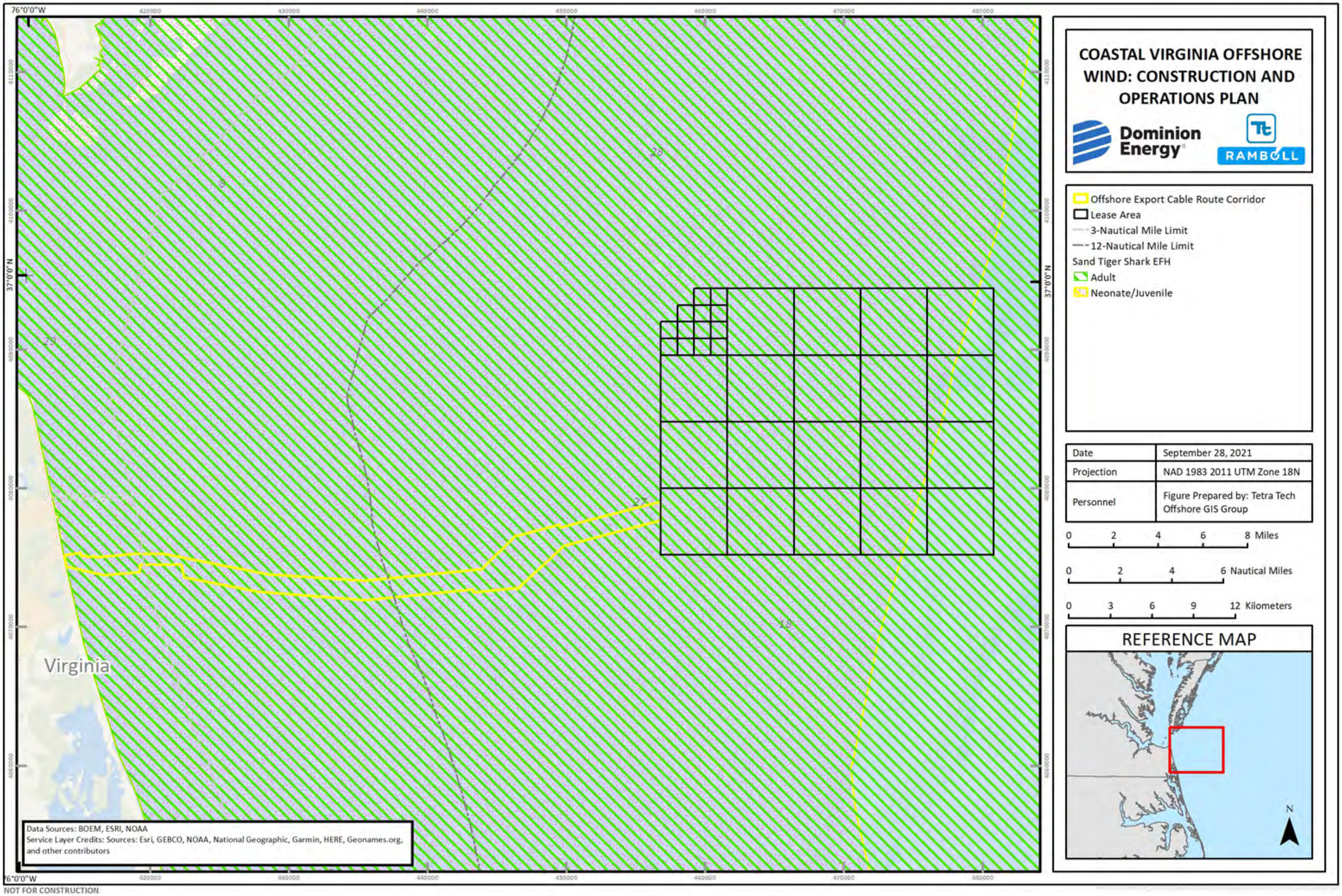

Figure E-1-31. Sand Tiger Shark (*Carcharhinus taurus*) Designated EFH in the Offshore Project Area

E-1.2.31 Sandbar Shark (*Carcharhinus plumbeus*)

Sandbar shark EFH for all life stages is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-32; Figure E-1-32).

Table E-1-32. Sandbar Shark (*Carcharhinus plumbeus*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Neonate	15,789	14,234	1,652
Juvenile	112,799	14,234	1,652
Adult	112,799	14,234	1,647
Percent of Project Area Covered by EFH by Life Stage			
Neonate	14.0%	100.0%	100.0%
Juvenile	100.0%	100.0%	100.0%
Adult	100.0%	100.0%	99.6%
Percent of Total Species EFH Area Covered by Project Area			
Neonate	0.098%	0.088%	0.010%
Juvenile	0.297%	0.038%	0.004%
Adult	0.096%	0.012%	0.001%

Sources: NOAA Fisheries 2017

The sandbar shark is a highly migratory species common to subtropical and warm temperate benthic habitats (NOAA Fisheries 2017). It is common to coastal areas from Cape Cod to the Gulf of Mexico, migrates seasonally, and segregates itself by sex throughout much of the year. The species feeds opportunistically on a variety of fishes, smaller sharks, cephalopods, gastropods, crabs, and shrimp (NOAA Fisheries 2017). Designated EFH for sandbar shark neonates and YOY is in coastal benthic habitats from Long Island, New York to Cape Lookout, North Carolina, including estuarine nursery habitat in Chesapeake Bay; they exhibit habitat preferences for sand, mud, shell, and rocky substrates in depths of 3 to 75 ft (1 to 23 m), where temperatures span 59 to 86°F (15 to 30°C) and salinities are within 15 to 35 ppt. Designated EFH for juveniles is in coastal habitats from New England to Georgia, including estuarine habitat in Chesapeake Bay; they exhibit habitat preferences for sand, mud, shell, and rocky substrates in depths of 6 to 20 ft (2 to 236 m), where temperatures span 59 to 86°F (15 to 30°C) and salinities are within 15 to 35 ppt. Designated EFH for adults is in coastal habitats from New England to the Florida Keys, spanning estuarine habitats to the continental shelf break in depths of 66 to 656 ft (20 to 200 m) (NOAA Fisheries 2017).

The sandbar shark is managed on the Atlantic Coast of the U.S. by NOAA's HMS Management Division under the Consolidated HMS FMP as a single stock: the Atlantic and Gulf of Mexico stock. The fishery stock is currently overfished but is not subject to overfishing (NOAA Fisheries 2017).

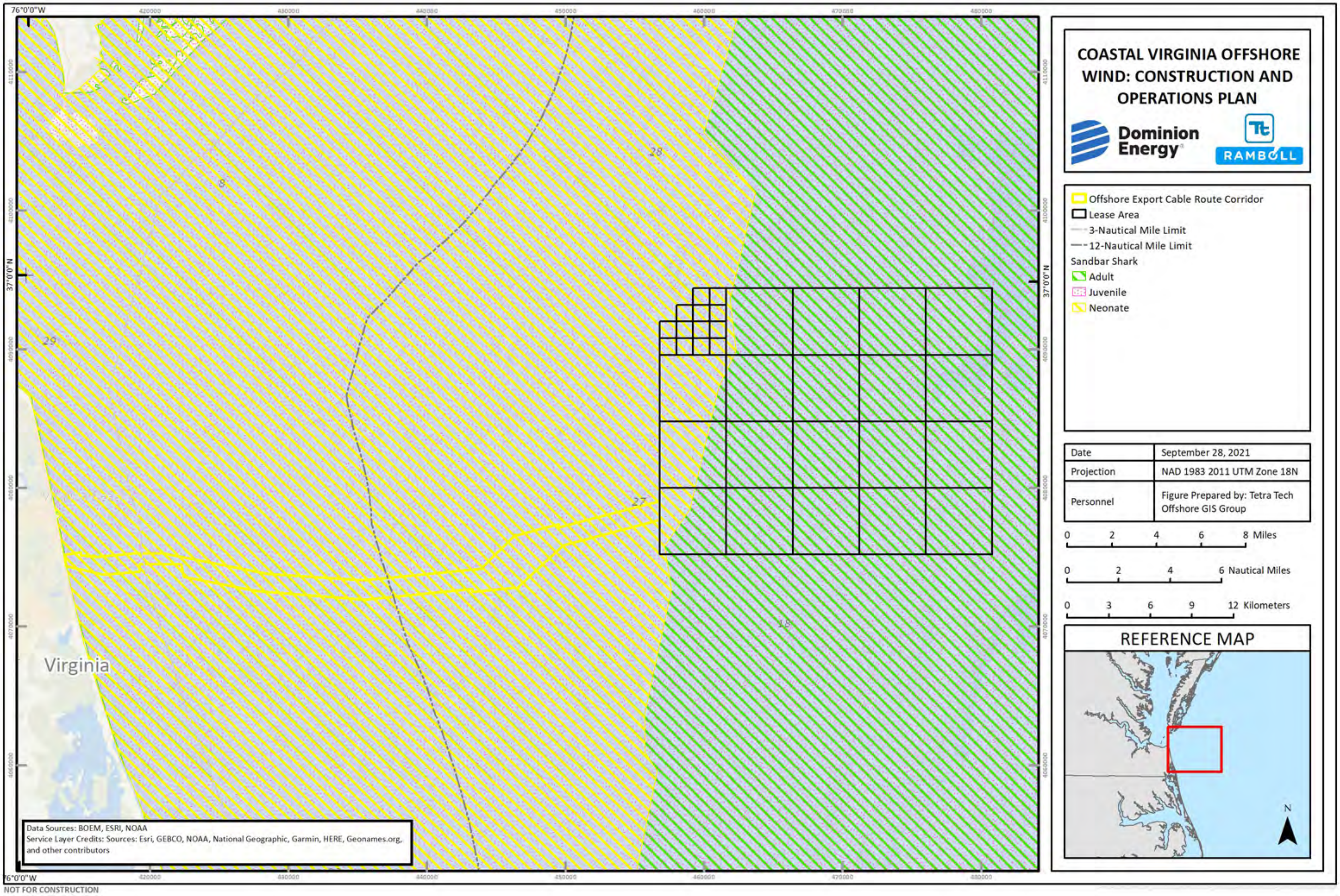

Figure E-1-32. Sandbar Shark (*Carcharhinus plumbeus*) Designated EFH in the Offshore Project Area

E-1.2.32 Smoothhound Shark / Smooth Dogfish (*Mustelus canis*)

Smoothhound shark/smooth dogfish EFH for all life stages is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-33; Figure E-1-33).

Table E-1-33. Smoothhound Shark / Smooth Dogfish (*Mustelus canis*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
ALL	112,799	14,234	1,647
Percent of Project Area Covered by EFH by Life Stage			
ALL	100.0%	100.0%	99.6%
Percent of Total Species EFH Area Covered by Project Area			
ALL	0.403%	0.051%	0.006%

Sources: NOAA Fisheries 2017

The smooth dogfish is a common coastal shark species found in the Atlantic Ocean from Massachusetts to northern Argentina (NOAA Fisheries 2017). The species is found primarily in benthic habitats on the continental shelf; it aggregates between North Carolina and the Chesapeake Bay in offshore habitats in the winter and moves inshore to coastal habitats in the spring when bottom temperatures exceed 43°F (6°C). Mating occurs from May through September; neonates rear in estuaries and inshore marsh creeks during June and July and YOY migrate to open waters in October. The species primarily feeds on large crustaceans and small fishes (NOAA Fisheries 2017). Designated EFH for all life stages of the smoothhound shark complex/smooth dogfish is in coastal and continental shelf benthic marine habitats and inshore bays and estuaries from the shoreline to depths of 656 ft (200 m), where temperatures span 43 to 81°F (6 to 27°C) (NOAA Fisheries 2017).

The smooth dogfish is managed on the Atlantic Coast of the U.S. by NOAA's HMS Management Division under the Consolidated HMS FMP as a single stock: the Atlantic stock. The fishery stock is not currently overfished or subject to overfishing (NOAA Fisheries 2017).

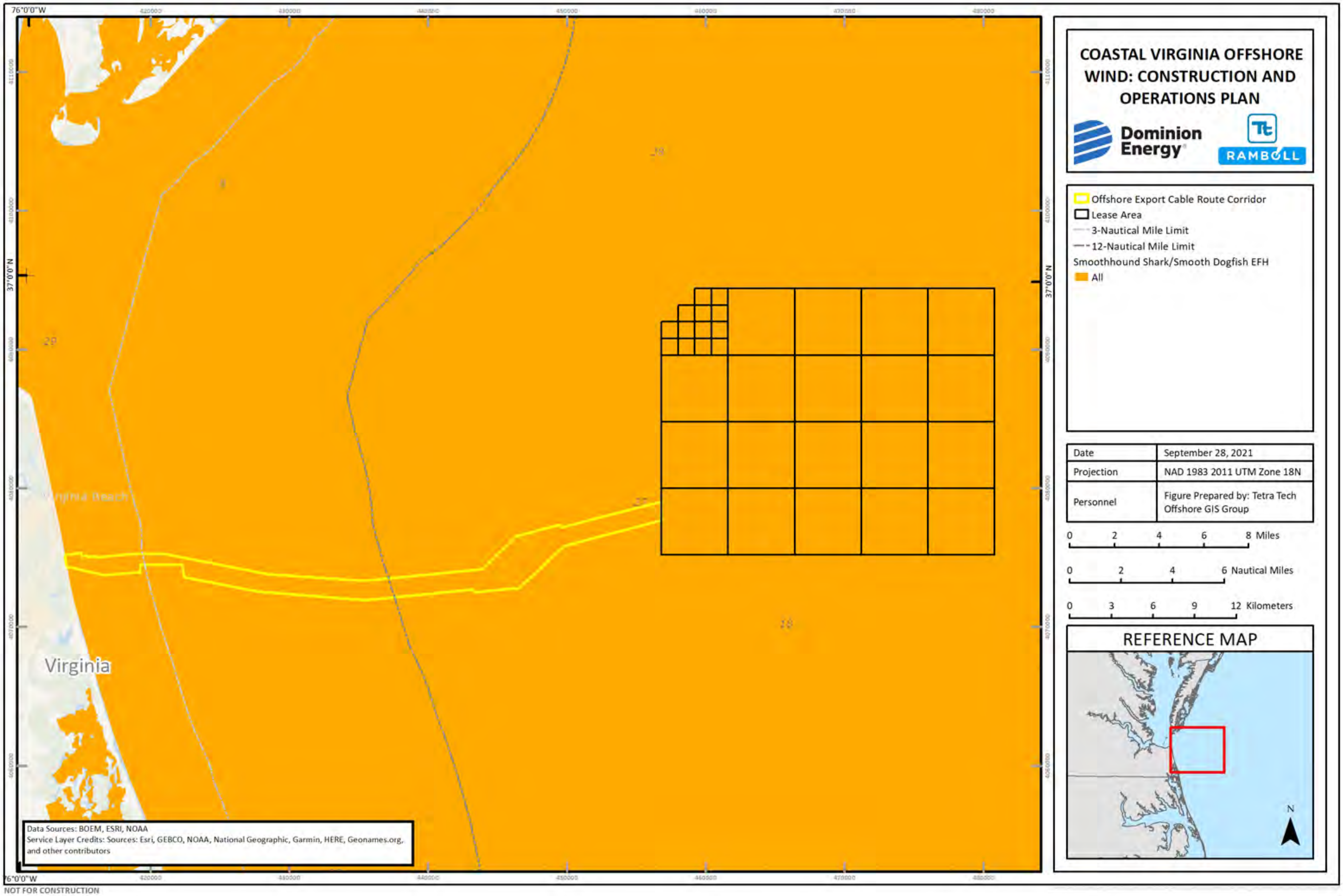

Figure E-1-33. Smoothhound Shark / Smooth Dogfish (*Mustelus canis*) Designated EFH in the Offshore Project Area

E-1.2.33 Tiger Shark (*Galeocerdo cuvier*)

No tiger shark neonate EFH is designated in the Offshore Project Area. Tiger shark juvenile and adult EFH is designated in the Lease Area and both federal and state waters of the Offshore Export Cable Route Corridor (Table E-1-34; Figure E-1-34).

Table E-1-34. Tiger Shark (*Galeocerdo cuvier*) Designated EFH in the Offshore Project Area

Action Area	Lease Area	Offshore Export Cable Route Corridor	
		Federal Waters	State Waters
Total Project Acreage	**112,799**	**14,234**	**1,652**
EFH Acreage in Project Area by Life Stage			
Juvenile/Adult	112,799	14,234	1,647
Percent of Project Area Covered by EFH by Life Stage			
Juvenile/Adult	100.0%	100.0%	99.6%
Percent of Total Species EFH Area Covered by Project Area			
Juvenile/Adult	0.403%	0.051%	0.006%

Sources: NOAA Fisheries 2017

The tiger shark is a highly migratory species that inhabits warm waters in shallow coastal and deep pelagic habitats (NOAA Fisheries 2017). In the western North Atlantic Ocean, it occurs in coastal and offshore waters from 40°N to the equator and is known to make long distance movements in pursuit of forage species. Juveniles and adults are generalists and consume a wide variety of fishes, other sharks, crustaceans, cephalopods, and marine mammals (NOAA Fisheries 2017). Designated EFH for juveniles and adults is in offshore pelagic habitats at the continental shelf break; individuals typically remain in the upper 164 ft (50 m) of the water column but are known to make dives to depths greater than 656 ft (200 m) (NOAA Fisheries 2017).

The tiger shark is managed in the Atlantic Coast of the U.S. by NOAA's HMS Management Division under the Consolidated HMS FMP as a single stock: the Atlantic and Gulf of Mexico stock. The stock status remains unknown (NOAA Fisheries 2017).

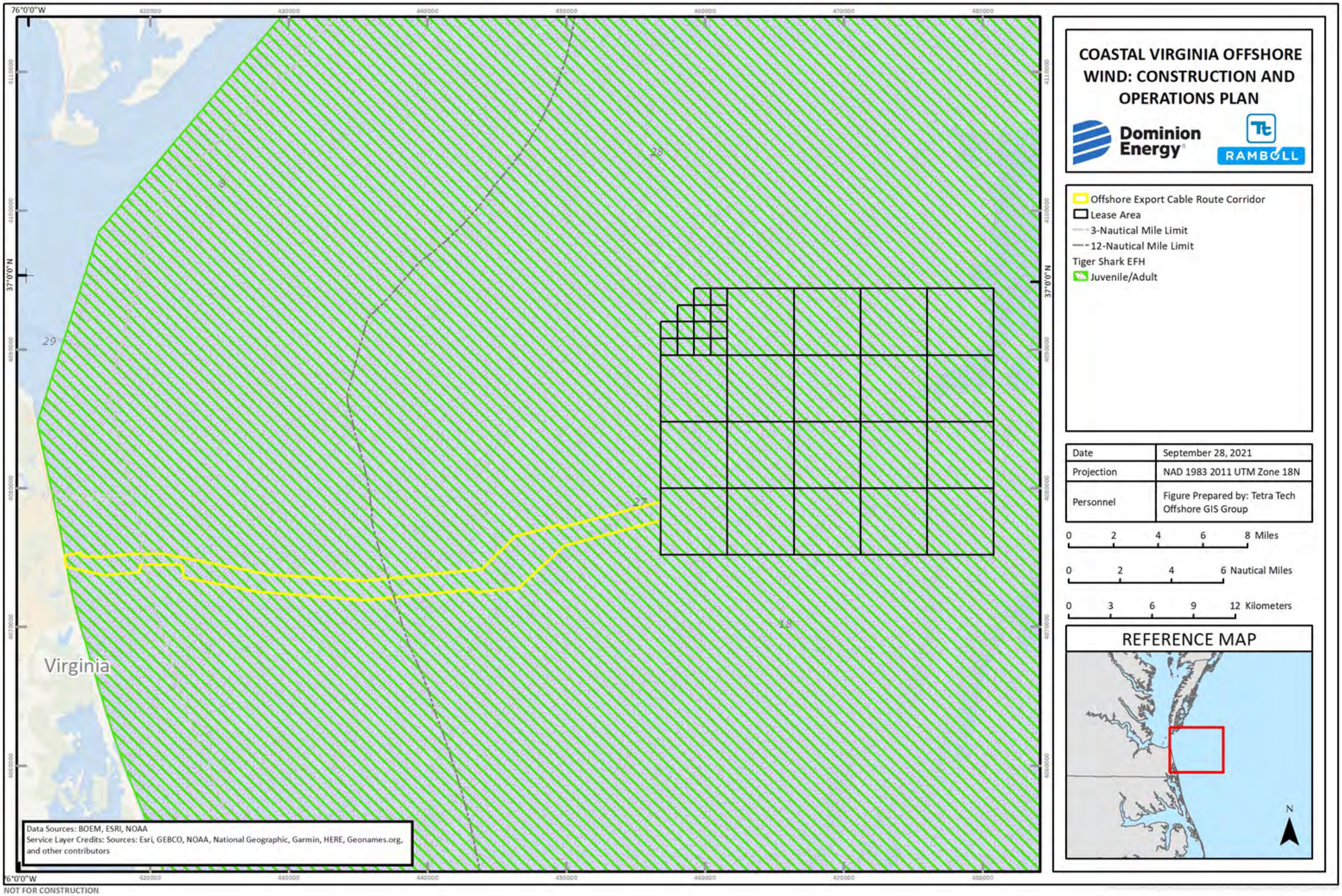

Figure E-1-34. Tiger Shark (*Galeocerdo cuvier*) Designated EFH in the Offshore Project Area

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ATTACHMENT E-2: OVERSIZED TABLES

CONSTRUCTION AND OPERATIONS PLAN

Coastal Virginia Offshore Wind Commercial Project

Appendix E, Attachment E-2
Oversized Tables

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TABLES

Table E-2-1. Summary of Designated EFH for Managed Species and Life Stages in the Offshore Project Area

Species	Stock Status a/	Life Stage	Depth (meters) b/	Habitat Type and Description b/	Typical Prey b/
Atlantic cod	1,2	Egg	0-70	Epipelagic; bays, estuaries, and upper 10 m of continental shelf water column	n/a
		Larva	0-75	Epipelagic; bays, estuaries, and upper 75 m of continental shelf water column	Plankton
Atlantic herring	1	Juveniles	0-300	Epipelagic; bays, estuaries, and intertidal and subtidal pelagic habitats	Zooplankton including copepods, decapod larvae, barnacle larvae, cladocerans, and mollusk larvae
		Adults			Euphausiids, chaetognaths, and copepods
Atlantic sea scallop	3	Eggs	18-110	Benthic; inshore and continental shelf habitats in the vicinity of adult scallops	n/a
		Larvae	Upper 10 m of water column	Pelagic; inshore and offshore habitat until settling as spat on gravel, pebbles, shells, macroalgae, and other seafloor surfaces	Phytoplankton and microzooplankton
		Juveniles	18-110	Benthic; attached to gravel, pebble, cobbles, and shells until losing their byssal threads and becoming active swimmers	
		Adults	18-110	Benthic; seafloor habitats with sand and gravel substrates	
Clearnose Skate	3	Juveniles	0-300	Benthic; bays, estuaries, and subtidal benthic habitats on coastal and inner continental shelf	Polychaetes, amphipods, mantis and mysid shrimps, crabs, squid, and fishes
		Adults			
Monkfish	3	Eggs	0-1,000	Pelagic in mucoidal egg veils	n/a
		Larvae	0-1,000	Pelagic; inshore areas and on continental shelf and slope	Zooplankton, including copepods, crustacean larvae, and chaetognaths
		Juveniles	20-400	Benthic; subtidal benthic habitats over soft mud, sand, gravel, pebbles, shell fragments, and rock outcroppings with attached algae	Small fishes, red shrimp, and squid
		Adults	0-800	Benthic; subtidal benthic habitats over soft mud, sand, gravel, pebbles, and shell fragments	Benthic and pelagic crustaceans, squid, and fishes
Pollock	3	Larva	30-1,250	Pelagic; bays, estuaries, inshore and offshore habitats	Copepods
Red hake	1,2	Adults	5-750	Benthic; bays, estuaries, outer continental shelf on depressions in soft mud and sand	Crustaceans, demersal and pelagic fish, squid
Windowpane flounder	3	Eggs	0-70	Pelagic; bays, estuaries, pelagic habitat	n/a
		Larvae			Plankton
		Juveniles	0-75	Benthic; intertidal and sub-tidal benthic habitats in estuaries, bays, and continental shelf over mud and sand substrates	Small crustaceans and fish larvae
		Adults			
Winter skate	3	Juveniles	0-371	Benthic; estuaries, bays, and subtidal benthic habitats on continental shelf	Polychaetes, amphipods, decapods, isopods, bivalves, and fishes

Species	Stock Status a/	Life Stage	Depth (meters) b/	Habitat Type and Description b/	Typical Prey b/
Witch flounder	1	Egg	10-170	Epipelagic; surface waters over continental shelf	n/a
		Larvae	0-250	Pelagic; continental shelf	Pelagic prey
Yellowtail flounder	3	Larvae	10-1,250	Pelagic; estuaries, bays, and upper 20 m of coastal and continental shelf habitats	Plankton
Atlantic butterfish	3	Eggs	0-1,500	Epipelagic; estuaries, bays, and upper 200 m of water column over continental shelf and slope	n/a
		Larvae	0-1,750		Plankton
		Juveniles	10-330	Pelagic; estuaries, bays, and inner and outer continental shelf	Thaliaceans, mollusks, crustaceans, coelenterates, polychaetes, small fishes, and ctenophores
		Adults	0-420		
Atlantic mackerel	1, 2	Eggs	10-325	Pelagic; estuaries, bays, and continental shelf	n/a
		Juveniles	0-320		Copepods, amphipods, mysid shrimp, decapods
		Adults	0-380		
Atlantic surfclam	3	Juveniles	8-66	Benthic; softbottom substrates to depths of 1m below sediment/water interface	Plankton
		Adults			
Black sea bass	3	Larvae	0-2,000	Epipelagic; estuaries and in the upper 100m of water column over continental shelf	Decapods
		Juveniles	0-400	Benthic; estuaries and continental shelf	Benthic and epibenthic crustaceans and small fishes
		Adults	20-400		Epibenthic invertebrates, small fishes, and squid
Bluefish	1	Eggs	30-70	Pelagic; continental shelf	n/a
		Larvae			Copepods
		Juveniles	5-20	Pelagic; estuaries and continental shelf	Fishes, crustaceans, and polychaetes
		Adults	Varies		
Longfin inshore squid	4	Eggs	0-50	Benthic; anchored to hardbottom on shells, rocks, boulders, vegetation, sand and mud	n/a
		Juveniles	50-100	Pelagic; coastal inshore waters and offshore continental shelf waters	Euphausiids, arrow worms, small crabs, polychaetes, and shrimp
		Adults	6-200	Pelagic; regional embayments, costal inshore and offshore continental shelf waters	Larval and juvenile fish and squid, adult fishes and squid
Scup	3	Juveniles	0-38	Benthic; estuaries, intertidal and subtidal habitats over continental shelf	Polychaetes, epibenthic amphipods, other crustaceans, mollusks, and fish eggs and larvae
		Adults	2-38	Benthic; estuaries, intertidal and subtidal habitats over continental shelf	Polychaetes, mollusks, small squid, detritus, insect larvae, hydroids, sand dollars, and small fishes
Spiny dogfish	3		25-364	Epibenthic and pelagic; outer continental shelf	Fishes, squid, and ctenophores

Species	Stock Status a/	Life Stage	Depth (meters) b/	Habitat Type and Description b/	Typical Prey b/
		Sub-adult females; Adult males and females			
Summer flounder	3	Eggs	9-110	Pelagic	n/a
		Larvae	9-70	Pelagic	Plankton, copepods
		Juveniles	0-152	Benthic; estuaries, salt marshes, seagrasses, mudflats, bays	Polychaetes, infaunal invertebrates, bivalve siphons, small fish
		Adults	0-152	Benthic; shallow coastal and estuarine waters to offshore outer continental shelf	Fishes and invertebrates
Atlantic albacore tuna	3	Juveniles	Varied	Epipelagic; offshore seaward of the continental shelf	Fishes and cephalopods
Atlantic angel shark	4	All	Varied	Benthic; continental shelf	Bony fishes, cephalopods, crustaceans, and portunid crabs
Atlantic bluefin tuna	4	Juveniles	20-100	Epipelagic; coastal and pelagic habitats to the continental shelf break	Zooplanktivorous fishes and crustaceans
		Adults			Fishes, cephalopods, benthic invertebrates
Atlantic sharpnose shark	3	Juveniles	0-180m	Estuarine, inshore, and nearshore waters	Bony fishes
		Adults			
Atlantic skipjack tuna	4	Juveniles	>20	Epipelagic; coastal and offshore habitats	Fishes, cephalopods, and crustaceans
		Adults			
Atlantic yellowfin tuna	3	Juveniles	Upper 100 m of water column	Epipelagic; coastal and offshore pelagic habitats seaward of the continental shelf break	Fishes, cephalopods, and crustaceans
		Adults			
Blacktip shark	3	Juvenile; Adult	1-9	Epipelagic; offshore surface waters and shallow coastal waters over silt, sand, mud, and seagrass habitats	Fishes, cephalopods, and crustaceans
Common thresher shark	4	All	5-13	Pelagic; nearshore	Invertebrates and small fishes
Dusky shark	1, 2	Neonate	4-60	Pelagic; offshore	Demersal and pelagic fishes and cephalopods
		Juvenile; Adult	20-200	Pelagic; coastal, inshore of the continental shelf break	
Sand tiger shark	4	Neonate; Juvenile	8-14	Bays and coastal sounds over mud, rocky substrates, and complex habitat	Fishes, crabs, and cephalopods
		Adult	1-4	Shallow coastal waters	
Sandbar shark	1	Neonate	1-23	Benthic; coastal and estuarine habitats over sand, mud, shell, and rocky substrates	Fishes, smaller sharks, cephalopods, gastropods, crabs, and shrimp

Species	Stock Status a/	Life Stage	Depth (meters) b/	Habitat Type and Description b/	Typical Prey b/
		Juvenile	1-236	Pelagic; coastal and estuarine habitats over sand, mud, shell, and rocky substrates	
		Adult	20-200	Benthic; coastal, estuarine, and shelf break habitats	
Smoothhound shark / smooth dogfish	3	All	0-200	Benthic; coastal and continental shelf, inshore bays and estuaries	Large crustaceans and small fishes
Tiger Shark	4	Juvenile	0-200	Epipelagic; shallow coastal and deep pelagic habitats at the continental shelf break	Fishes, other sharks, crustaceans, cephalopods, and marine mammals
		Adult			

Notes:
a/ NOAA Fisheries Stock Status Update as of 2nd Quarter, 2021; 1=overfished; 2=overfishing; 3=recovered; 4=not mentioned
b/ See EFH Source documents listed in Attachment E-1.

Table E-2-2. Summary of Potential Impacts to Managed Species and Life Stages in the Offshore Project Area

Managed Species	Lease Area				Offshore Export Cable Route Corridor				Supporting Information
	Life Stage								
	E	L	J	A	E	L	J	A	
Atlantic Cod (*Gadus morhua*)	--	X	--	--	X	X	--	--	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									Eggs and larvae are pelagic and have a minimal chance of entrainment.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat									Eggs and larvae are pelagic.
Atlantic Herring (*Clupea harengus*)	--	--	X	X	--	--	X	X	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									Juveniles and adults are pelagic, highly mobile, and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat									The Project would not affect pelagic prey or habitat.
Atlantic Sea Scallop (*Placopecten magellanicus*)	X	X	X	X	--	--	--	--	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration	✓	✓	✓	✓					Demersal eggs, settled spat, sessile juveniles, and adults with limited mobility could be disturbed, injured, or crushed by direct contact with construction equipment. Sessile life stages could also be buried by sediment deposition. All life stages could be adversely affected by impact pile driving.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat	✓	+	+	✓					Eggs settled on hard structure may be less viable than those settled on unconsolidated natural substrate, while spat and juveniles may benefit from increased hardbottom available for settlement. Adults would be displaced laterally to adjacent softbottom. No changes are expected to pelagic prey.
Clearnose Skate (*Raja eglanteria*)	--	n/a	X	X	--	n/a	X	X	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration			✓	✓			✓	✓	Juveniles and adults could be disturbed, injured, or crushed by direct contact with construction equipment or indirect contact with noise and vibration. Impacts would be minimal because these life stages are mobile and can avoid injury. Demersal prey may also be injured or temporarily displaced.

Managed Species	Lease Area				Offshore Export Cable Route Corridor				Supporting Information
	Life Stage								
	E	L	J	A	E	L	J	A	
Operations: Loss of softbottom habitat; introduction of hardbottom habitat			✓	✓			✓	✓	Juveniles, adults, and demersal prey would be displaced by novel structure laterally to adjacent softbottom.
Monkfish (*Lophius americanus*)	X	X	X	--	X	X	--	X	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration			✓					✓	Eggs and larvae are pelagic and have a minimal chance of entrainment. Juveniles in the Lease Area and adults in the Offshore Export Cable Route Corridor could be disturbed, injured, or crushed by direct contact with construction equipment or indirect contact with noise and vibration. Impacts would be minimal because these life stages are mobile and can avoid injury. Demersal prey may also be injured or temporarily displaced.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat			+					+	Juveniles and adults are known to forage on the edge of complex reef habitat and may benefit from the introduction of novel structure.
Pollock (*Pollachius virens*)	--	X	--	--	--	X	--	--	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									Larvae are pelagic and have a minimal chance of entrainment.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat									Larvae are pelagic.
Red Hake (*Urophycis chuss*)	--	--	--	X	--	--	--	--	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration				✓					Adults could be disturbed, injured, or crushed by direct contact with construction equipment or indirect contact with noise and vibration. Impacts would be minimal because adults are mobile and EFH for this life stage only intersects with the southern edge of the Lease Area.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat				+					Adults are known to aggregate around complex reef habitat and may benefit from the introduction of novel structure.

Managed Species	Lease Area				Offshore Export Cable Route Corridor				Supporting Information
	Life Stage								
	E	L	J	A	E	L	J	A	
Windowpane Flounder (*Scophthalmus aquosus*)	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration			✓	✓			✓	✓	Eggs and larvae are pelagic and have a minimal chance of entrainment. Juveniles and adults could be disturbed, injured, or crushed by direct contact with construction equipment or indirect contact with noise and vibration. Impacts would be minimal because these life stages are mobile and can avoid injury. Demersal prey may also be injured or temporarily displaced.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat			✓	✓			✓	✓	Juveniles, adults, and demersal prey would be displaced by novel structure laterally to adjacent softbottom.
Winter Skate (*Leucoraja ocellata*)	**--**	**n/a**	**X**	**--**	**--**	**n/a**	**X**	**--**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration			✓				✓		Juveniles could be disturbed, injured, or crushed by direct contact with construction equipment or indirect contact with noise and vibration. Impacts would be minimal because juveniles stages are mobile and can avoid injury. Demersal prey may also be injured or temporarily displaced.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat			✓				✓		Juveniles, and demersal prey would be displaced by novel structure laterally to adjacent softbottom.
Witch Flounder (*Glyptocephalus cynoglossus*)	**X**	**X**	**--**	**--**	**X**	**X**	**--**	**--**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									Eggs and larvae are pelagic and have a minimal chance of entrainment.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat									Eggs and larvae are pelagic.
Yellowtail Flounder (*Limanda ferruginea*)	**--**	**X**	**--**	**--**	**--**	**X**	**--**	**--**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									Eggs and larvae are pelagic and have a minimal chance of entrainment.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat									Eggs and larvae are pelagic.

Managed Species	Lease Area				Offshore Export Cable Route Corridor				Supporting Information
	Life Stage								
	E	L	J	A	E	L	J	A	
Atlantic Butterfish (*Peprilus triacanthus*)	--	X	X	X	X	--	X	X	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									Eggs and larvae are pelagic and have a minimal chance of entrainment. Juveniles and adults are pelagic, highly mobile, and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat									The Project would not affect pelagic prey or habitat.
Atlantic Mackerel (*Scomber scombrus*)	X	--	X	X	X	--	X	X	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									Eggs are pelagic and have minimal chance of entrainment. Juveniles and adults are pelagic, highly mobile, and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat									The Project would not affect pelagic prey or habitat.
Atlantic Surfclam (*Spisula solidissima*)	--	--	X	X	--	--	X	X	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration			✓	✓			✓	✓	Juveniles and adults buried in unconsolidated sediments could be disturbed, injured, or crushed by direct contact with construction equipment or indirect contact with noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat			✓	✓			✓	✓	Juveniles and adults would be displaced by novel structure laterally to adjacent softbottom.
Black Sea Bass (*Centropristis striata*)	--	X	X	X	--	X	X	X	
Construction: Direct disturbance, injury, or mortality of life stage; sediment deposition; entrainment; noise and vibration			✓	✓			✓	✓	Larvae are pelagic and have minimal chance of entrainment. Juveniles and adults could be disturbed, injured, or crushed by direct contact with construction equipment or indirect contact with noise and vibration. Impacts would be minimal because these life stages are mobile and can avoid injury. Demersal prey may also be injured or temporarily displaced.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat			+	+			+	+	Juveniles and adults are heavily structure-associated and exhibit strong site fidelity. They may benefit from the introduction of novel structure.

Managed Species	Lease Area				Offshore Export Cable Route Corridor				Supporting Information
	Life Stage								
	E	L	J	A	E	L	J	A	
Bluefish (*Pomatomus saltatrix*)	X	X	X	--	X	X	X	X	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									Eggs and larvae are pelagic and have a minimal chance of entrainment. Juveniles and adults are pelagic, highly mobile, and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat									The Project would not affect pelagic prey or habitat.
Longfin Inshore Squid (*Doryteuthis [Amerigo] pealeii*)	--	--	X	X	X	--	X	X	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration					✓				Benthic eggs could be disturbed, injured, or crushed by direct contact with construction equipment. They could also be buried by sediment deposition. Juveniles and adults are pelagic, highly mobile, and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat					✓+				Eggs are attached to hard substrates and may benefit from increased hardbottom available for attachment.
Scup (*Stenotomus chrysops*)	--	--	X	X	--	--	X	X	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration			✓	✓			✓	✓	Juveniles and adults could be disturbed, injured, or crushed by direct contact with construction equipment or indirect contact with noise and vibration. Impacts would be minimal because these life stages are mobile and can avoid injury. Demersal prey may also be injured or temporarily displaced.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat			+	+			+	+	Juveniles and adults are known to aggregate around complex reef habitat and may benefit from the introduction of novel structure.
Spiny Dogfish (*Squalus acanthias*)	n/a	--	--	X	n/a	--	--	X	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									Sub-adult females and adult males and females are pelagic, highly mobile, and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat			+	+			+	+	Sub-adult females and adult males and females are known to aggregate around complex reef habitat and may benefit from the introduction of novel structure.

Managed Species	Lease Area				Offshore Export Cable Route Corridor				Supporting Information
	Life Stage								
	E	L	J	A	E	L	J	A	
Summer Flounder (*Paralichthys dentatus*)	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration			✓	✓			✓	✓	Eggs and larvae are pelagic and have a minimal chance of entrainment. Juveniles and adults could be disturbed, injured, or crushed by direct contact with construction equipment or indirect contact with noise and vibration. Impacts would be minimal because these life stages are mobile and can avoid injury. Demersal prey may also be injured or temporarily displaced.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat			✓	✓			✓	✓	Juveniles, adults, and demersal prey would be displaced by novel structure laterally to adjacent softbottom.
Albacore Tuna (*Thunnus alalonga*)	**--**	**--**	**X**	**--**	**--**	**--**	**X**	**--**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									Juveniles are pelagic, highly mobile, and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat			+				+		Juveniles are known to aggregate around structure in the water column and may benefit from the introduction of novel structure.
Atlantic Angel Shark (*Squatina dumeril*)	**n/a**	**X**	**X**	**X**	**n/a**	**X**	**X**	**X**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									All life stages are highly mobile and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat		+	+	+		+	+	+	All life stages are known to aggregate around complex reef habitat and may benefit from the introduction of novel structure.
Atlantic Bluefin Tuna (*Thunnus thynnus*)	**--**	**--**	**X**	**X**	**--**	**--**	**X**	**X**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									Juveniles and adults are pelagic, highly mobile, and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat			+	+			+	+	Juveniles and adults are known to aggregate around structure in the water column and may benefit from the introduction of novel structure.

Managed Species	Lease Area				Offshore Export Cable Route Corridor				Supporting Information
	Life Stage								
	E	L	J	A	E	L	J	A	
Atlantic Sharpnose Shark (*Rhizoprionodon terraenovae*)	**n/a**	**--**	**--**	**X**	**n/a**	**--**	**X**	**X**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									Juveniles and adults are pelagic, highly mobile, and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat				+			+	+	Juveniles and adults are known to aggregate around structure in the water column and may benefit from the introduction of novel structure.
Atlantic Skipjack Tuna (*Katsuwonus pelamis*)	**--**	**--**	**X**	**X**	**--**	**--**	**X**	**X**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									Juveniles and adults are pelagic, highly mobile, and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat			+	+			+	+	Juveniles and adults are known to aggregate around structure in the water column and may benefit from the introduction of novel structure.
Atlantic Yellowfin Tuna (*Thunnus albacares*)	**--**	**--**	**X**	**X**	**--**	**--**	**X**	**--**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									Juveniles and adults are pelagic, highly mobile, and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat			+	+			+		Juveniles and adults are known to aggregate around structure in the water column and may benefit from the introduction of novel structure.
Blacktip Shark (*Carcharhinus limbatus*)	**n/a**	**--**	**--**	**X**	**n/a**	**--**	**X**	**X**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									Juveniles and adults are pelagic, highly mobile, and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat			+	+			+	+	Juveniles and adults are known to aggregate around structure in the water column and may benefit from the introduction of novel structure.
Common Thresher Shark (*Alopias vulpinus*)	**n/a**	**X**	**X**	**X**	**n/a**	**X**	**X**	**X**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									All life stages are pelagic, highly mobile, and can avoid injury due to physical interactions or noise and vibration.

Managed Species	Lease Area				Offshore Export Cable Route Corridor				Supporting Information
	Life Stage								
	E	L	J	A	E	L	J	A	
Operations: Loss of softbottom habitat; introduction of hardbottom habitat		+	+	+		+	+	+	All life stages are known to aggregate around structure in the water column and may benefit from the introduction of novel structure.
Dusky Shark (*Carcharhinus obscurus*)	**n/a**	**X**	**X**	**X**	**n/a**	**X**	**X**	**X**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									All life stages are pelagic, highly mobile, and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat		+	+	+		+	+	+	All life stages are known to aggregate around structure in the water column and may benefit from the introduction of novel structure.
Sand Tiger Shark (*Carcharhinus taurus*)	**n/a**	**X**	**X**	**X**	**n/a**	**X**	**X**	**X**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									All life stages are highly mobile and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat		+	+	+		+	+	+	All life stages are known to aggregate around complex reef habitat and may benefit from the introduction of novel structure.
Sandbar Shark (*Carcharhinus plumbeus*)	**n/a**	**X**	**X**	**X**	**n/a**	**X**	**X**	**X**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									All life stages are highly mobile and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat		+	+	+		+	+	+	All life stages are known to aggregate around complex reef habitat and may benefit from the introduction of novel structure.
Smooth Dogfish (*Mustelus canis*)	**n/a**	**X**	**X**	**X**	**n/a**	**X**	**X**	**X**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									All life stages are highly mobile and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat		+	+	+		+	+	+	All life stages are known to aggregate around complex reef habitat and may benefit from the introduction of novel structure.

Managed Species	Lease Area				Offshore Export Cable Route Corridor				Supporting Information
	Life Stage								
	E	L	J	A	E	L	J	A	
Tiger shark (*Galeocerdo cuvier*)	**n/a**	**--**	**X**	**X**	**n/a**	**--**	**X**	**X**	
Construction: Direct disturbance, injury, or mortality of life stage; sediment suspension and deposition; entrainment; noise and vibration									All life stages are highly mobile and can avoid injury due to physical interactions or noise and vibration.
Operations: Loss of softbottom habitat; introduction of hardbottom habitat			+	+			+	+	All life stages are known to aggregate around complex reef habitat and may benefit from the introduction of novel structure.

Legend:
X: EFH for this life stage is designated in the portion of the Project Area indicated
--: No EFH for this life stage is designated in the portion of the Project Area indicated
n/a: Life stage does not exist
E: Egg
L: Larva (and neonate sharks)
J: Juvenile
A: Adults (and sub-adult female spiny dogfish)
✓: Likely adverse impact
+: Likely beneficial effect
Tan: Negligible or no adverse impact

ATTACHMENT E-3: OVERSIZED MAPS

CONSTRUCTION AND OPERATIONS PLAN

Coastal Virginia Offshore Wind Commercial Project

Attachment E-3
Oversized Maps

Prepared for:

Dominion Energy

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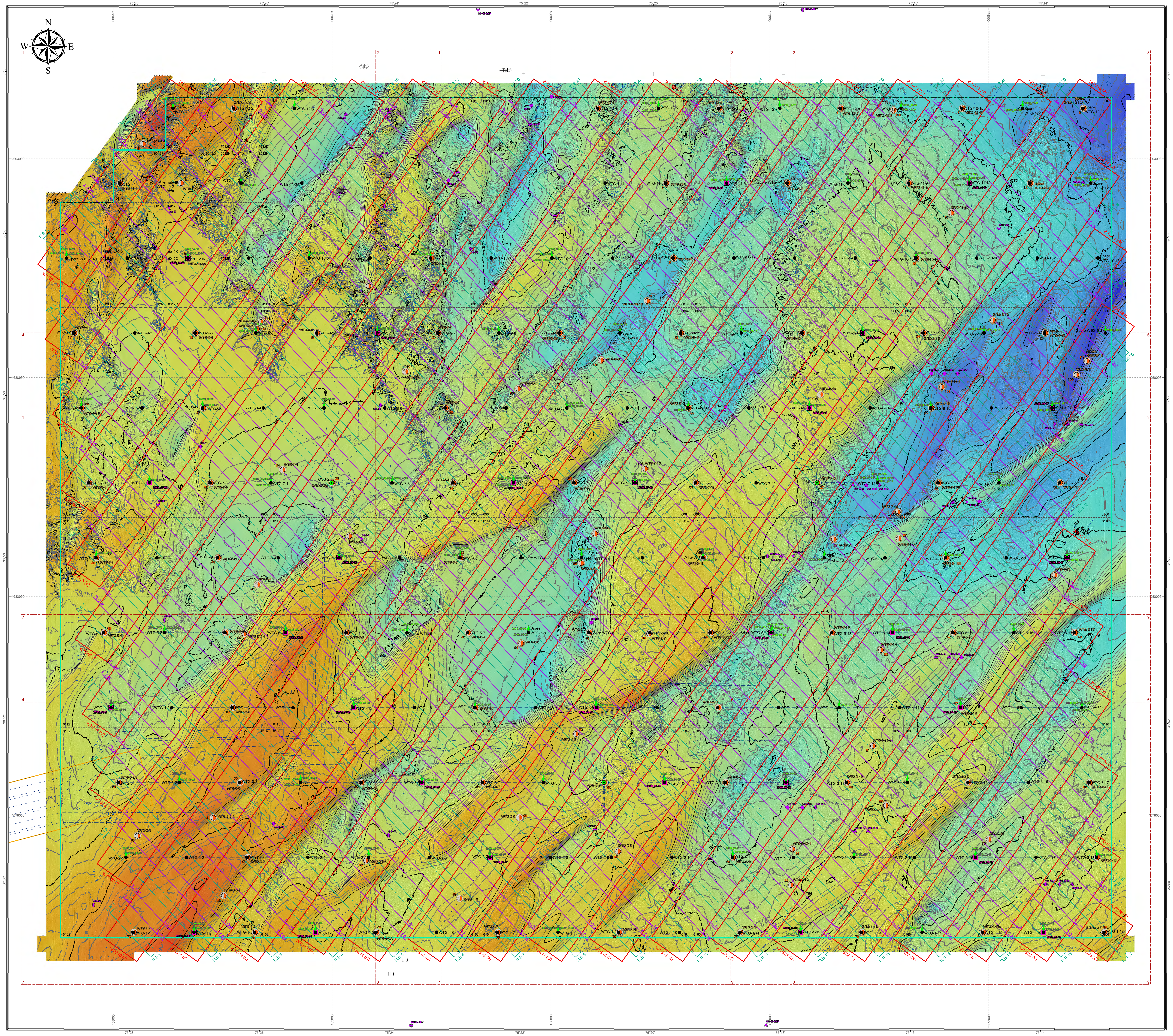
October 2021

APPENDIX E ESSENTIAL FISH HABITAT ASSESSMENT ATTACHMENT E-3

FIGURES



General Map Symbols

- Dominion Lease Boundary — OCS-A 0483
- Proposed Cable Route — "Conceptual cables routes; Detailed re-routing/micro-siting will follow"
- TLC Planned Line
- TLB Corridor
- WTG Corridor
- Cable Corridor
- BOEM Lease Block Main Chart — OCS-A 0483
- Tile Panel 1 - 9 Main Chart
- WTG Location — Preliminary position/subject to change
- OSS Location — Preliminary position/subject to change
- Grab Sample
- Box Corer
- Geotechnical Boring
- Benthic Sample
- CPT
- Charted Shipwreck — Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Bathymetry

- -30 Major Contours (2.5 m interval)
- Minor Contours (0.50 m interval)
- Slope Gradient >= 10°

Bathymetric Grid

-18 -21 -24 -27 -30 -33 -36 -39 -42

MBES surface was created at 50 cm resolution.
Bathymetric Grid: values are elevation, in meters

Multibeam Echosounder Processing Notes

Multibeam bathymetry data were processed in QPS Qimera 2.2.1.

Data Import and Navigation

Qinsy Database (DB) files were imported into Qimera 2.2.1, and an initial surface was made; post-processed POSPac PP-RTX results in the form of Smoothed Best Estimate Trajectories (SBETs) were imported. In Qimera, position and altitude data were analyzed for erroneous points; these data points were flagged and then removed.

Sound Velocity Correction

Sound velocity data were imported, evaluated for erroneous points, and applied to the MBES data. Unless sound velocity errors were noted, "Nearest in Distance Within Time – 360 minutes" was the method for pairing SV casts to the DB files.

Vertical Datum

The data were then converted to the working vertical datum, MLLW, by the application of NOAA V-Datum separation model; this separation model shifted the SBET from its native ellipsoidal elevation.The data were checked for tidal errors, refraction, and noise and adjusted where necessary.

Data Cleaning

Data were filtered using an TPU (Total Propagated Uncertainty) filter for IHO Special Order. Data were then manually edited and cleaned using the swath, slice, and 3D editor tools in Qimera. The Density Grid was analyzed prior to cutting any outer beams (if necessary) to ensure a minimum of 5 pings per square meter. The final surface was inspected using the Uncertainty Grid (95% confidence level) for any remaining outliers to be removed. Final QC was performed using the Density, Uncertainty (95%), Total Horizontal Uncertainty (THU), and Total Vertical Uncertainty (TVU) grids.

General Information

Equipment

Survey Vessels: M/V Marcelle[1]/M/V Sarah Bordelon[2]/ R/V Kommandor Iona[3]/ R/V Kommandor Stuart[4]/ M/V GO Discovery[5]/M/V Minerva Uno[6]
Positioning System : Applanix POSMV and Hemisphere
USBL : Sonardyne Ranger 2 (19-34 kHz)
Multibeam Echosounder : Teledyne T50 (200-400 kHz)
R2Sonic 2024 (200-400 kHz)[6]
Sidescan Sonar : EdgeTech 4200 (300/600 kHz)
Magnetometer : Geometrics G-882 (TVG)
Subbottom Profiler : Innomar SES-2000 medium
Multi Channel Seismic[1,4,5] : AAS-Boom and Geospark 200+400 and 96-Element Streamer
Single Channel Seismic[2,5,6] : AAS-Boom and SCS Streamer
Sparker[3] : Geospark 200+400 and 96-Element Streamer
Sound Velocity Profiler : AML MVP30/MVP200[3]
Acquistion Software : QINSy

TerraSond Personnel

Commercial Manager : Scott Croft
Project Manager : Don Ross
Project Manager : James Hougham
Production Manager : Kate Mildon
Technical Manager : Chris McHugh
Geophysical Manager : Scott Hiller
Operations Manager : William Busey
Party Chief : Mark MacLean
Lead Surveyor : Larry Andrews
Director HSEQ : Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

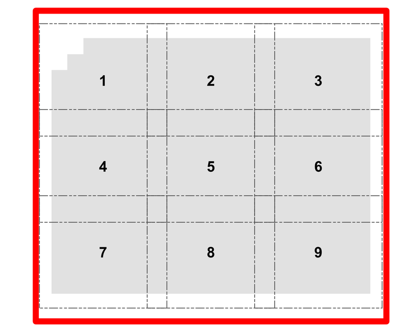
CRS Name :NAD 1983 (2011) UTM Zone 18N
EPSG Code :6347
Geodetic Datum :North American 1983
Projection :Universal Transverse Mercator
Units :Meter

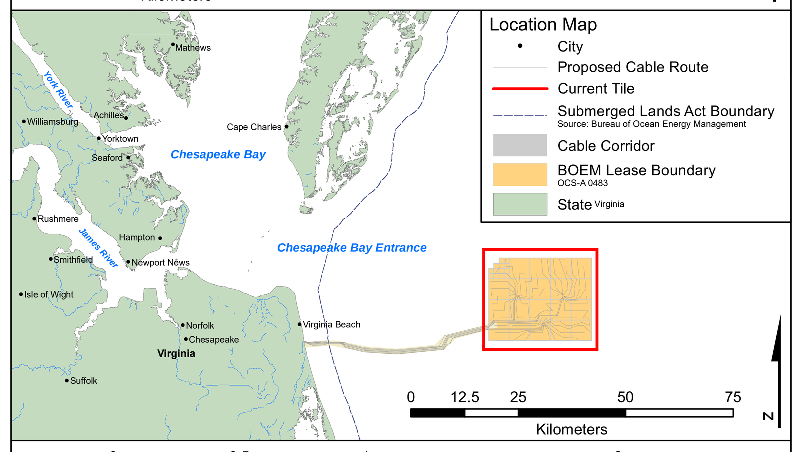
Vertical Coordinate Reference System

Datum :Mean Lower Low Water (MLLW)
Axis -down :Depth

Tile Index Overview

- Current Tile
- BOEM Lease Block — OCS-A 0483
- Tile Panel 1 - 9





0 0.5 1 2 Miles
0 0.5 1 2 3 4 Kilometers
1:27,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS®

Client: Dominion Energy®

Project Title: CVOW-C Geophysical Survey 2021

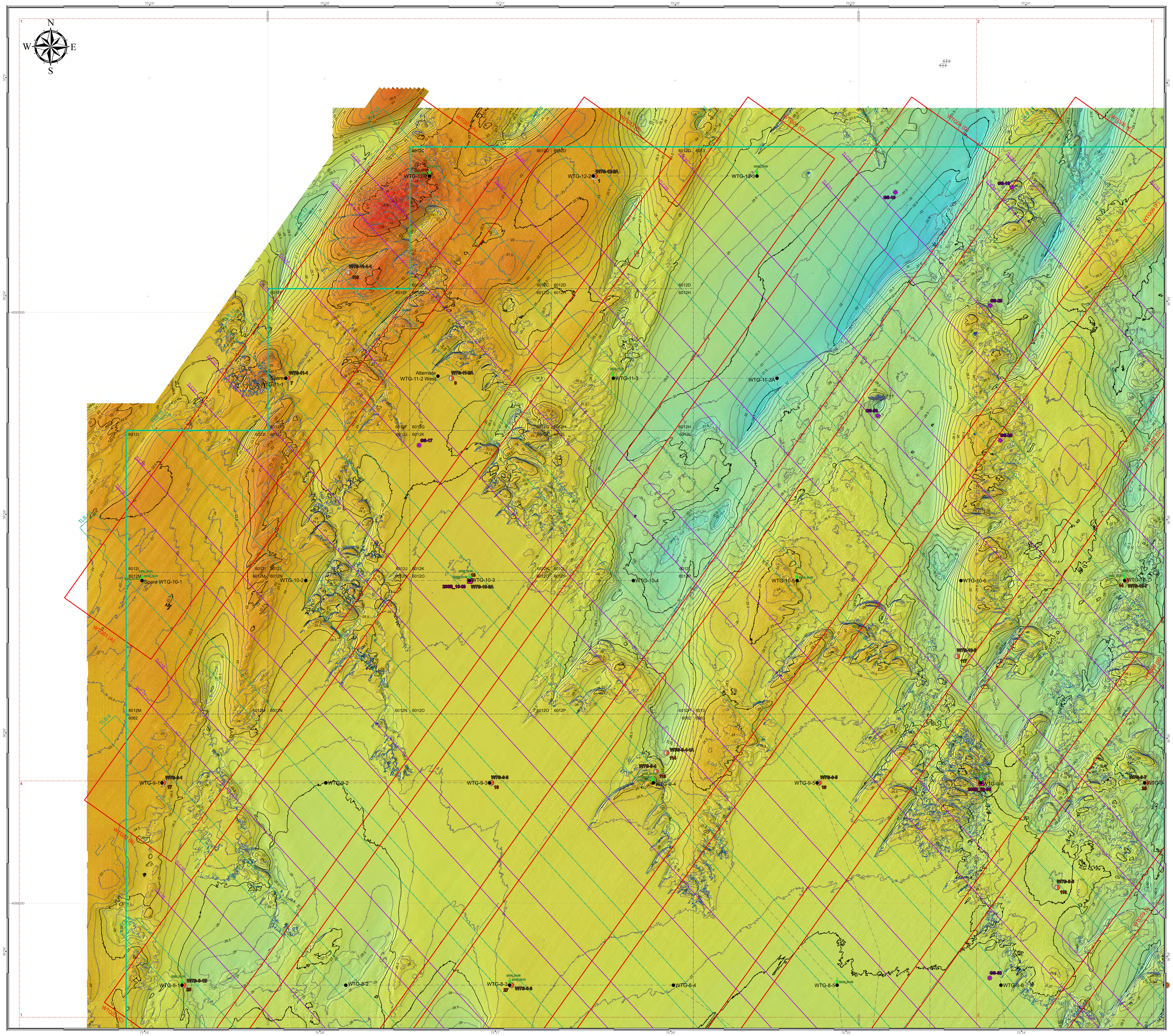
Chart Title: CHART 2 BATHYMETRY OVERVIEW

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
06/14/21	Rev00	CLS	KDW	KMM
07/29/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/29/2021

File Name: Dominion_Bathymetry_Rev01_Chart_Overview.pdf



General Map Symbols

- Dominion Lease Boundary — OCS-A 0483
- Proposed Cable Route — "Conceptual cables routes; Detailed re-routing/micro-siting will follow"
- TLC Planned Line
- TLB Corridor
- WTG Corridor
- Cable Corridor
- BOEM Lease Block Main Chart — OCS-A 0483
- Tile Panel 1 - 9 Main Chart
- WTG Location — Preliminary position/subject to change
- OSS Location — Preliminary position/subject to change
- Grab Sample
- Box Corer
- Geotechnical Boring
- Benthic Sample
- CPT
- Charted Shipwreck — Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Bathymetry

- Major Contours (2.5 m interval)
- Minor Contours (0.50 m interval)
- Slope Gradient >= 10°

The elevation values for the current display:

Minimum: -34.26m

Maximum: -18.11m

Bathymetric Grid

-18 -21 -24 -27 -30 -33 -36 -39 -42

MBES surface was created at 50 cm resolution.
Bathymetric Grid: values are elevation, in meters

Multibeam Echosounder Processing Notes

Multibeam bathymetry data were processed in QPS Qimera 2.2.1.

Data Import and Navigation

Qinsy Database (DB) files were imported into Qimera 2.2.1, and an initial surface was made; post-processed POSPac PP-RTX results in the form of Smoothed Best Estimate Trajectories (SBETs) were imported. In Qimera, position and altitude data were analyzed for erroneous points; these data points were flagged and then removed.

Sound Velocity Correction

Sound velocity data were imported, evaluated for erroneous points, and applied to the MBES data. Unless sound velocity errors were noted, "Nearest in Distance Within Time – 360 minutes" was the method for pairing SV casts to the DB files.

Vertical Datum

The data were then converted to the working vertical datum, MLLW, by the application of NOAA V-Datum separation model; this separation model shifted the SBET from its native ellipsoidal elevation.The data were checked for tidal errors, refraction, and noise and adjusted where necessary.

Data Cleaning

Data were filtered using an TPU (Total Propagated Uncertainty) filter for IHO Special Order. Data were then manually edited and cleaned using the swath, slice, and 3D editor tools in Qimera. The Density Grid was analyzed prior to cutting any outer beams (if necessary) to ensure a minimum of 5 pings per square meter. The final surface was inspected using the Uncertainty Grid (95% confidence level) for any remaining outliers to be removed. Final QC was performed using the Density, Uncertainty (95%), Total Horizontal Uncertainty (THU), and Total Vertical Uncertainty (TVU) grids.

General Information

Equipment

Survey Vessels	M/V Marcelle[1]/M/V Sarah Bordelon[2]/ R/V Kommandor Iona[3]/ R/V Kommandor Stuart[4]/ M/V GO Discovery[5]/M/V Minerva Uno[6]
Positioning System	: Applanix POSMV and Hemisphere
USBL	: Sonardyne Ranger 2 (19-34 kHz)
Multibeam Echosounder	: Teledyne T50 (200-400 kHz) R2Sonic 2024 (200-400 kHz)[6]
Sidescan Sonar	: EdgeTech 4200 (300/600 kHz)
Magnetometer	: Geometrics G-882 (TVG)
Subbottom Profiler	: Innomar SES-2000 medium
Multi Channel Seismic[1,4,5]	: AAS-Boom and Geospark 200+400 and 96-Element Streamer
Single Channel Seismic[2,5,6]	: AAS-Boom and SCS Streamer
Sparker[3]	: Geospark 200+400 and 96-Element Streamer
Sound Velocity Profiler	: AML MVP30/MVP200[3]
Acquistion Software	: QINSy

TerraSond Personnel

Commercial Manager	: Scott Croft
Project Manager	: Don Ross
Project Manager	: James Hougham
Production Manager	: Kate Mildon
Technical Manager	: Chris McHugh
Geophysical Manager	: Scott Hiller
Operations Manager	: William Busey
Party Chief	: Mark MacLean
Lead Surveyor	: Larry Andrews
Director HSEQ	: Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

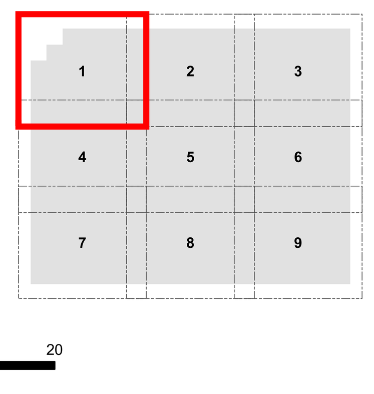
CRS Name	:NAD 1983 (2011) UTM Zone 18N
EPSG Code	:6347
Geodetic Datum	:North American 1983
Projection	:Universal Transverse Mercator
Units	:Meter

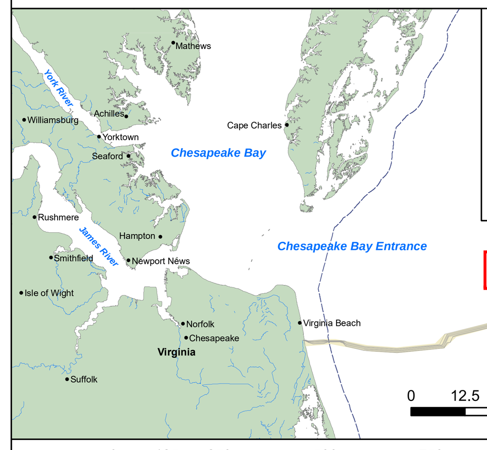
Vertical Coordinate Reference System

Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

Tile Index Overview

- Current Tile
- BOEM Lease Block OCS-A 0483
- Tile Panel 1 - 9





Location Map

- City
- Proposed Cable Route
- Current Tile
- Submerged Lands Act Boundary — Source: Bureau of Ocean Energy Management
- Cable Corridor
- BOEM Lease Boundary OCS-A 0483
- State Virginia

0 125 250 500 750 1,000 1,250 Meters

0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

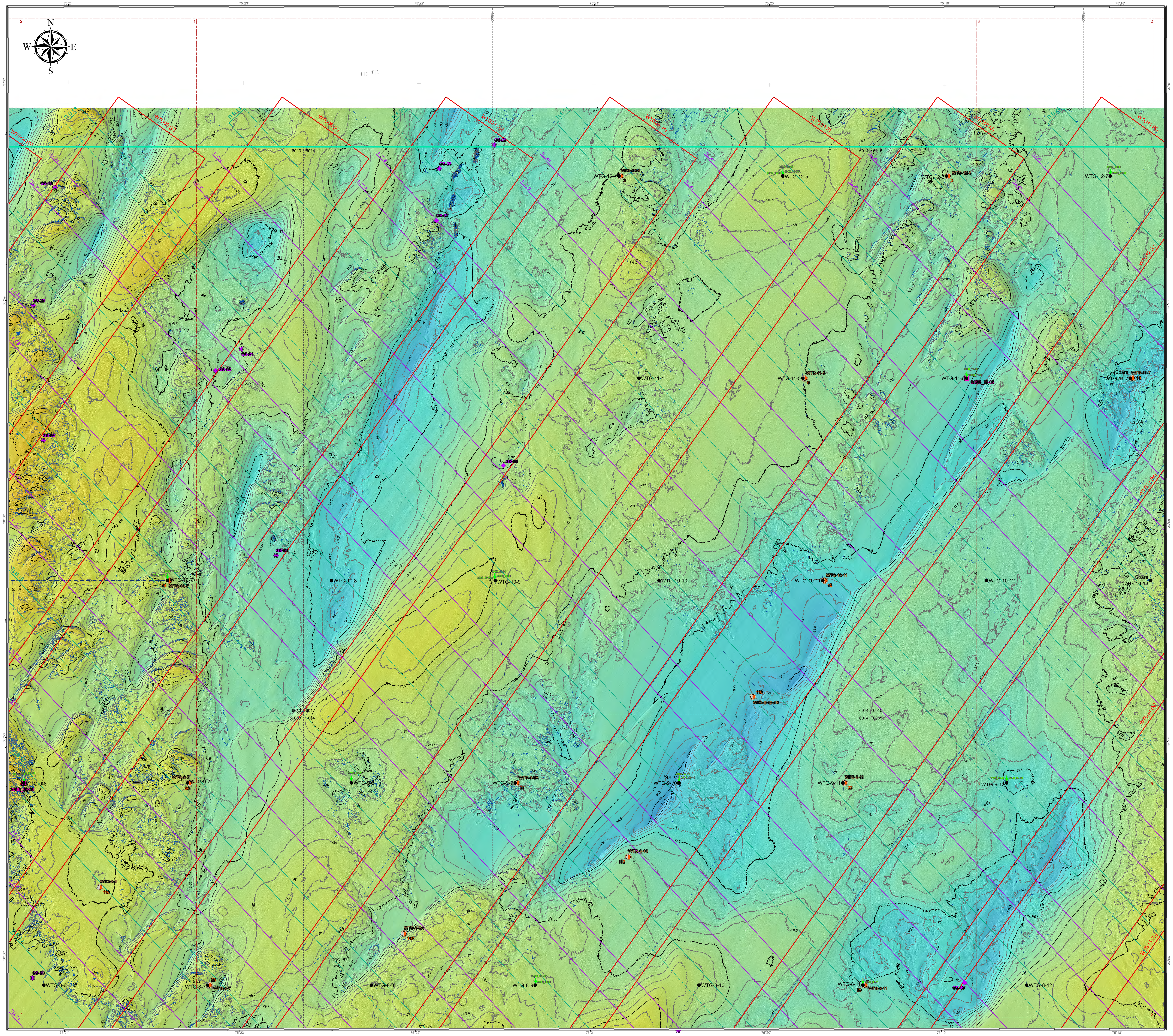
Chart Title: CHART 2 BATHYMETRY TILE 1 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/04/21	DRAFT	CLS	KMM	KMM
06/14/21	Rev00	CLS	KDW	KMM
07/29/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/29/2021

File Name: Dominion_Bathymetry_Rev01.pdf



General Map Symbols

- Dominion Lease Boundary OCS-A 0483
- Proposed Cable Route "Conceptual cables routes; Detailed re-routing/micro-siting will follow"
- TLC Planned Line
- TLB Corridor
- WTG Corridor
- Cable Corridor
- BOEM Lease Block Main Chart OCS-A 0483
- Tile Panel 1 - 9 Main Chart
- WTG Location Preliminary position/subject to change
- OSS Location Preliminary position/subject to change
- Grab Sample
- Box Corer
- Geotechnical Boring
- Benthic Sample
- CPT
- Charted Shipwreck Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Bathymetry

- Major Contours (2.5 m interval)
- Minor Contours (0.50 m interval)
- Slope Gradient >= 10°

The elevation values for the current display:
Minimum: -36.24m
Maximum: -19.68m

Bathymetric Grid

-18 -21 -24 -27 -30 -33 -36 -39 -42

MBES surface was created at 50 cm resolution.
Bathymetric Grid: values are elevation, in meters

Multibeam Echosounder Processing Notes

Multibeam bathymetry data were processed in QPS Qimera 2.2.1.

Data Import and Navigation

Qinsy Database (DB) files were imported into Qimera 2.2.1, and an initial surface was made; post-processed POSPac PP-RTX results in the form of Smoothed Best Estimate Trajectories (SBETs) were imported. In Qimera, position and altitude data were analyzed for erroneous points; these data points were flagged and then removed.

Sound Velocity Correction

Sound velocity data were imported, evaluated for erroneous points, and applied to the MBES data. Unless sound velocity errors were noted, "Nearest in Distance Within Time – 360 minutes" was the method for pairing SV casts to the DB files.

Vertical Datum

The data were then converted to the working vertical datum, MLLW, by the application of NOAA V-Datum separation model; this separation model shifted the SBET from its native ellipsoidal elevation.The data were checked for tidal errors, refraction, and noise and adjusted where necessary.

Data Cleaning

Data were filtered using an TPU (Total Propagated Uncertainty) filter for IHO Special Order. Data were then manually edited and cleaned using the swath, slice, and 3D editor tools in Qimera. The Density Grid was analyzed prior to cutting any outer beams (if necessary) to ensure a minimum of 5 pings per square meter. The final surface was inspected using the Uncertainty Grid (95% confidence level) for any remaining outliers to be removed. Final QC was performed using the Density, Uncertainty (95%), Total Horizontal Uncertainty (THU), and Total Vertical Uncertainty (TVU) grids.

General Information

Equipment

Survey Vessels	M/V Marcelle[1]/M/V Sarah Bordelon[2]/ R/V Kommandor Iona[3]/ R/V Kommandor Stuart[4]/ M/V GO Discovery[5]/M/V Minerva Uno[6]
Positioning System	: Applanix POSMV and Hemisphere
USBL	: Sonardyne Ranger 2 (19-34 kHz)
Multibeam Echosounder	: Teledyne T50 (200-400 kHz) R2Sonic 2024 (200-400 kHz)[6]
Sidescan Sonar	: EdgeTech 4200 (300/600 kHz)
Magnetometer	: Geometrics G-882 (TVG)
Subbottom Profiler	: Innomar SES-2000 medium
Multi Channel Seismic[1,4,5]	: AAS-Boom and Geospark 200+400 and 96-Element Streamer
Single Channel Seismic[2,5,6]	: AAS-Boom and SCS Streamer
Sparker[3]	: Geospark 200+400 and 96-Element Streamer
Sound Velocity Profiler	: AML MVP30/MVP200[3]
Acquistion Software	: QINSy

TerraSond Personnel

Commercial Manager	: Scott Croft
Project Manager	: Don Ross
Project Manager	: James Hougham
Production Manager	: Kate Mildon
Technical Manager	: Chris McHugh
Geophysical Manager	: Scott Hiller
Operations Manager	: William Busey
Party Chief	: Mark MacLean
Lead Surveyor	: Larry Andrews
Director HSEQ	: Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

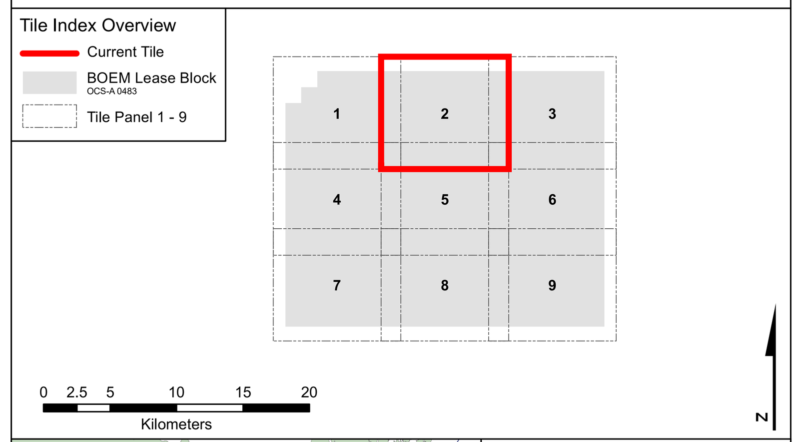
CRS Name	:NAD 1983 (2011) UTM Zone 18N
EPSG Code	:6347
Geodetic Datum	:North American 1983
Projection	:Universal Transverse Mercator
Units	:Meter

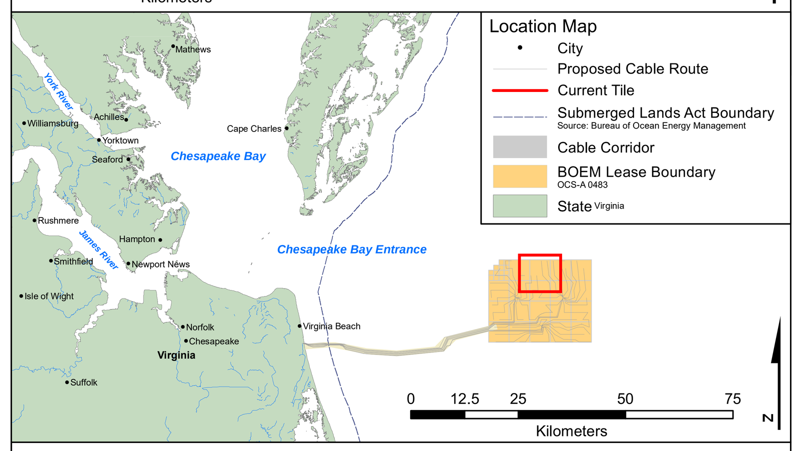
Vertical Coordinate Reference System

Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

Tile Index Overview

- Current Tile
- BOEM Lease Block OCS-A 0483
- Tile Panel 1 - 9





0 125 250 500 750 1,000 1,250 Meters
0 500 1,000 2,000 3,000 4,000 5,000 Feet
1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

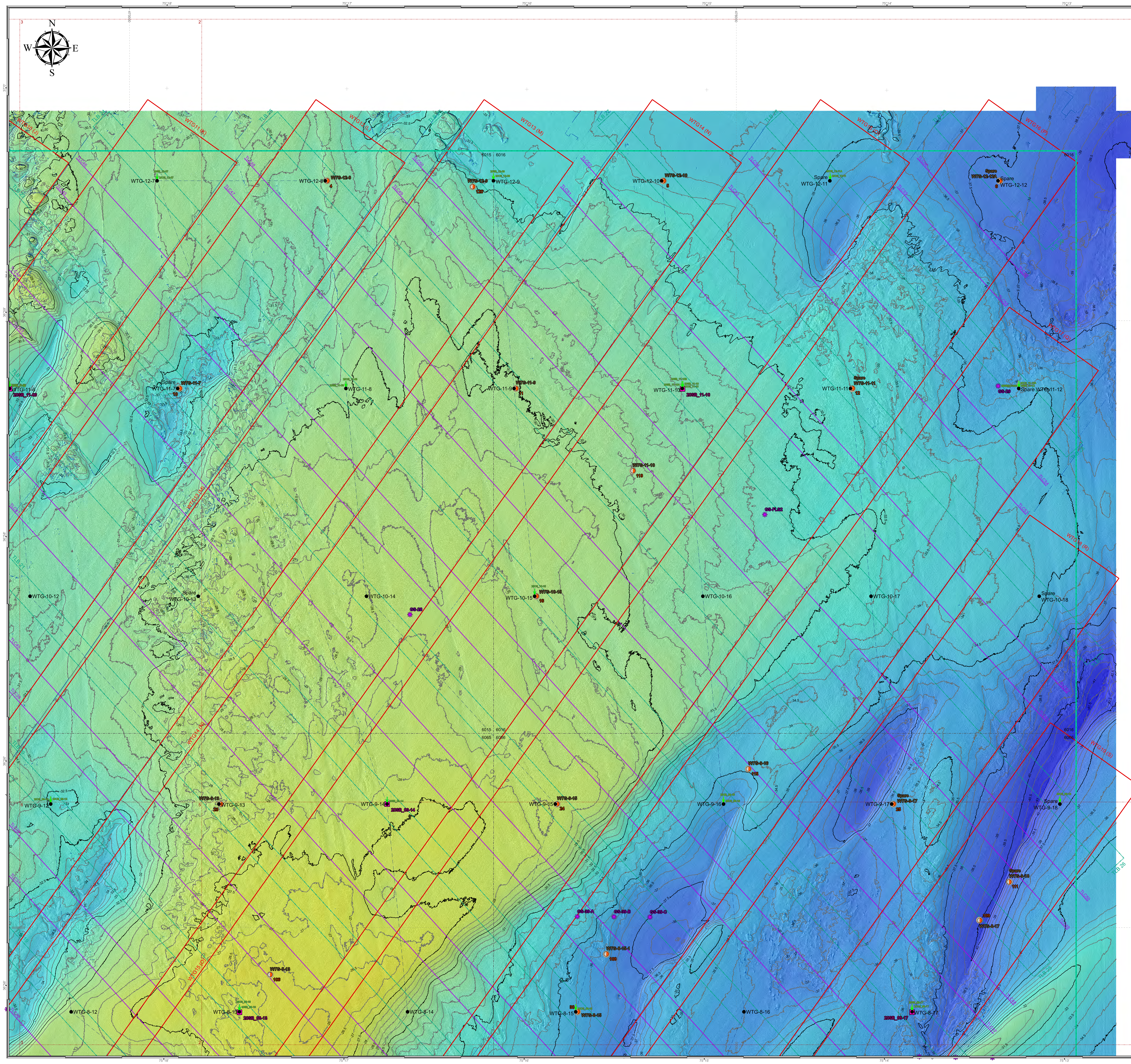
Chart Title: CHART 2 BATHYMETRY TILE 2 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/04/21	DRAFT	CLS	KMM	KMM
06/14/21	Rev00	CLS	KDW	KMM
07/29/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/29/2021

File Name: Dominion_Bathymetry_Rev01.pdf



General Map Symbols

- Dominion Lease Boundary — OCS-A 0483
- Proposed Cable Route — "Conceptual cables routes; Detailed re-routing/micro-siting will follow"
- TLC Planned Line
- TLB Corridor
- WTG Corridor
- Cable Corridor
- BOEM Lease Block Main Chart — OCS-A 0483
- Tile Panel 1 - 9 Main Chart
- WTG Location — Preliminary position/subject to change
- OSS Location — Preliminary position/subject to change
- Grab Sample
- Box Corer
- Geotechnical Boring
- Benthic Sample
- CPT
- Charted Shipwreck — Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Bathymetry

- Major Contours (2.5 m interval)
- Minor Contours (0.50 m interval)
- Slope Gradient >= 10°

The elevation values for the current display:

Minimum: -41.74m

Maximum: -27.38m

Bathymetric Grid

-18 -21 -24 -27 -30 -33 -36 -39 -42

MBES surface was created at 50 cm resolution.
Bathymetric Grid: values are elevation, in meters

Multibeam Echosounder Processing Notes

Multibeam bathymetry data were processed in QPS Qimera 2.2.1.

Data Import and Navigation

Qinsy Database (DB) files were imported into Qimera 2.2.1, and an initial surface was made; post-processed POSPac PP-RTX results in the form of Smoothed Best Estimate Trajectories (SBETs) were imported. In Qimera, position and altitude data were analyzed for erroneous points; these data points were flagged and then removed.

Sound Velocity Correction

Sound velocity data were imported, evaluated for erroneous points, and applied to the MBES data. Unless sound velocity errors were noted, "Nearest in Distance Within Time – 360 minutes" was the method for pairing SV casts to the DB files.

Vertical Datum

The data were then converted to the working vertical datum, MLLW, by the application of NOAA V-Datum separation model; this separation model shifted the SBET from its native ellipsoidal elevation.The data were checked for tidal errors, refraction, and noise and adjusted where necessary.

Data Cleaning

Data were filtered using an TPU (Total Propagated Uncertainty) filter for IHO Special Order. Data were then manually edited and cleaned using the swath, slice, and 3D editor tools in Qimera. The Density Grid was analyzed prior to cutting any outer beams (if necessary) to ensure a minimum of 5 pings per square meter. The final surface was inspected using the Uncertainty Grid (95% confidence level) for any remaining outliers to be removed. Final QC was performed using the Density, Uncertainty (95%), Total Horizontal Uncertainty (THU), and Total Vertical Uncertainty (TVU) grids.

General Information

Equipment

Survey Vessels	M/V Marcelle[1]/M/V Sarah Bordelon[2]/ R/V Kommandor Iona[3]/ R/V Kommandor Stuart[4]/ M/V GO Discovery[5]/M/V Minerva Uno[6]
Positioning System	: Applanix POSMV and Hemisphere
USBL	: Sonardyne Ranger 2 (19-34 kHz)
Multibeam Echosounder	: Teledyne T50 (200-400 kHz) R2Sonic 2024 (200-400 kHz)[6]
Sidescan Sonar	: EdgeTech 4200 (300/600 kHz)
Magnetometer	: Geometrics G-882 (TVG)
Subbottom Profiler	: Innomar SES-2000 medium
Multi Channel Seismic[1,4,5]	: AAS-Boom and Geospark 200+400 and 96-Element Streamer
Single Channel Seismic[2,5,6]	: AAS-Boom and SCS Streamer
Sparker[3]	: Geospark 200+400 and 96-Element Streamer
Sound Velocity Profiler	: AML MVP30/MVP200[3]
Acquistion Software	: QINSy

TerraSond Personnel

Commercial Manager	: Scott Croft
Project Manager	: Don Ross
Project Manager	: James Hougham
Production Manager	: Kate Mildon
Technical Manager	: Chris McHugh
Geophysical Manager	: Scott Hiller
Operations Manager	: William Busey
Party Chief	: Mark MacLean
Lead Surveyor	: Larry Andrews
Director HSEQ	: Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

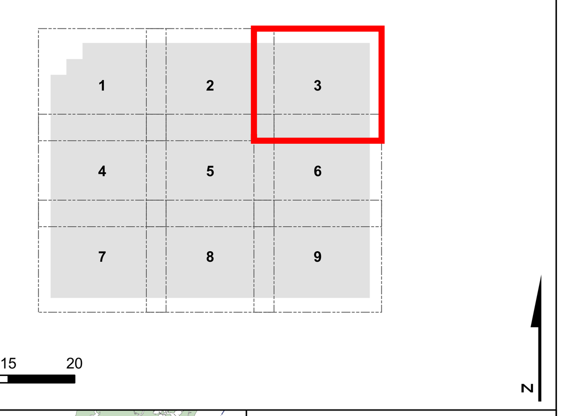
CRS Name	:NAD 1983 (2011) UTM Zone 18N
EPSG Code	:6347
Geodetic Datum	:North American 1983
Projection	:Universal Transverse Mercator
Units	:Meter

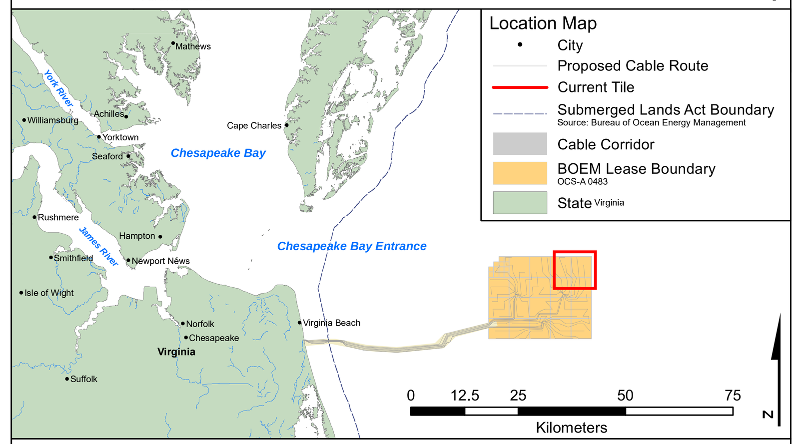
Vertical Coordinate Reference System

Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

Tile Index Overview

- Current Tile
- BOEM Lease Block — OCS-A 0483
- Tile Panel 1 - 9





0 125 250 500 750 1,000 1,250 Meters

0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

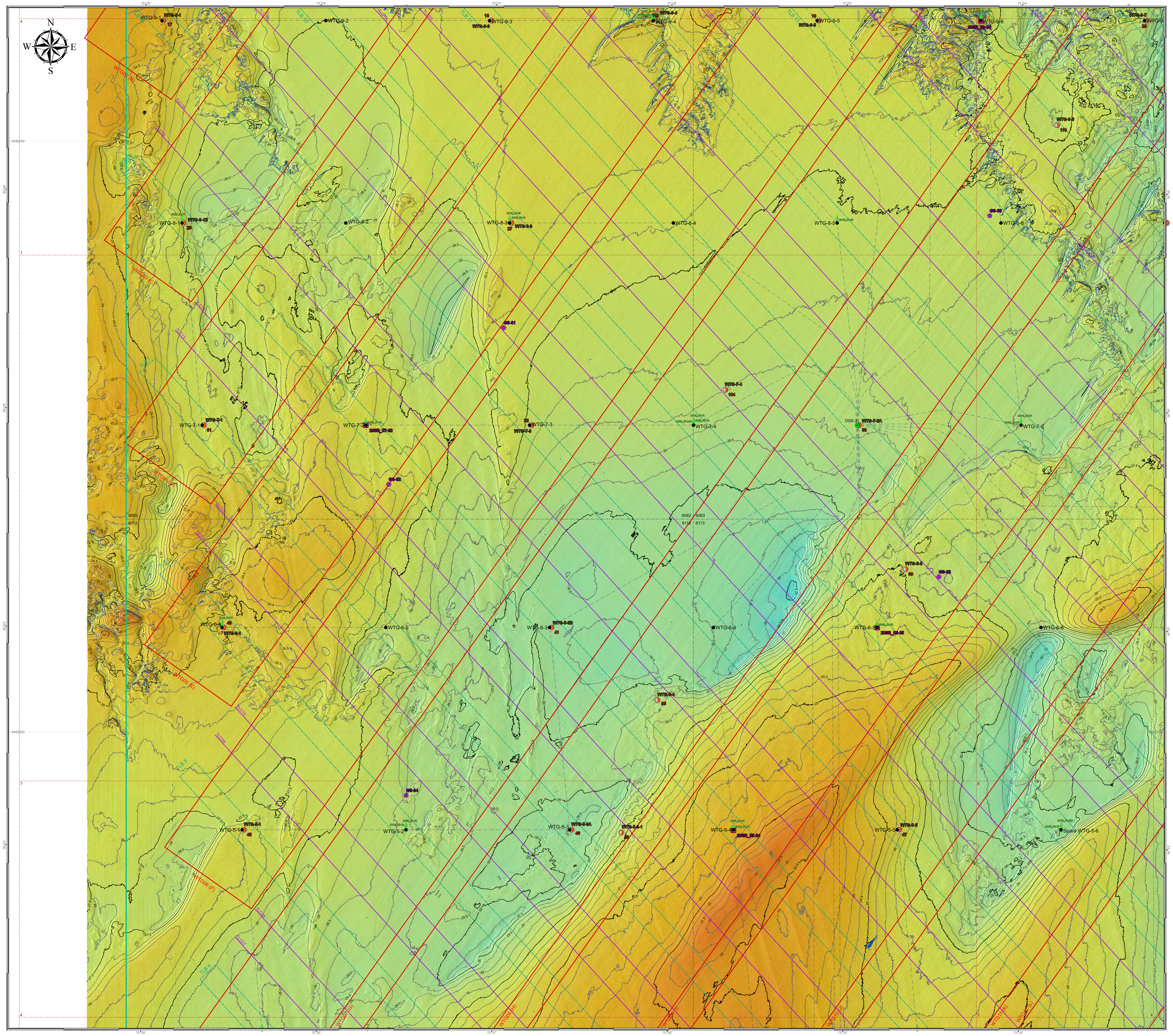
Chart Title: CHART 2 BATHYMETRY TILE 3 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/04/21	DRAFT	CLS	KMM	KMM
06/14/21	Rev00	CLS	KDW	KMM
07/29/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/29/2021

File Name: Dominion_Bathymetry_Rev01.pdf



General Map Symbols

- Dominion Lease Boundary — OCS-A 0483
- Proposed Cable Route — "Conceptual cables routes; Detailed re-routing/micro-siting will follow"
- TLC Planned Line
- TLB Corridor
- WTG Corridor
- Cable Corridor
- BOEM Lease Block (Main Chart) — OCS-A 0483
- Tile Panel 1 - 9 (Main Chart)
- WTG Location — Preliminary position/subject to change
- OSS Location — Preliminary position/subject to change
- Grab Sample
- Box Corer
- Geotechnical Boring
- Benthic Sample
- CPT
- Charted Shipwreck — Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Bathymetry

- Major Contours (2.5 m interval)
- Minor Contours (0.50 m interval)
- Slope Gradient >= 10°

The elevation values for the current display:
Minimum: -32.83m
Maximum: -22.25m

Bathymetric Grid

-18 -21 -24 -27 -30 -33 -36 -39 -42

MBES surface was created at 50 cm resolution.
Bathymetric Grid: values are elevation, in meters

Multibeam Echosounder Processing Notes

Multibeam bathymetry data were processed in QPS Qimera 2.2.1.

Data Import and Navigation

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Vertical Datum

The data were then converted to the working vertical datum, MLLW, by the application of NOAA V-Datum separation model; this separation model shifted the SBET from its native ellipsoidal elevation.The data were checked for tidal errors, refraction, and noise and adjusted where necessary.

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General Information

Equipment

Survey Vessels	M/V Marcelle[1]/M/V Sarah Bordelon[2]/ R/V Kommandor Iona[3]/ R/V Kommandor Stuart[4]/ M/V GO Discovery[5]/M/V Minerva Uno[6]
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Acquistion Software	: QINSy

TerraSond Personnel

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Project Manager	: Don Ross
Project Manager	: James Hougham
Production Manager	: Kate Mildon
Technical Manager	: Chris McHugh
Geophysical Manager	: Scott Hiller
Operations Manager	: William Busey
Party Chief	: Mark MacLean
Lead Surveyor	: Larry Andrews
Director HSEQ	: Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

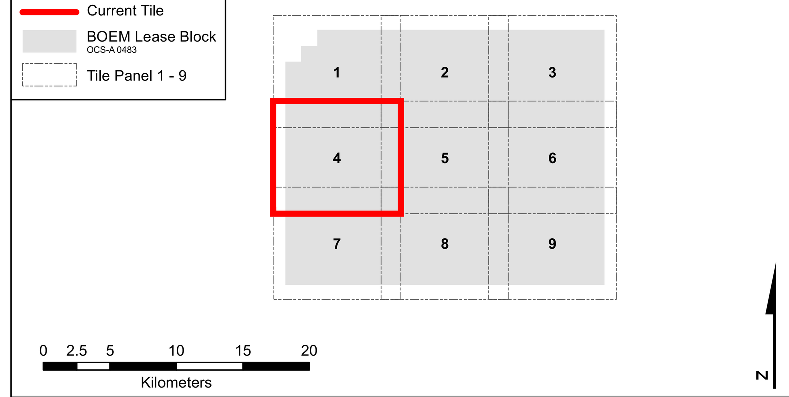
CRS Name	:NAD 1983 (2011) UTM Zone 18N
EPSG Code	:6347
Geodetic Datum	:North American 1983
Projection	:Universal Transverse Mercator
Units	:Meter

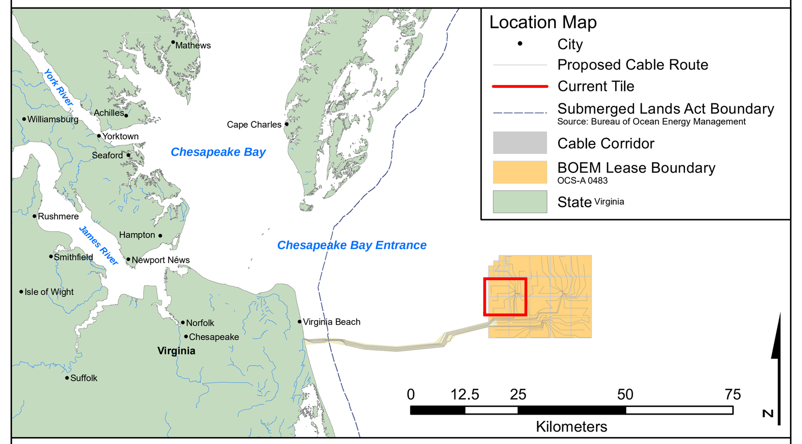
Vertical Coordinate Reference System

Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

Tile Index Overview

- Current Tile
- BOEM Lease Block — OCS-A 0483
- Tile Panel 1 - 9





0 125 250 500 750 1,000 1,250 Meters
0 500 1,000 2,000 3,000 4,000 5,000 Feet
1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS
Client: Dominion Energy

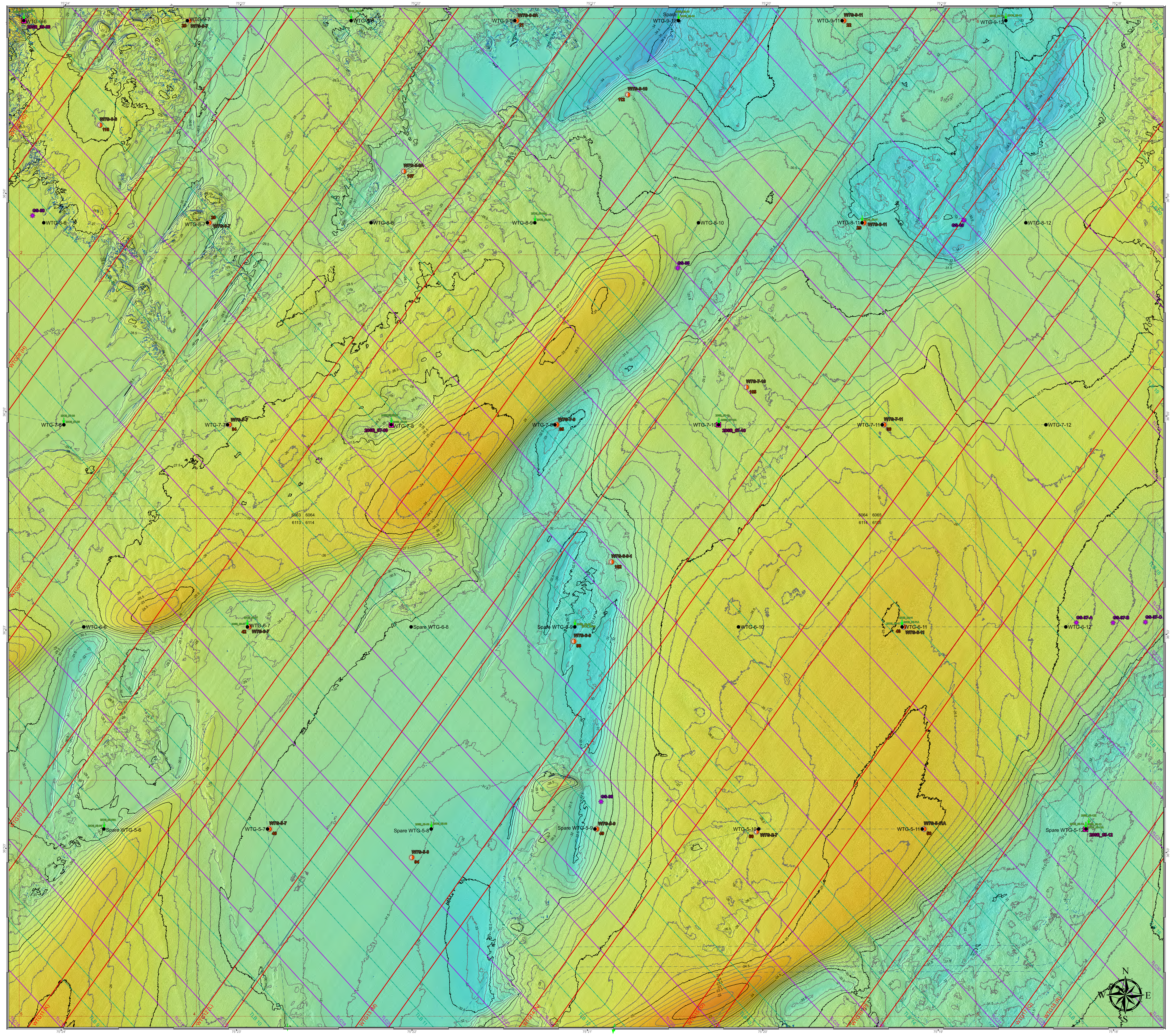
Project Title: CVOW-C Geophysical Survey 2021

Chart Title: CHART 2 BATHYMETRY TILE 4 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/04/21	DRAFT	CLS	KMM	KMM
06/14/21	Rev00	CLS	KDW	KMM
07/29/21	Rev01	CLS	KDW	KMM

Rev01
Date: 7/29/2021

File Name: Dominion_Bathymetry_Rev01.pdf



General Map Symbols

- Dominion Lease Boundary — OCS-A 0483
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- WTG Location — Preliminary position/subject to change
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- Charted Shipwreck — Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Bathymetry

- Major Contours (2.5 m interval)
- Minor Contours (0.50 m interval)
- Slope Gradient >= 10°

The elevation values for the current display:

Minimum: -35.76m

Maximum: -23.45m

Bathymetric Grid

-18 -21 -24 -27 -30 -33 -36 -39 -42

MBES surface was created at 50 cm resolution.
Bathymetric Grid: values are elevation, in meters

Multibeam Echosounder Processing Notes

Multibeam bathymetry data were processed in QPS Qimera 2.2.1.

Data Import and Navigation

Qinsy Database (DB) files were imported into Qimera 2.2.1, and an initial surface was made; post-processed POSPac PP-RTX results in the form of Smoothed Best Estimate Trajectories (SBETs) were imported. In Qimera, position and altitude data were analyzed for erroneous points; these data points were flagged and then removed.

Sound Velocity Correction

Sound velocity data were imported, evaluated for erroneous points, and applied to the MBES data. Unless sound velocity errors were noted, "Nearest in Distance Within Time – 360 minutes" was the method for pairing SV casts to the DB files.

Vertical Datum

The data were then converted to the working vertical datum, MLLW, by the application of NOAA V-Datum separation model; this separation model shifted the SBET from its native ellipsoidal elevation.The data were checked for tidal errors, refraction, and noise and adjusted where necessary.

Data Cleaning

Data were filtered using an TPU (Total Propagated Uncertainty) filter for IHO Special Order. Data were then manually edited and cleaned using the swath, slice, and 3D editor tools in Qimera. The Density Grid was analyzed prior to cutting any outer beams (if necessary) to ensure a minimum of 5 pings per square meter. The final surface was inspected using the Uncertainty Grid (95% confidence level) for any remaining outliers to be removed. Final QC was performed using the Density, Uncertainty (95%), Total Horizontal Uncertainty (THU), and Total Vertical Uncertainty (TVU) grids.

General Information

Equipment

Survey Vessels	M/V Marcelle[1]/M/V Sarah Bordelon[2]/ R/V Kommandor Iona[3]/ R/V Kommandor Stuart[4]/ M/V GO Discovery[5]/M/V Minerva Uno[6]
Positioning System	: Applanix POSMV and Hemisphere
USBL	: Sonardyne Ranger 2 (19-34 kHz)
Multibeam Echosounder	: Teledyne T50 (200-400 kHz) R2Sonic 2024 (200-400 kHz)[6]
Sidescan Sonar	: EdgeTech 4200 (300/600 kHz)
Magnetometer	: Geometrics G-882 (TVG)
Subbottom Profiler	: Innomar SES-2000 medium
Multi Channel Seismic[1,4,5]	: AAS-Boom and Geospark 200+400 and 96-Element Streamer
Single Channel Seismic[2,5,6]	: AAS-Boom and SCS Streamer
Sparker[3]	: Geospark 200+400 and 96-Element Streamer
Sound Velocity Profiler	: AML MVP30/MVP200[3]
Acquistion Software	: QINSy

TerraSond Personnel

Commercial Manager	: Scott Croft
Project Manager	: Don Ross
Project Manager	: James Hougham
Production Manager	: Kate Mildon
Technical Manager	: Chris McHugh
Geophysical Manager	: Scott Hiller
Operations Manager	: William Busey
Party Chief	: Mark MacLean
Lead Surveyor	: Larry Andrews
Director HSEQ	: Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

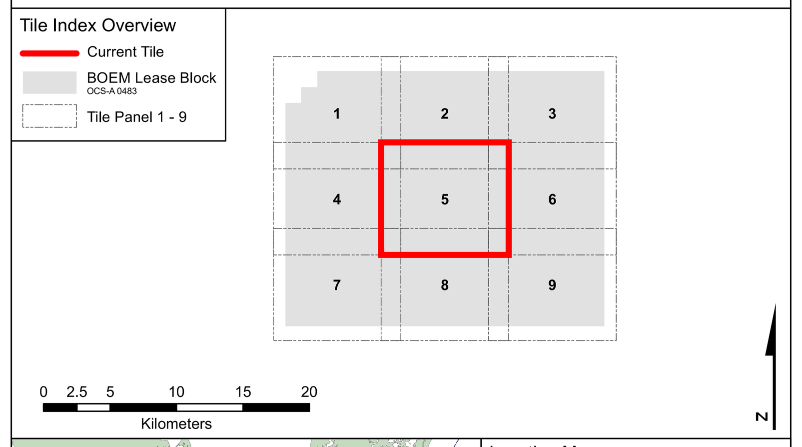
CRS Name	:NAD 1983 (2011) UTM Zone 18N
EPSG Code	:6347
Geodetic Datum	:North American 1983
Projection	:Universal Transverse Mercator
Units	:Meter

Vertical Coordinate Reference System

Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

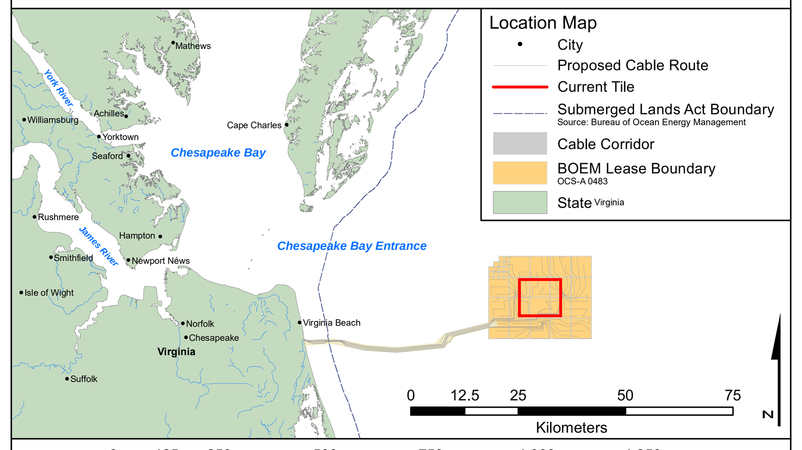
Tile Index Overview

- Current Tile
- BOEM Lease Block — OCS-A 0483
- Tile Panel 1 - 9



Location Map

- City
- Proposed Cable Route
- Current Tile
- Submerged Lands Act Boundary
- Cable Corridor
- BOEM Lease Boundary
- State



0 125 250 500 750 1,000 1,250 Meters

0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

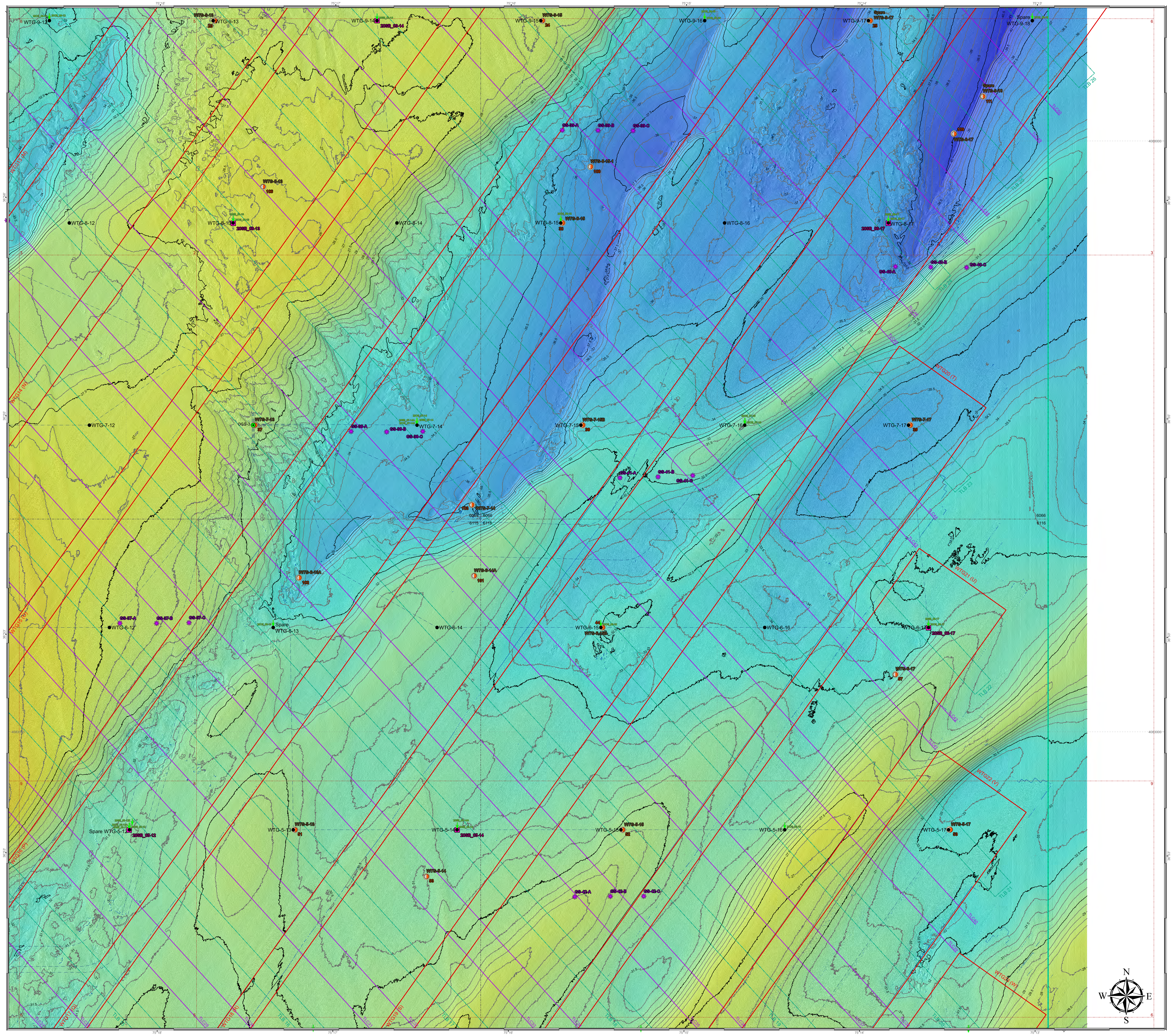
Chart Title: CHART 2 BATHYMETRY TILE 5 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/04/21	DRAFT	CLS	KMM	KMM
06/14/21	Rev00	CLS	KDW	KMM
07/29/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/29/2021

File Name: Dominion_Bathymetry_Rev01.pdf



General Map Symbols

- Dominion Lease Boundary — OCS-A 0483
- Proposed Cable Route — "Conceptual cables routes; Detailed re-routing/micro-siting will follow"
- TLC Planned Line
- TLB Corridor
- WTG Corridor
- Cable Corridor
- BOEM Lease Block Main Chart — OCS-A 0483
- Tile Panel 1 - 9 Main Chart
- WTG Location — Preliminary position/subject to change
- OSS Location — Preliminary position/subject to change
- Grab Sample
- Box Corer
- Geotechnical Boring
- Benthic Sample
- CPT
- Charted Shipwreck — Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Bathymetry

- -30 Major Contours (2.5 m interval)
- Minor Contours (0.50 m interval)
- Slope Gradient >= 10°

The elevation values for the current display:

Minimum: -41.27m

Maximum: -25.72m

Bathymetric Grid

-18 -21 -24 -27 -30 -33 -36 -39 -42

MBES surface was created at 50 cm resolution.
Bathymetric Grid: values are elevation, in meters

Multibeam Echosounder Processing Notes

Multibeam bathymetry data were processed in QPS Qimera 2.2.1.

Data Import and Navigation

Qinsy Database (DB) files were imported into Qimera 2.2.1, and an initial surface was made; post-processed POSPac PP-RTX results in the form of Smoothed Best Estimate Trajectories (SBETs) were imported. In Qimera, position and altitude data were analyzed for erroneous points; these data points were flagged and then removed.

Sound Velocity Correction

Sound velocity data were imported, evaluated for erroneous points, and applied to the MBES data. Unless sound velocity errors were noted, "Nearest in Distance Within Time – 360 minutes" was the method for pairing SV casts to the DB files.

Vertical Datum

The data were then converted to the working vertical datum, MLLW, by the application of NOAA V-Datum separation model; this separation model shifted the SBET from its native ellipsoidal elevation.The data were checked for tidal errors, refraction, and noise and adjusted where necessary.

Data Cleaning

Data were filtered using an TPU (Total Propagated Uncertainty) filter for IHO Special Order. Data were then manually edited and cleaned using the swath, slice, and 3D editor tools in Qimera. The Density Grid was analyzed prior to cutting any outer beams (if necessary) to ensure a minimum of 5 pings per square meter. The final surface was inspected using the Uncertainty Grid (95% confidence level) for any remaining outliers to be removed. Final QC was performed using the Density, Uncertainty (95%), Total Horizontal Uncertainty (THU), and Total Vertical Uncertainty (TVU) grids.

General Information

Equipment

Survey Vessels	M/V Marcelle[1]/M/V Sarah Bordelon[2]/ R/V Kommandor Iona[3]/ R/V Kommandor Stuart[4]/ M/V GO Discovery[5]/M/V Minerva Uno[6]
Positioning System	: Applanix POSMV and Hemisphere
USBL	: Sonardyne Ranger 2 (19-34 kHz)
Multibeam Echosounder	: Teledyne T50 (200-400 kHz) R2Sonic 2024 (200-400 kHz)[6]
Sidescan Sonar	: EdgeTech 4200 (300/600 kHz)
Magnetometer	: Geometrics G-882 (TVG)
Subbottom Profiler	: Innomar SES-2000 medium
Multi Channel Seismic[1,4,5]	: AAS-Boom and Geospark 200+400 and 96-Element Streamer
Single Channel Seismic[2,5,6]	: AAS-Boom and SCS Streamer
Sparker[3]	: Geospark 200+400 and 96-Element Streamer
Sound Velocity Profiler	: AML MVP30/MVP200[3]
Acquistion Software	: QINSy

TerraSond Personnel

Commercial Manager	: Scott Croft
Project Manager	: Don Ross
Project Manager	: James Hougham
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Technical Manager	: Chris McHugh
Geophysical Manager	: Scott Hiller
Operations Manager	: William Busey
Party Chief	: Mark MacLean
Lead Surveyor	: Larry Andrews
Director HSEQ	: Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

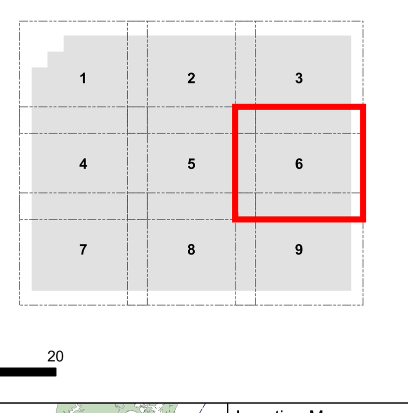
CRS Name	:NAD 1983 (2011) UTM Zone 18N
EPSG Code	:6347
Geodetic Datum	:North American 1983
Projection	:Universal Transverse Mercator
Units	:Meter

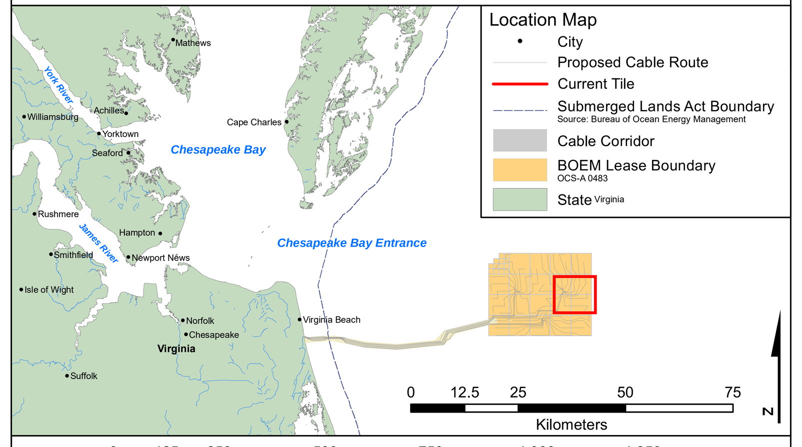
Vertical Coordinate Reference System

Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

Tile Index Overview

- Current Tile
- BOEM Lease Block — OCS-A 0483
- Tile Panel 1 - 9





0 125 250 500 750 1,000 1,250 Meters

0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

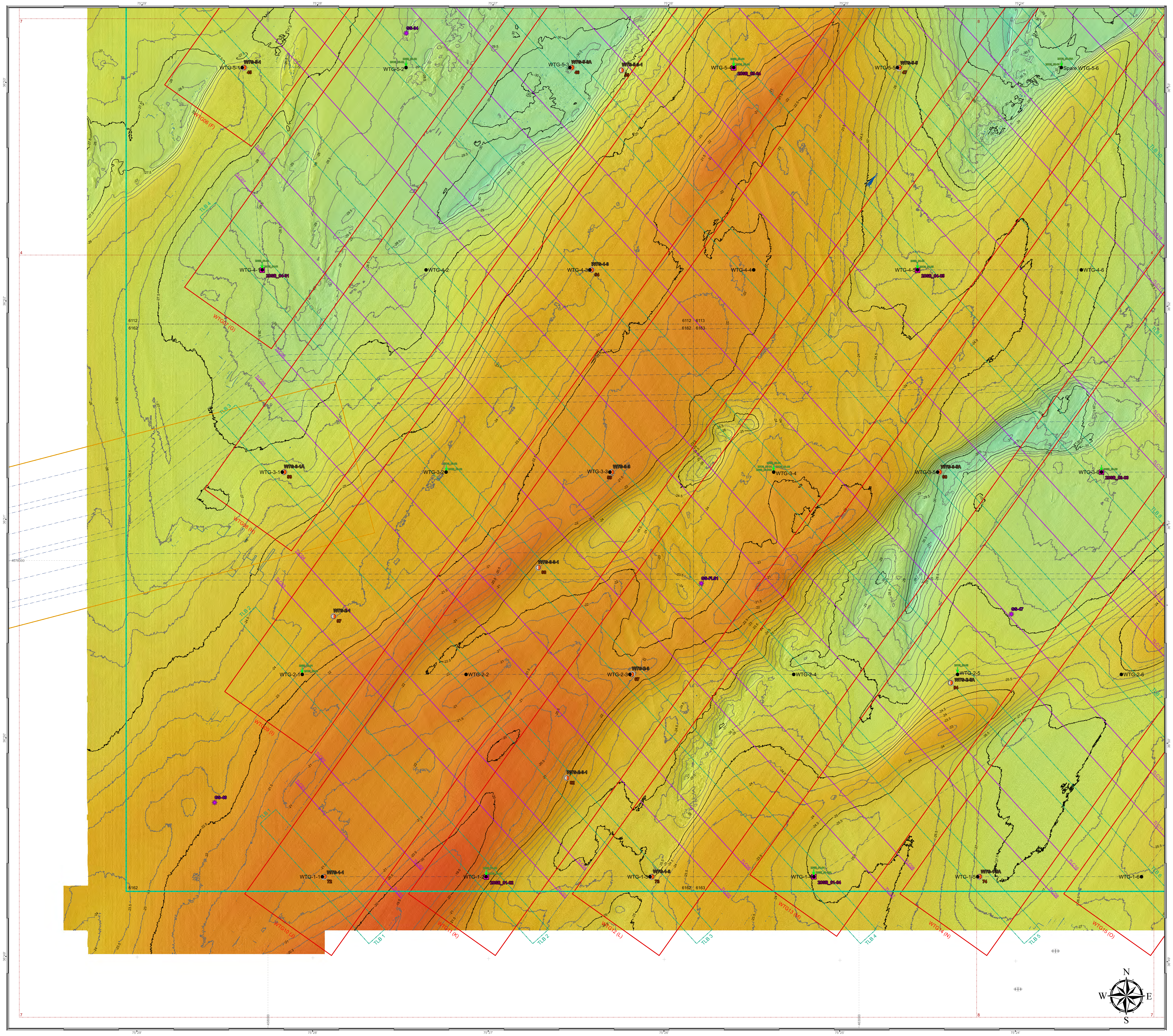
Chart Title: CHART 2 BATHYMETRY TILE 6 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/04/21	DRAFT	CLS	KMM	KMM
06/14/21	Rev00	CLS	KDW	KMM
07/29/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/29/2021

File Name: Dominion_Bathymetry_Rev01.pdf



General Map Symbols

- Dominion Lease Boundary OCS-A 0483
- Proposed Cable Route "Conceptual cables routes; Detailed re-routing/micro-siting will follow"
- TLC Planned Line
- TLB Corridor
- WTG Corridor
- Cable Corridor
- BOEM Lease Block Main Chart OCS-A 0483
- Tile Panel 1 - 9 Main Chart
- WTG Location Preliminary position/subject to change
- OSS Location Preliminary position/subject to change
- Grab Sample
- Box Corer
- Geotechnical Boring
- Benthic Sample
- CPT
- Charted Shipwreck Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Bathymetry

- Major Contours (2.5 m interval)
- Minor Contours (0.50 m interval)
- Slope Gradient >= 10°

The elevation values for the current display:

Minimum: -31.77m

Maximum: -19.19m

Bathymetric Grid

-18 -21 -24 -27 -30 -33 -36 -39 -42

MBES surface was created at 50 cm resolution.
Bathymetric Grid: values are elevation, in meters

Multibeam Echosounder Processing Notes

Multibeam bathymetry data were processed in QPS Qimera 2.2.1.

Data Import and Navigation

Qinsy Database (DB) files were imported into Qimera 2.2.1, and an initial surface was made; post-processed POSPac PP-RTX results in the form of Smoothed Best Estimate Trajectories (SBETs) were imported. In Qimera, position and altitude data were analyzed for erroneous points; these data points were flagged and then removed.

Sound Velocity Correction

Sound velocity data were imported, evaluated for erroneous points, and applied to the MBES data. Unless sound velocity errors were noted, "Nearest in Distance Within Time – 360 minutes" was the method for pairing SV casts to the DB files.

Vertical Datum

The data were then converted to the working vertical datum, MLLW, by the application of NOAA V-Datum separation model; this separation model shifted the SBET from its native ellipsoidal elevation.The data were checked for tidal errors, refraction, and noise and adjusted where necessary.

Data Cleaning

Data were filtered using an TPU (Total Propagated Uncertainty) filter for IHO Special Order. Data were then manually edited and cleaned using the swath, slice, and 3D editor tools in Qimera. The Density Grid was analyzed prior to cutting any outer beams (if necessary) to ensure a minimum of 5 pings per square meter. The final surface was inspected using the Uncertainty Grid (95% confidence level) for any remaining outliers to be removed. Final QC was performed using the Density, Uncertainty (95%), Total Horizontal Uncertainty (THU), and Total Vertical Uncertainty (TVU) grids.

General Information

Equipment

Survey Vessels	M/V Marcelle[1]/M/V Sarah Bordelon[2]/ R/V Kommandor Iona[3]/ R/V Kommandor Stuart[4]/ M/V GO Discovery[5]/M/V Minerva Uno[6]
Positioning System	: Applanix POSMV and Hemisphere
USBL	: Sonardyne Ranger 2 (19-34 kHz)
Multibeam Echosounder	: Teledyne T50 (200-400 kHz) R2Sonic 2024 (200-400 kHz)[6]
Sidescan Sonar	: EdgeTech 4200 (300/600 kHz)
Magnetometer	: Geometrics G-882 (TVG)
Subbottom Profiler	: Innomar SES-2000 medium
Multi Channel Seismic[1,4,5]	: AAS-Boom and Geospark 200+400 and 96-Element Streamer
Single Channel Seismic[2,5,6]	: AAS-Boom and SCS Streamer
Sparker[3]	: Geospark 200+400 and 96-Element Streamer
Sound Velocity Profiler	: AML MVP30/MVP200[3]
Acquistion Software	: QINSy

TerraSond Personnel

Commercial Manager	: Scott Croft
Project Manager	: Don Ross
Project Manager	: James Hougham
Production Manager	: Kate Mildon
Technical Manager	: Chris McHugh
Geophysical Manager	: Scott Hiller
Operations Manager	: William Busey
Party Chief	: Mark MacLean
Lead Surveyor	: Larry Andrews
Director HSEQ	: Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

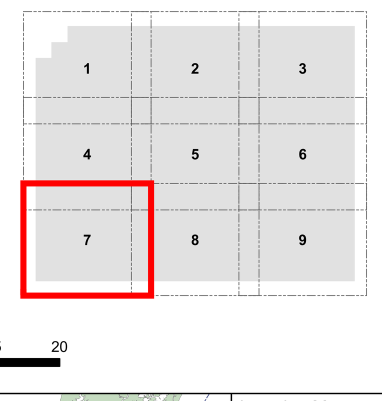
CRS Name	:NAD 1983 (2011) UTM Zone 18N
EPSG Code	:6347
Geodetic Datum	:North American 1983
Projection	:Universal Transverse Mercator
Units	:Meter

Vertical Coordinate Reference System

Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

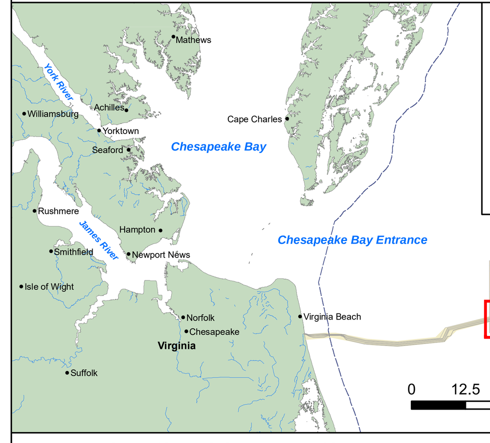
Tile Index Overview

- Current Tile
- BOEM Lease Block OCS-A 0483
- Tile Panel 1 - 9



Location Map

- City
- Proposed Cable Route
- Current Tile
- Submerged Lands Act Boundary
- Cable Corridor
- BOEM Lease Boundary OCS-A 0483
- State Virginia



0 125 250 500 750 1,000 1,250 Meters

0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

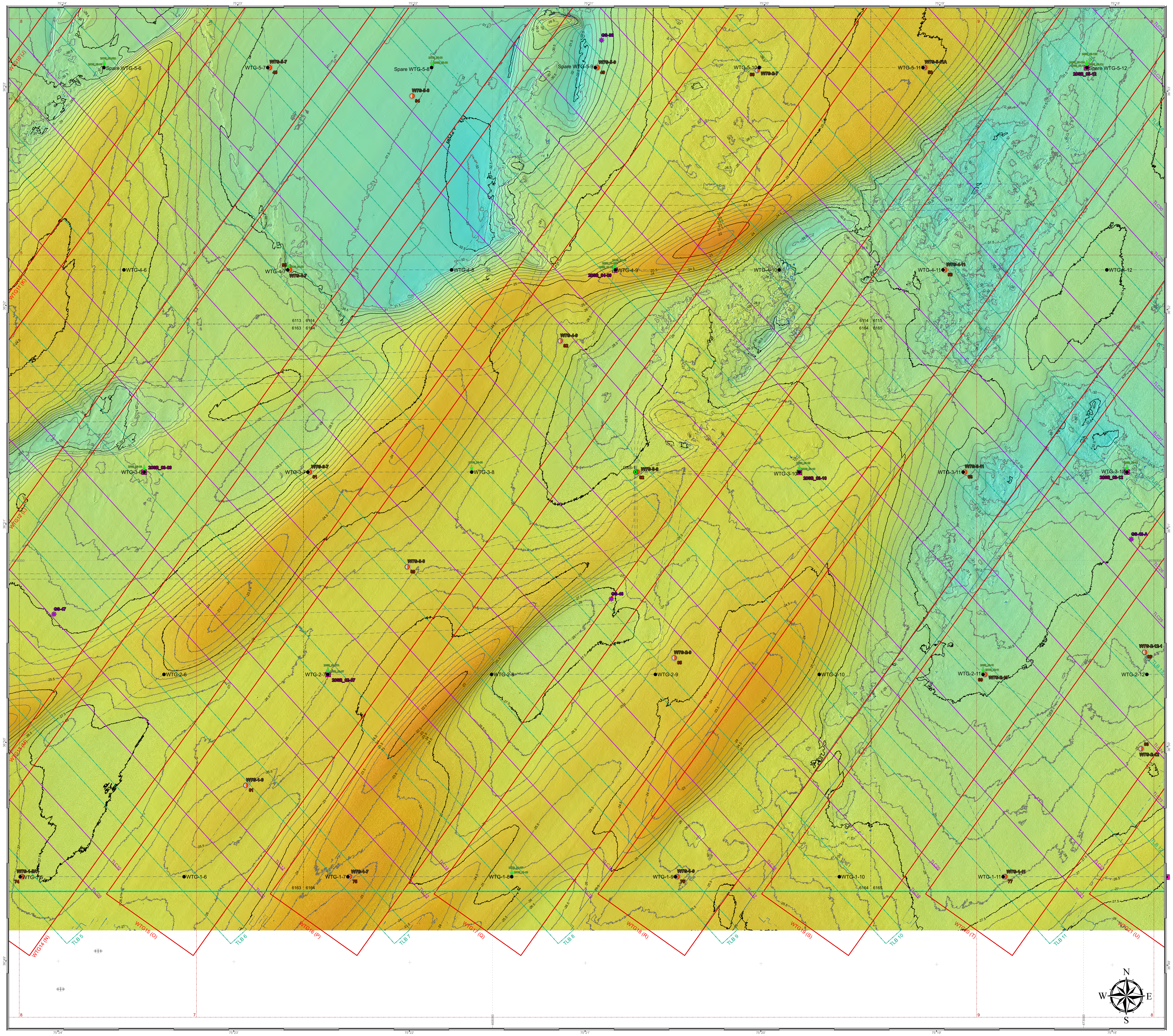
Chart Title: CHART 2 BATHYMETRY TILE 7 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/04/21	DRAFT	CLS	KMM	KMM
06/14/21	Rev00	CLS	KDW	KMM
07/29/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/29/2021

File Name: Dominion_Bathymetry_Rev01.pdf



General Map Symbols

- Dominion Lease Boundary — OCS-A 0483
- Proposed Cable Route — "Conceptual cables routes; Detailed re-routing/micro-siting will follow"
- TLC Planned Line
- TLB Corridor
- WTG Corridor
- Cable Corridor
- BOEM Lease Block Main Chart — OCS-A 0483
- Tile Panel 1 - 9 Main Chart
- WTG Location — Preliminary position/subject to change
- OSS Location — Preliminary position/subject to change
- Grab Sample
- Box Corer
- Geotechnical Boring
- Benthic Sample
- CPT
- Charted Shipwreck — Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Bathymetry

- Major Contours (2.5 m interval)
- Minor Contours (0.50 m interval)
- Slope Gradient >= 10°

The elevation values for the current display:

Minimum: -33.33m

Maximum: -21.8m

Bathymetric Grid

-18 -21 -24 -27 -30 -33 -36 -39 -42

MBES surface was created at 50 cm resolution.
Bathymetric Grid: values are elevation, in meters

Multibeam Echosounder Processing Notes

Multibeam bathymetry data were processed in QPS Qimera 2.2.1.

Data Import and Navigation

Qinsy Database (DB) files were imported into Qimera 2.2.1, and an initial surface was made; post-processed POSPac PP-RTX results in the form of Smoothed Best Estimate Trajectories (SBETs) were imported. In Qimera, position and altitude data were analyzed for erroneous points; these data points were flagged and then removed.

Sound Velocity Correction

Sound velocity data were imported, evaluated for erroneous points, and applied to the MBES data. Unless sound velocity errors were noted, "Nearest in Distance Within Time – 360 minutes" was the method for pairing SV casts to the DB files.

Vertical Datum

The data were then converted to the working vertical datum, MLLW, by the application of NOAA V-Datum separation model; this separation model shifted the SBET from its native ellipsoidal elevation.The data were checked for tidal errors, refraction, and noise and adjusted where necessary.

Data Cleaning

Data were filtered using an TPU (Total Propagated Uncertainty) filter for IHO Special Order. Data were then manually edited and cleaned using the swath, slice, and 3D editor tools in Qimera. The Density Grid was analyzed prior to cutting any outer beams (if necessary) to ensure a minimum of 5 pings per square meter. The final surface was inspected using the Uncertainty Grid (95% confidence level) for any remaining outliers to be removed. Final QC was performed using the Density, Uncertainty (95%), Total Horizontal Uncertainty (THU), and Total Vertical Uncertainty (TVU) grids.

General Information

Equipment

Survey Vessels	M/V Marcelle[1]/M/V Sarah Bordelon[2]/ R/V Kommandor Iona[3]/ R/V Kommandor Stuart[4]/ M/V GO Discovery[5]/M/V Minerva Uno[6]
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Acquistion Software	: QINSy

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Project Manager	: James Hougham
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This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

CRS Name	:NAD 1983 (2011) UTM Zone 18N
EPSG Code	:6347
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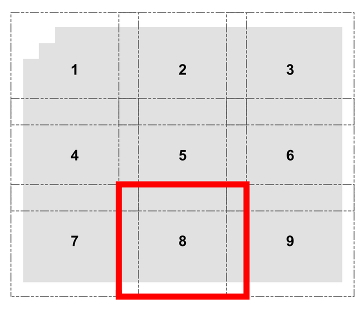
Units	:Meter

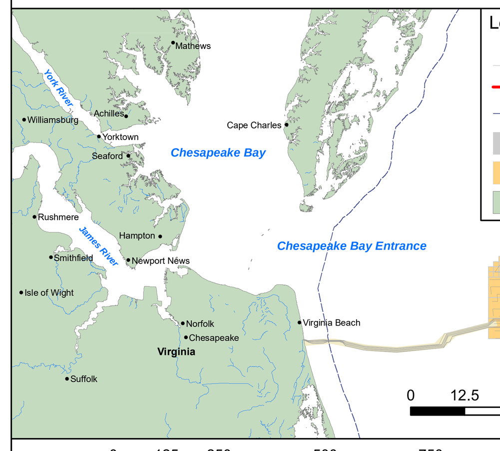
Vertical Coordinate Reference System

Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

Tile Index Overview

- Current Tile
- BOEM Lease Block — OCS-A 0483
- Tile Panel 1 - 9





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Survey Contractor: TERRASOND — PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

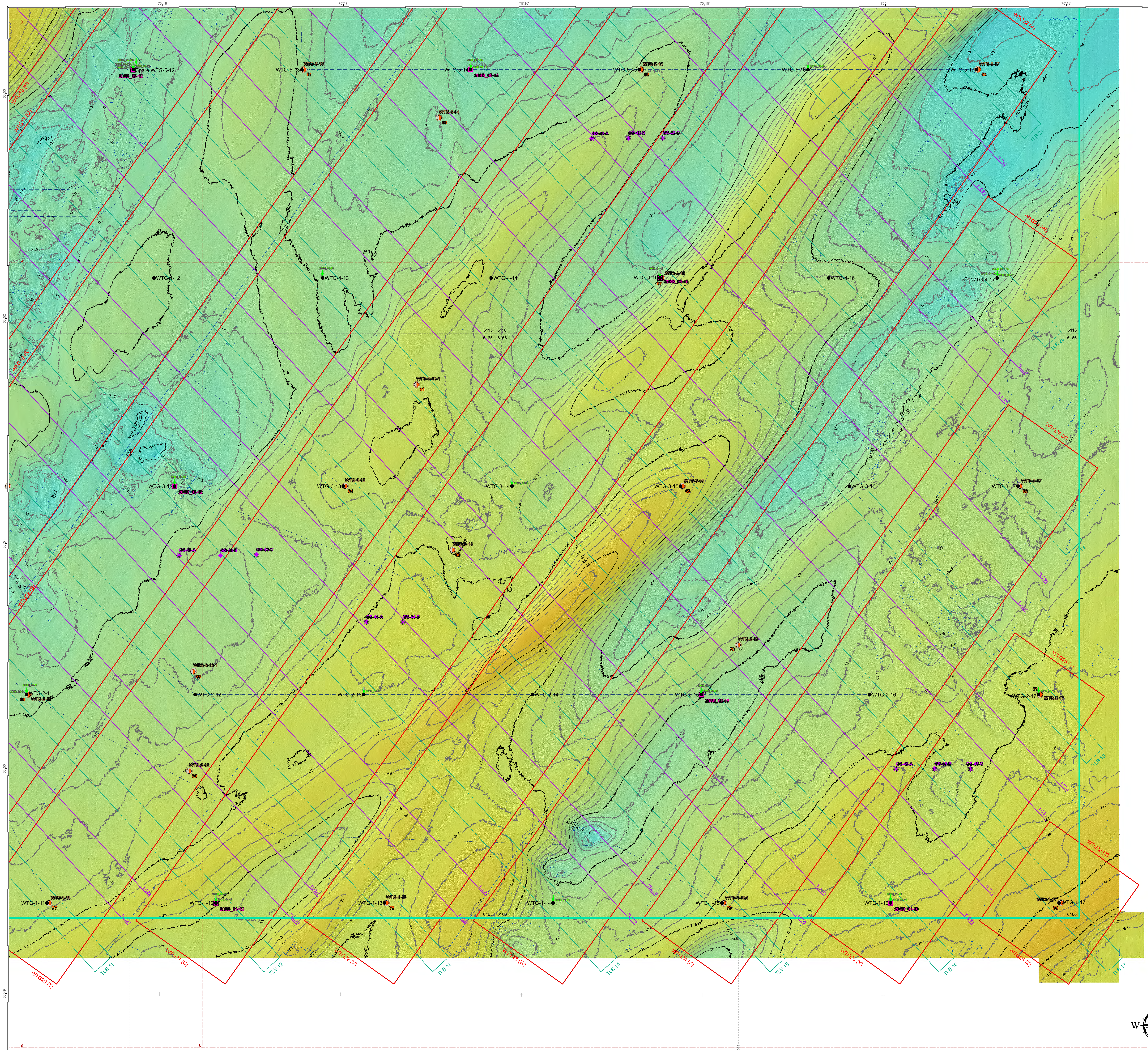
Chart Title: CHART 2 BATHYMETRY TILE 8 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/04/21	DRAFT	CLS	KMM	KMM
06/14/21	Rev00	CLS	KDW	KMM
07/29/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/29/2021

File Name: Dominion_Bathymetry_Rev01.pdf



General Map Symbols

- Dominion Lease Boundary (OCS-A 0483)
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- Charted Shipwreck (Source: NOAA Office of Coast Survey)

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Bathymetry

- Major Contours (2.5 m interval)
- Minor Contours (0.50 m interval)
- Slope Gradient >= 10°

The elevation values for the current display:
Minimum: -33.51m
Maximum: -24.06m

Bathymetric Grid

-18 -21 -24 -27 -30 -33 -36 -39 -42

MBES surface was created at 50 cm resolution.
Bathymetric Grid: values are elevation, in meters

Multibeam Echosounder Processing Notes

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General Information

Equipment

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Single Channel Seismic[2,5,6]	: AAS-Boom and SCS Streamer
Sparker[3]	: Geospark 200+400 and 96-Element Streamer
Sound Velocity Profiler	: AML MVP30/MVP200[3]
Acquistion Software	: QINSy

TerraSond Personnel

Commercial Manager	: Scott Croft
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Production Manager	: Kate Mildon
Technical Manager	: Chris McHugh
Geophysical Manager	: Scott Hiller
Operations Manager	: William Busey
Party Chief	: Mark MacLean
Lead Surveyor	: Larry Andrews
Director HSEQ	: Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

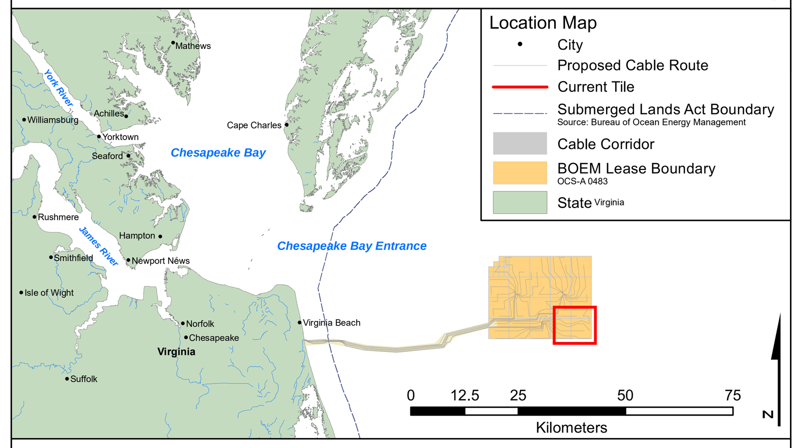
CRS Name	:NAD 1983 (2011) UTM Zone 18N
EPSG Code	:6347
Geodetic Datum	:North American 1983
Projection	:Universal Transverse Mercator
Units	:Meter

Vertical Coordinate Reference System

Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

Tile Index Overview

- Current Tile
- BOEM Lease Block (OCS-A 0483)
- Tile Panel 1 - 9



0 125 250 500 750 1,000 1,250 Meters

0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

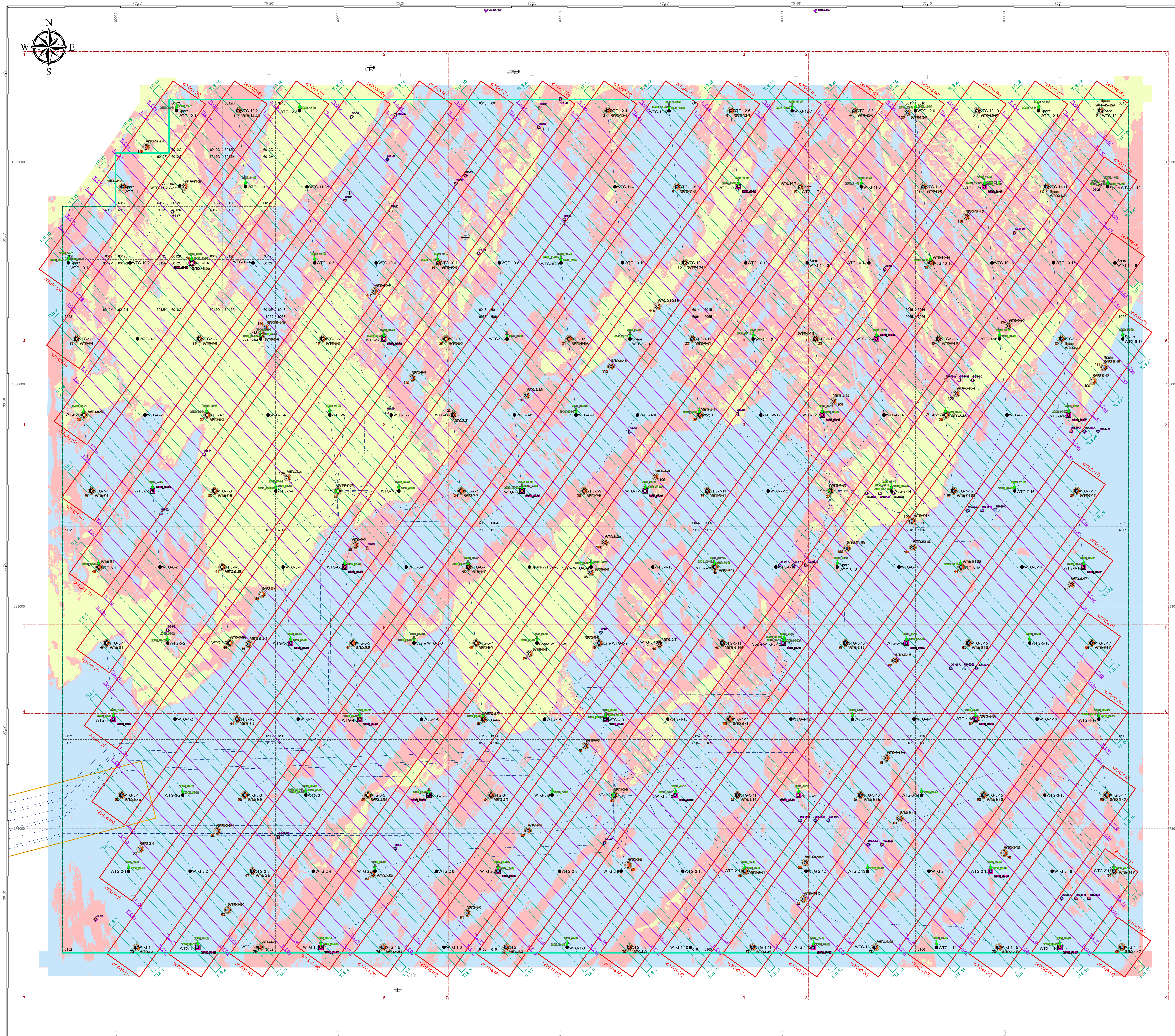
Chart Title: CHART 2 BATHYMETRY TILE 9 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/04/21	DRAFT	CLS	KMM	KMM
06/14/21	Rev00	CLS	KDW	KMM
07/29/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/29/2021

File Name: Dominion_Bathymetry_Rev01.pdf



General Map Symbols

- Dominion Lease Boundary — OCS-A 0483
- Proposed Cable Route — "Conceptual cables routes; Detailed re-routing/micro-siting will follow"
- TLC Planned Line
- TLB Corridor
- WTG Corridor
- Cable Corridor
- BOEM Lease Block Main Chart — OCS-A 0483
- Tile Panel 1 - 9 Main Chart
- WTG Location — Preliminary position/subject to change
- OSS Location — Preliminary position/subject to change
- Grab Sample
- Box Corer
- Geotechnical Boring
- Benthic Sample
- CPT
- Charted Shipwreck — Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

CMECS Subgroup Classification

- Fine Sand — minimum grain size 0.0625mm, maximum grain size 0.25mm
- Medium Sand — minimum grain size 0.25mm, maximum grain size 0.5mm
- Coarse Sand — minimum grain size 0.5mm retained by #40, maximum grain size 2.0mm passing #10

Geotechnical Samples

- Fine Sand/Very Fine Sand
- Medium Sand
- Coarse Sand
- Very Coarse Sand
- Granule/Pebble

ASTM Classification

Class	Gravel		Coarse Sand	Medium Sand		Fine Sand			
Sieve Size or No.	3/8"	#4	#10	#20	#40	#60	#100	#140	#200
Particle Size (mm)	9.500	4.750	2.000	0.850	0.425	0.250	0.150	0.106	0.075
Particle Size (mm)	64	4	2	1	0.5	0.25	0.125		0.0625
Substrate SubGroup	Pebble		Granule	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand/Very Fine Sand		

CMECS Classification

Geologic Setting

The survey area lies along a portion of mid North Atlantic continental shelf that is subject to multiple concurrent processes that shape the overall geologic/stratigraphic framework of the region. These include glacio-eustatic sea level changes, variations in sediment supply from and proximity to the Chesapeake Bay drainage system, and storm related effects on sediment supply and distribution.

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Sediment Mapping

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General Information

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Survey Vessels	M/V Marcelle[1]/M/V Sarah Bordelon[2]/ R/V Kommandor Iona[3]/ R/V Kommandor Stuart[4]/ M/V GO Discovery[5]/M/V Minerva Uno[6]
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Subbottom Profiler	: Innomar SES-2000 medium
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Tile Index Overview

- Current Tile
- BOEM Lease Block — OCS-A 0483
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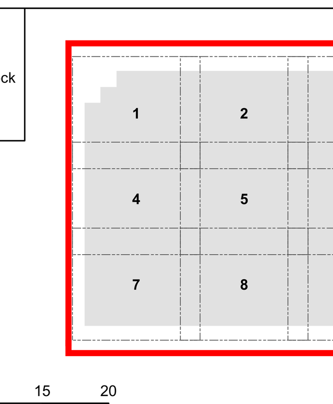
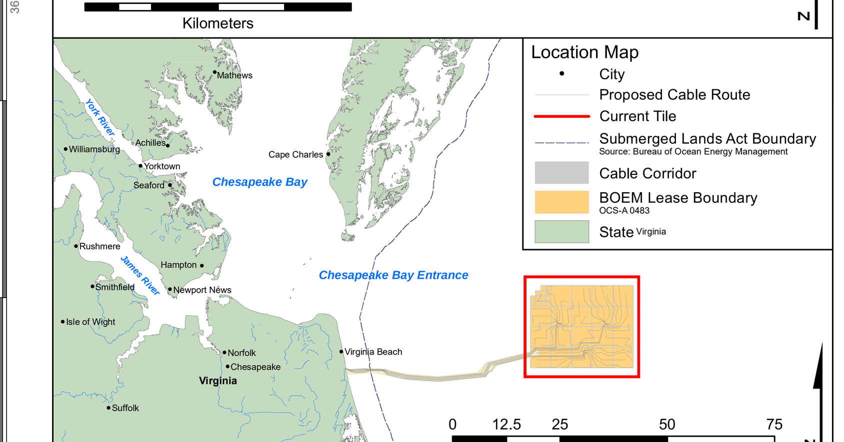


Location Map

- City
- Proposed Cable Route
- Current Tile
- Submerged Lands Act Boundary
- Cable Corridor
- BOEM Lease Boundary
- State



0 0.5 1 2 Miles

0 0.5 1 2 3 4 Kilometers

1:27,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS®

Client: Dominion Energy®

Project Title: CVOW-C Geophysical Survey 2021

Chart Title:

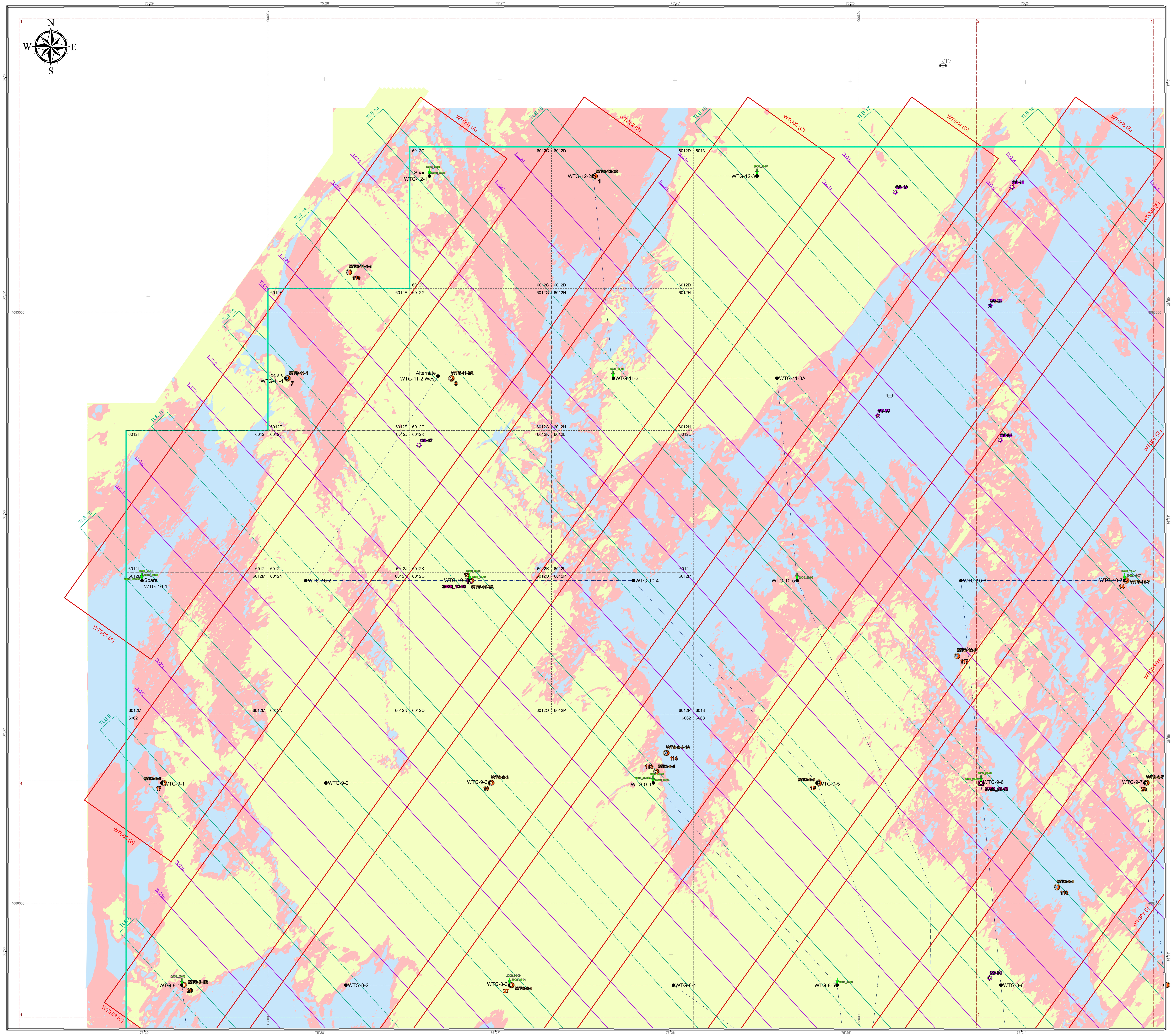
CHART 3d
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE SEABED SEDIMENT CLASSIFICATION (CMECS) OVERVIEW

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
06/21/21	Rev00	CLS	KDW	KMM
07/30/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/30/2021

File Name: Dominion_GeoSurfaceFeatures_Sediment_CMECS_Rev01_Chart_Overview.pdf



General Map Symbols

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- WTG Corridor
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- Charted Shipwreck Source: NOAA Office of Coast Survey

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Class	Gravel		Coarse Sand	Medium Sand		Fine Sand			
Sieve Size or No.	3/8"	#4	#10	#20	#40	#60	#100	#140	#200
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Substrate SubGroup	Pebble		Granule	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand/ Very Fine Sand		
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Geologic Setting

The survey area lies along a portion of mid North Atlantic continental shelf that is subject to multiple concurrent processes that shape the overall geologic/stratigraphic framework of the region. These include glacio-eustatic sea level changes, variations in sediment supply from and proximity to the Chesapeake Bay drainage system, and storm related effects on sediment supply and distribution.

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General Information

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Operations Manager	: William Busey
Party Chief	: Mark MacLean
Lead Surveyor	: Larry Andrews
Director HSEQ	: Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

CRS Name :NAD 1983 (2011) UTM Zone 18N
EPSG Code :6347
Geodetic Datum :North American 1983
Projection :Universal Transverse Mercator
Units :Meter

Vertical Coordinate Reference System

Datum :Mean Lower Low Water (MLLW)
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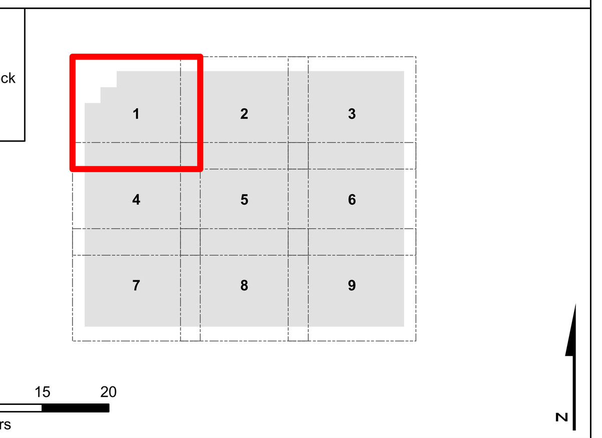
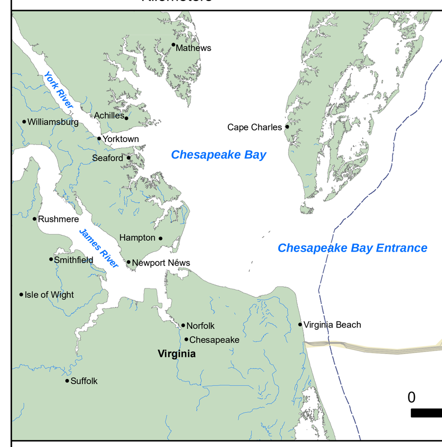
Tile Index Overview

- Current Tile
- BOEM Lease Block OCS-A 0483
- Tile Panel 1 - 9





Location Map

- City
- Proposed Cable Route
- Current Tile
- Submerged Lands Act Boundary
- Cable Corridor
- BOEM Lease Boundary OCS-A 0483
- State Virginia

0 125 250 500 750 1,000 1,250 Meters
0 500 1,000 2,000 3,000 4,000 5,000 Feet
1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

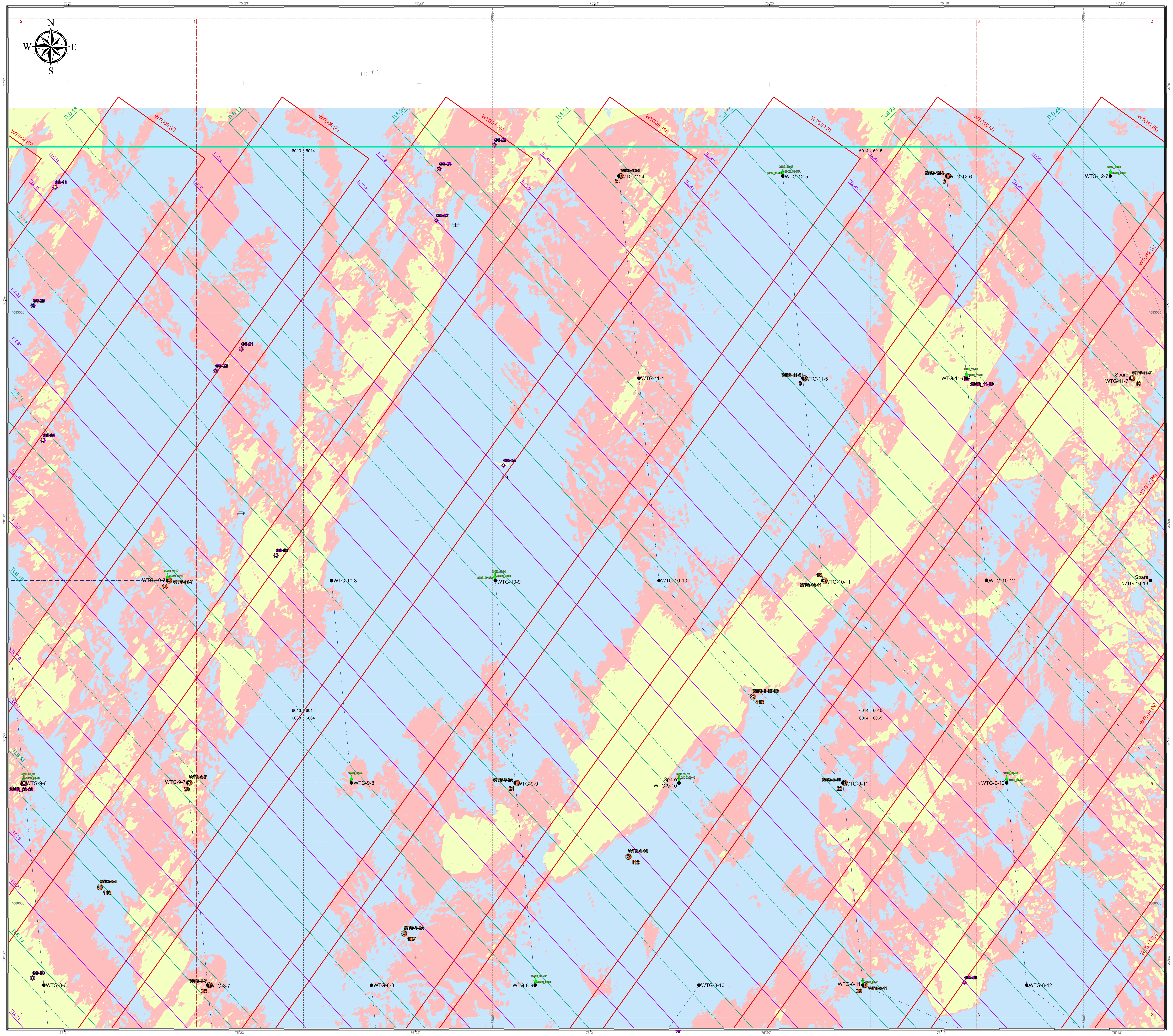
Chart Title:

CHART 3d
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE SEABED SEDIMENT CLASSIFICATION (CMECS)
TILE 1 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
06/21/21	Rev00	CLS	KDW	KMM
07/30/21	Rev01	CLS	KDW	KMM

Rev01
Date: 7/30/2021

File Name: Dominion_GeoSurfaceFeatures_Sediment_CMECS_Rev01.pdf



General Map Symbols

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Sieve Size or No.	3/8"	#4	#10	#20	#40	#60	#100	#140	#200	
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This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

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Datum	:Mean Lower Low Water (MLLW)
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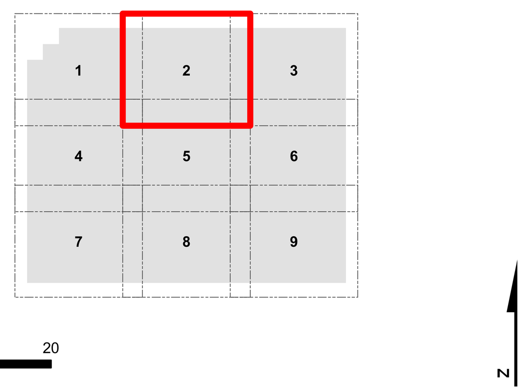
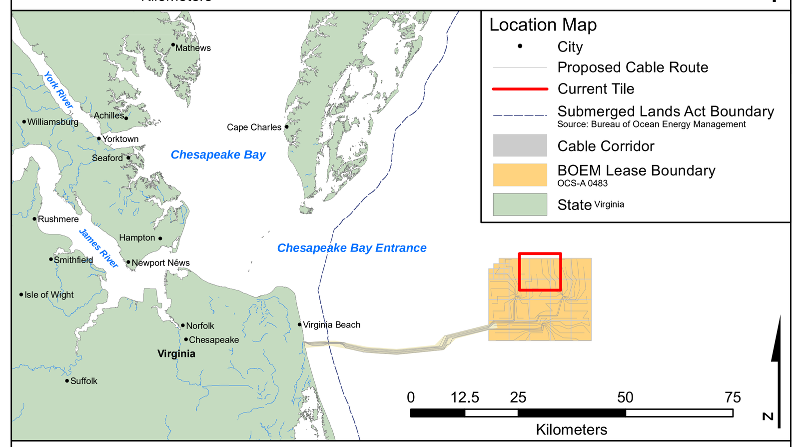
Tile Index Overview

- Current Tile
- BOEM Lease Block OCS-A 0483
- Tile Panel 1 - 9





0 125 250 500 750 1,000 1,250 Meters
0 500 1,000 2,000 3,000 4,000 5,000 Feet
1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS®

Client: Dominion Energy®

Project Title:
CVOW-C Geophysical Survey 2021

Chart Title:
CHART 3d
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE SEABED SEDIMENT CLASSIFICATION (CMECS)
TILE 2 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
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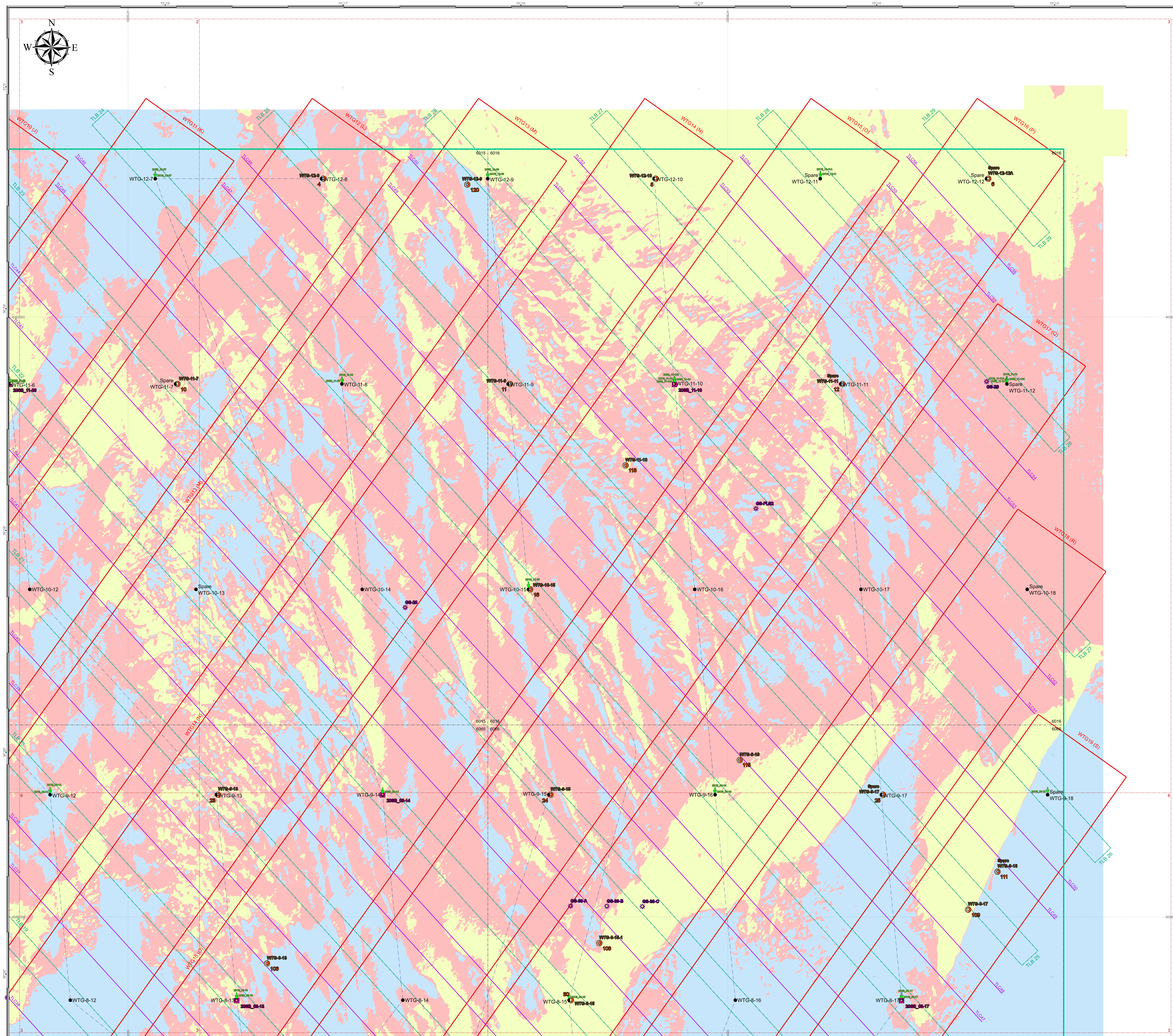
Rev01
Date: 7/30/2021

File Name: Dominion_GeoSurfaceFeatures_Sediment_CMECS_Rev01.pdf



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This geophysical survey was conducted April 29th, 2020 through June13th, 2021

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Datum :Mean Lower Low Water (MLLW)
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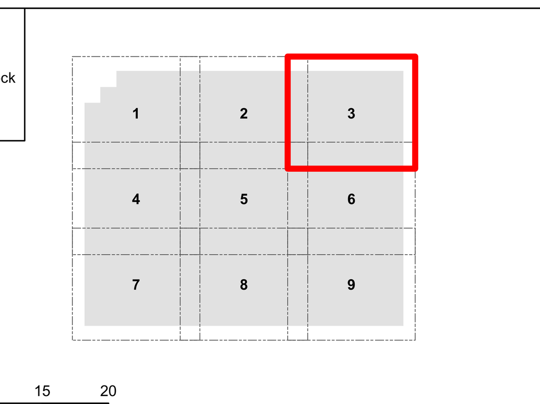
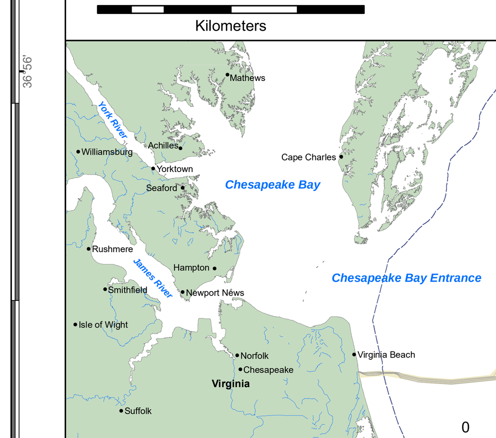
Tile Index Overview

- Current Tile
- BOEM Lease Block OCS-A 0483
- Tile Panel 1 - 9





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Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title:

CVOW-C Geophysical Survey 2021

Chart Title:

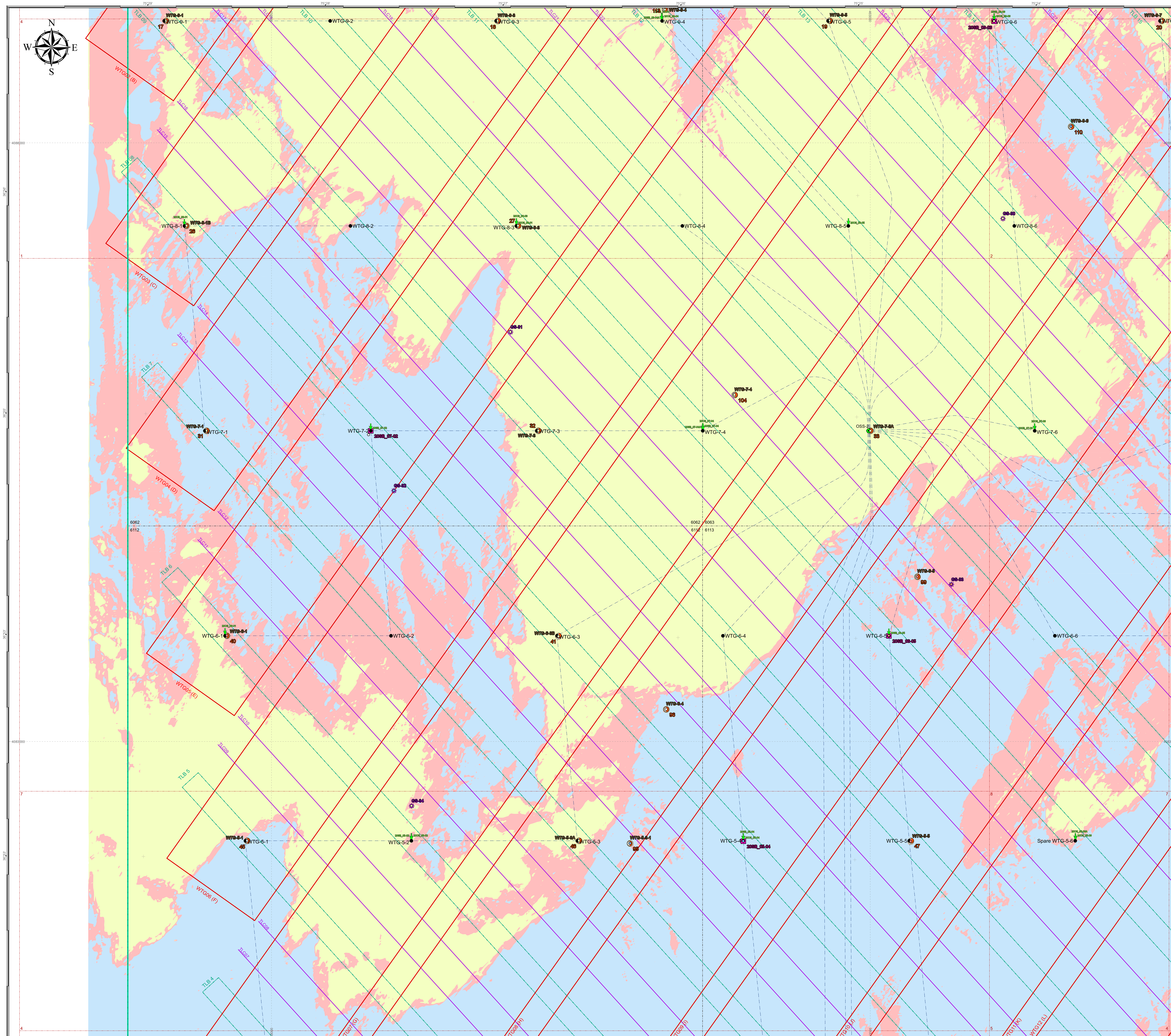
CHART 3d
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE SEABED SEDIMENT CLASSIFICATION (CMECS)
TILE 3 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
06/21/21	Rev00	CLS	KDW	KMM
07/30/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/30/2021

File Name: Dominion_GeoSurfaceFeatures_Sediment_CMECS_Rev01.pdf



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- Charted Shipwreck Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
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- Fine Sand/Very Fine Sand
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ASTM Classification									
Class	Gravel		Coarse Sand	Medium Sand		Fine Sand			
Sieve Size or No.	3/8"	#4	#10	#20	#40	#60	#100	#140	#200
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Particle Size (mm)	64	4	2	1	0.5	0.25	0.125		0.0625
Substrate SubGroup	Pebble		Granule	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand/Very Fine Sand		
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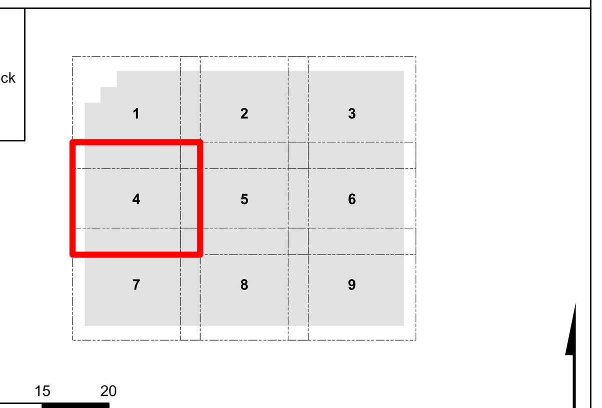

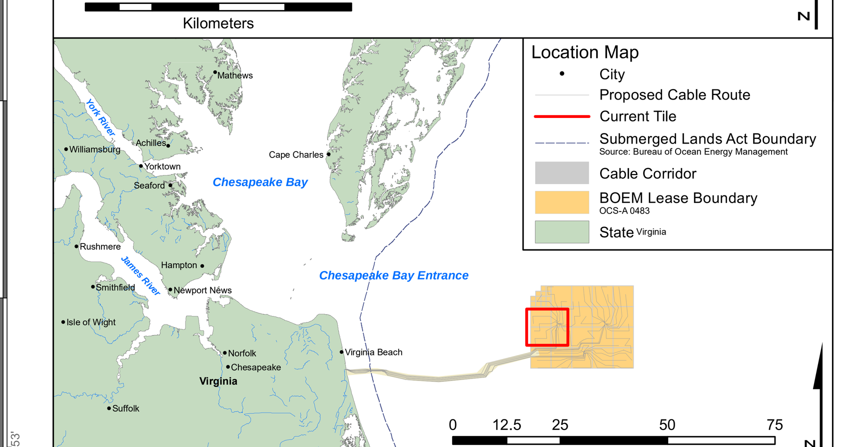

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Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

Chart Title:

CHART 3d
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE
SEABED SEDIMENT CLASSIFICATION (CMECS)
TILE 4 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
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Rev01

Date: 7/30/2021

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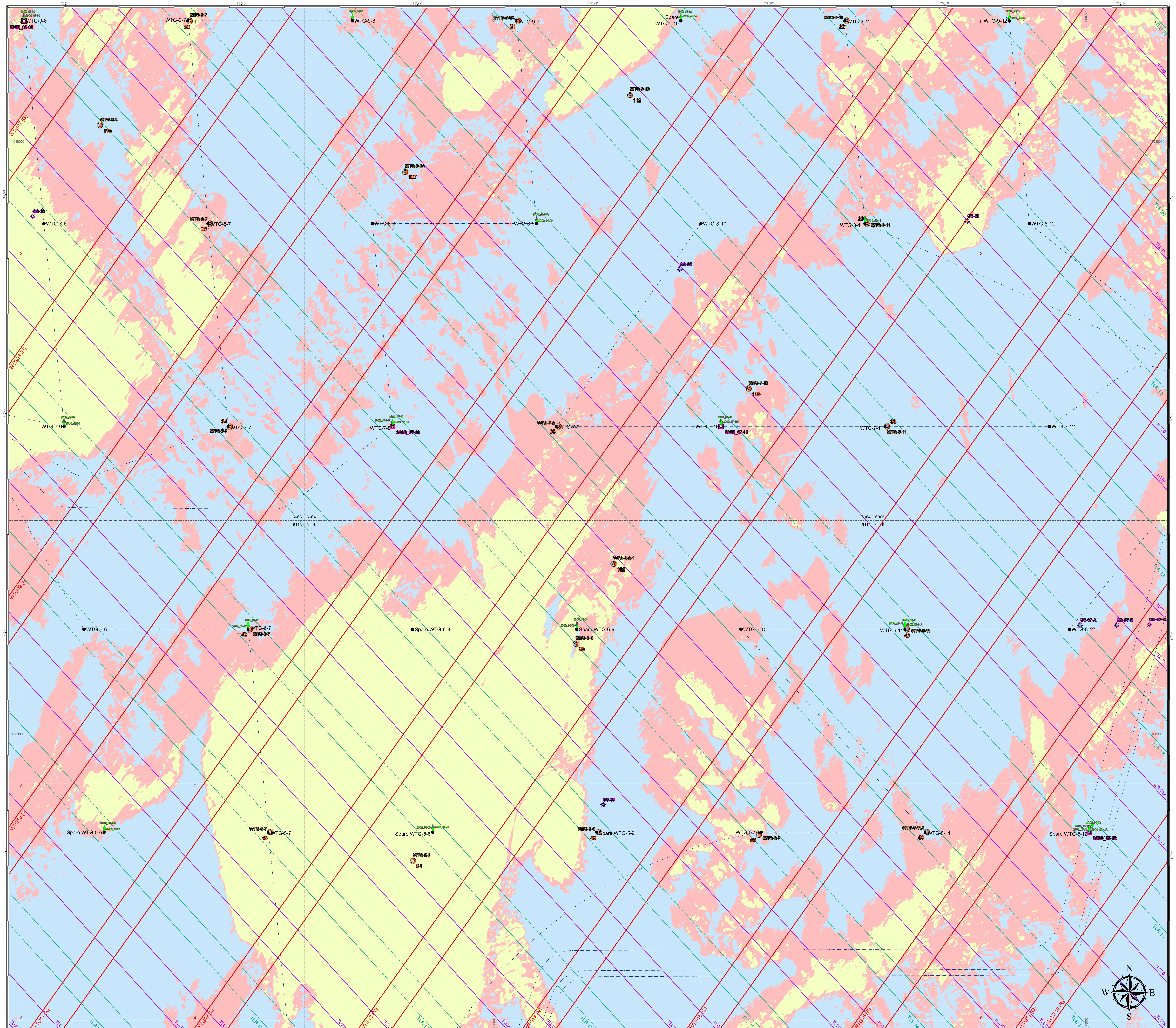

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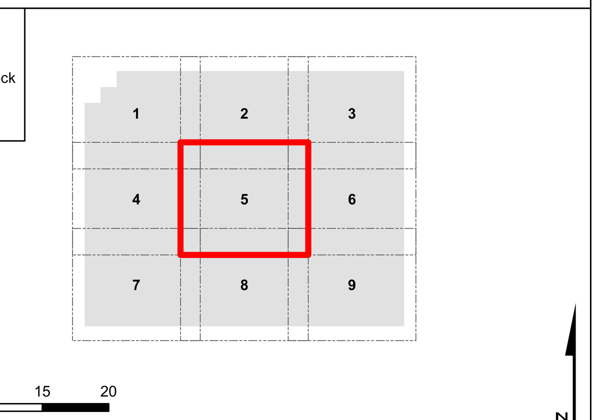
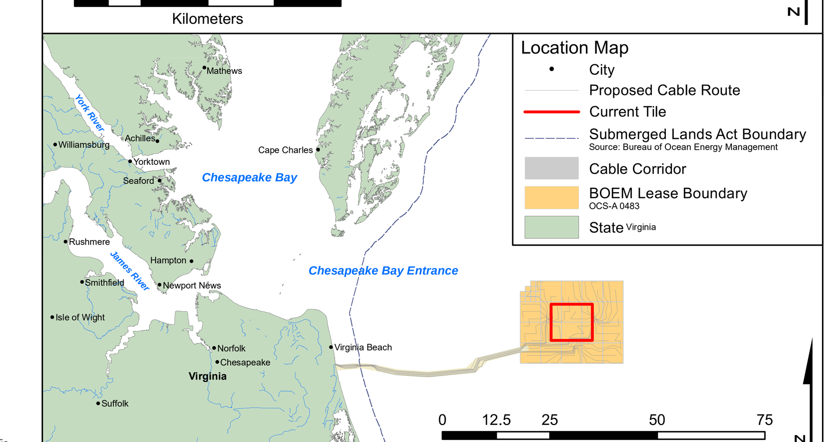
Tile Index Overview

- Current Tile
- BOEM Lease Block OCS-A 0483
- Tile Panel 1 - 9





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0 500 1,000 2,000 3,000 4,000 5,000 Feet
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Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS
Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

Chart Title: CHART 3d
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE
SEABED SEDIMENT CLASSIFICATION (CMECS)
TILE 5 of 9

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Rev01
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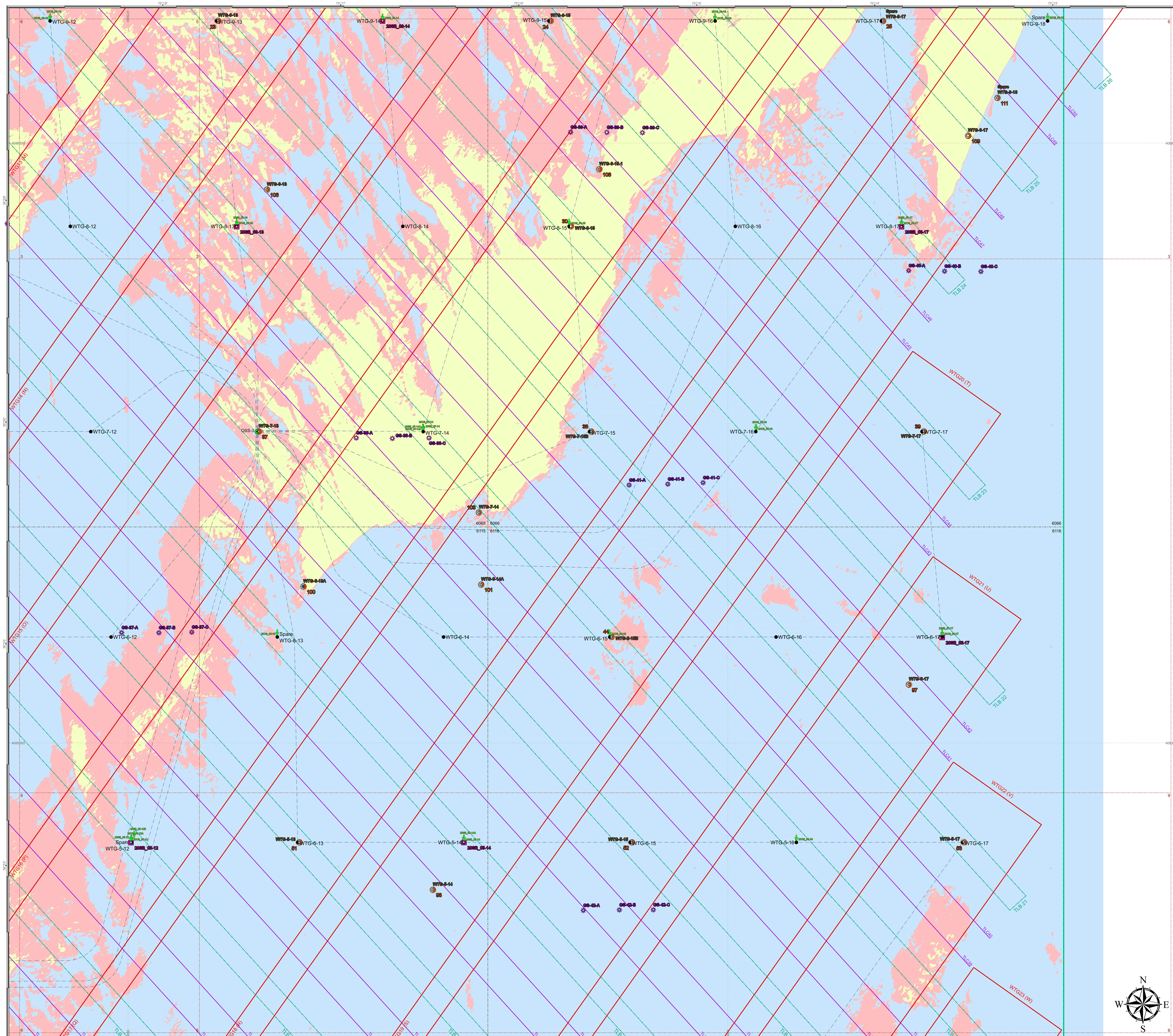
File Name: Dominion_GeoSurfaceFeatures_Sediment_CMECS_Rev01.pdf



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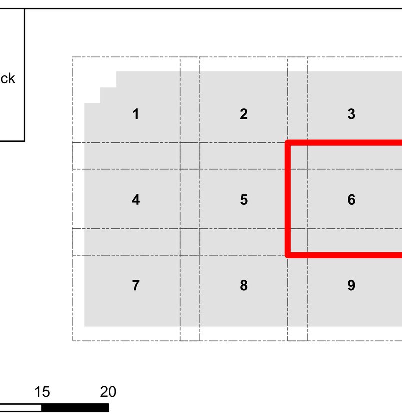
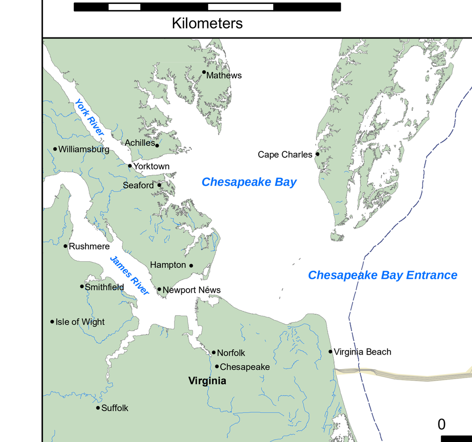




Location Map
- City
- Proposed Cable Route
- Current Tile
- Submerged Lands Act Boundary
- Cable Corridor
- BOEM Lease Boundary
- State

0 125 250 500 750 1,000 1,250 Meters
0 500 1,000 2,000 3,000 4,000 5,000 Feet
1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS®

Client: Dominion Energy®

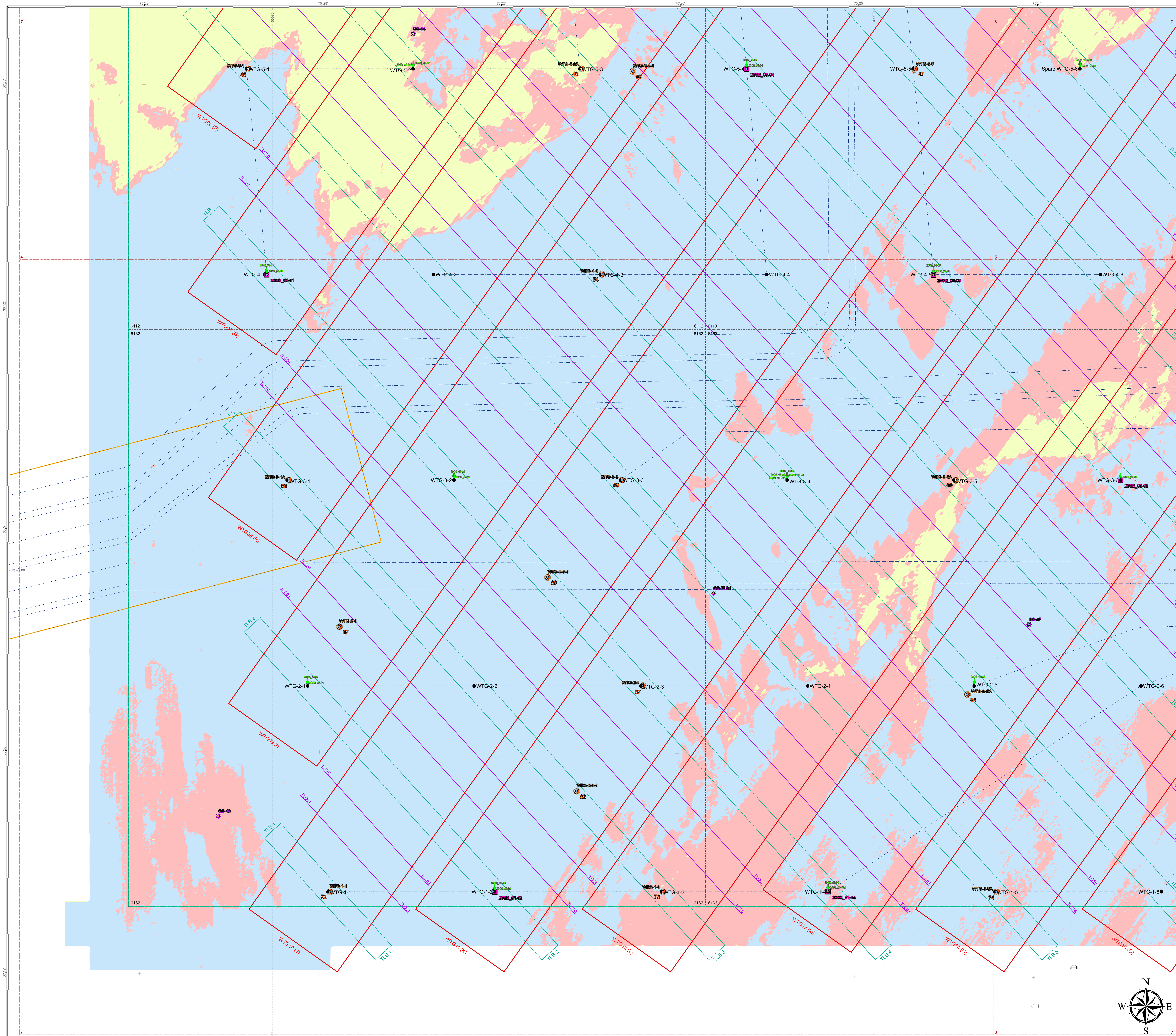
Project Title:
CVOW-C Geophysical Survey 2021

Chart Title:
CHART 3d
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE SEABED SEDIMENT CLASSIFICATION (CMECS)
TILE 6 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
06/21/21	Rev00	CLS	KDW	KMM
07/30/21	Rev01	CLS	KDW	KMM

Rev01
Date: 7/30/2021

File Name: Dominion_GeoSurfaceFeatures_Sediment_CMECS_Rev01.pdf



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ASTM Classification

Class	Gravel		Coarse Sand	Medium Sand		Fine Sand			
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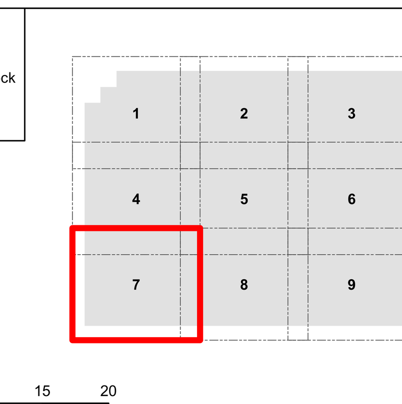

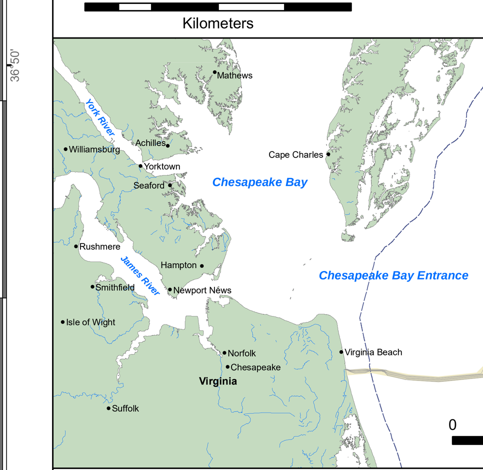

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Project Title:

CVOW-C Geophysical Survey 2021

Chart Title:

CHART 3d

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TILE 7 of 9

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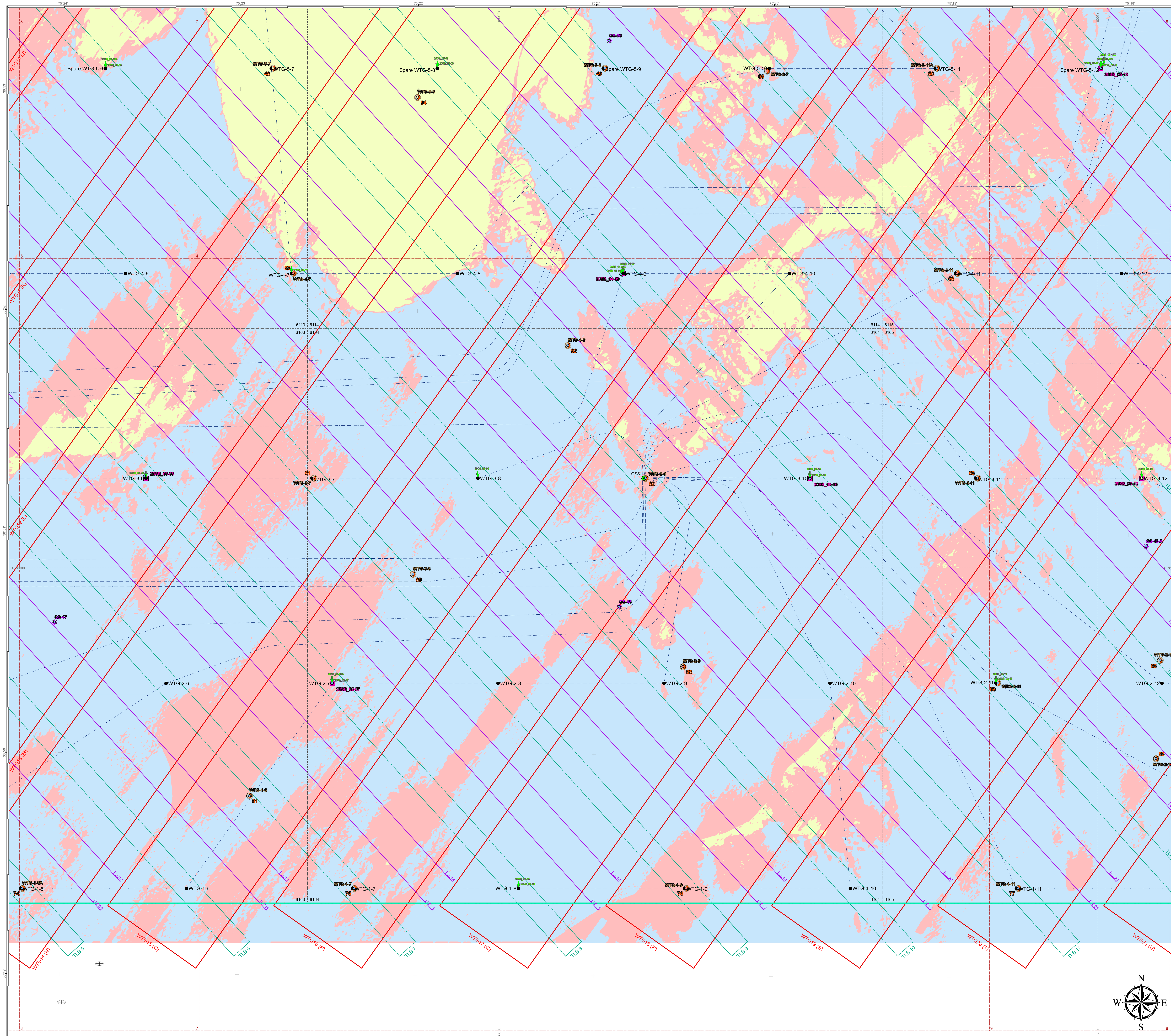

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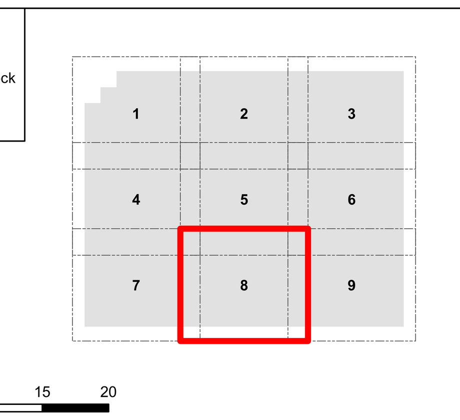

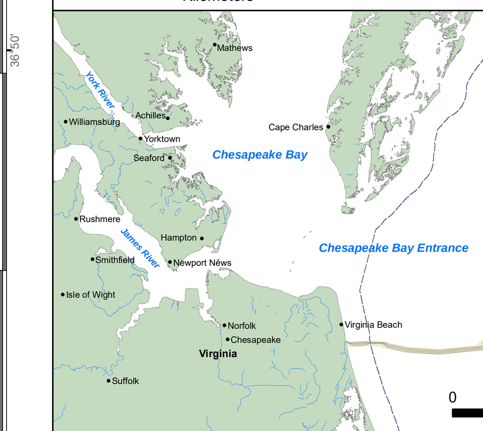

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Survey Contractor: TERRASOND — PRECISION GEOSPATIAL SOLUTIONS
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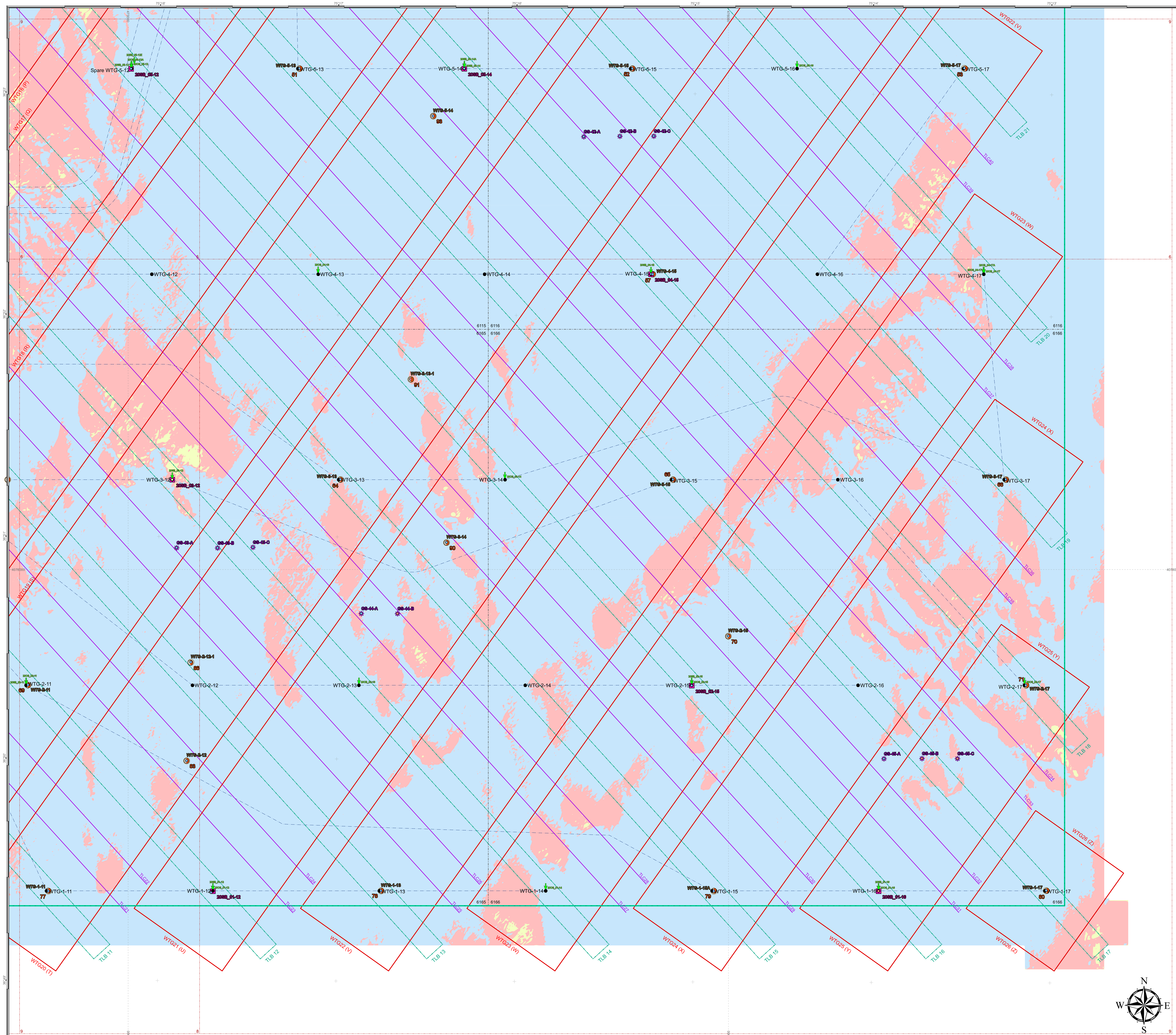

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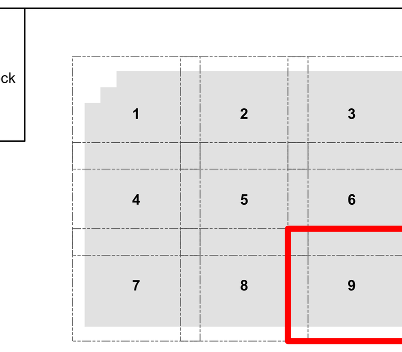

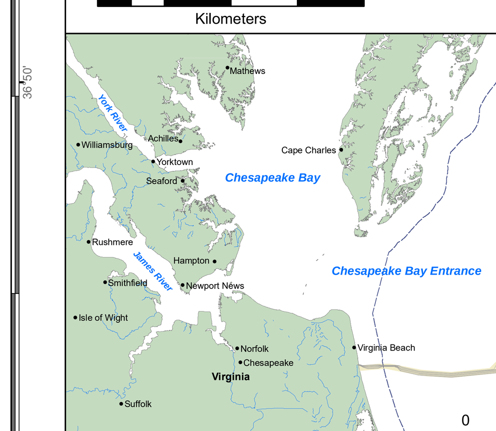

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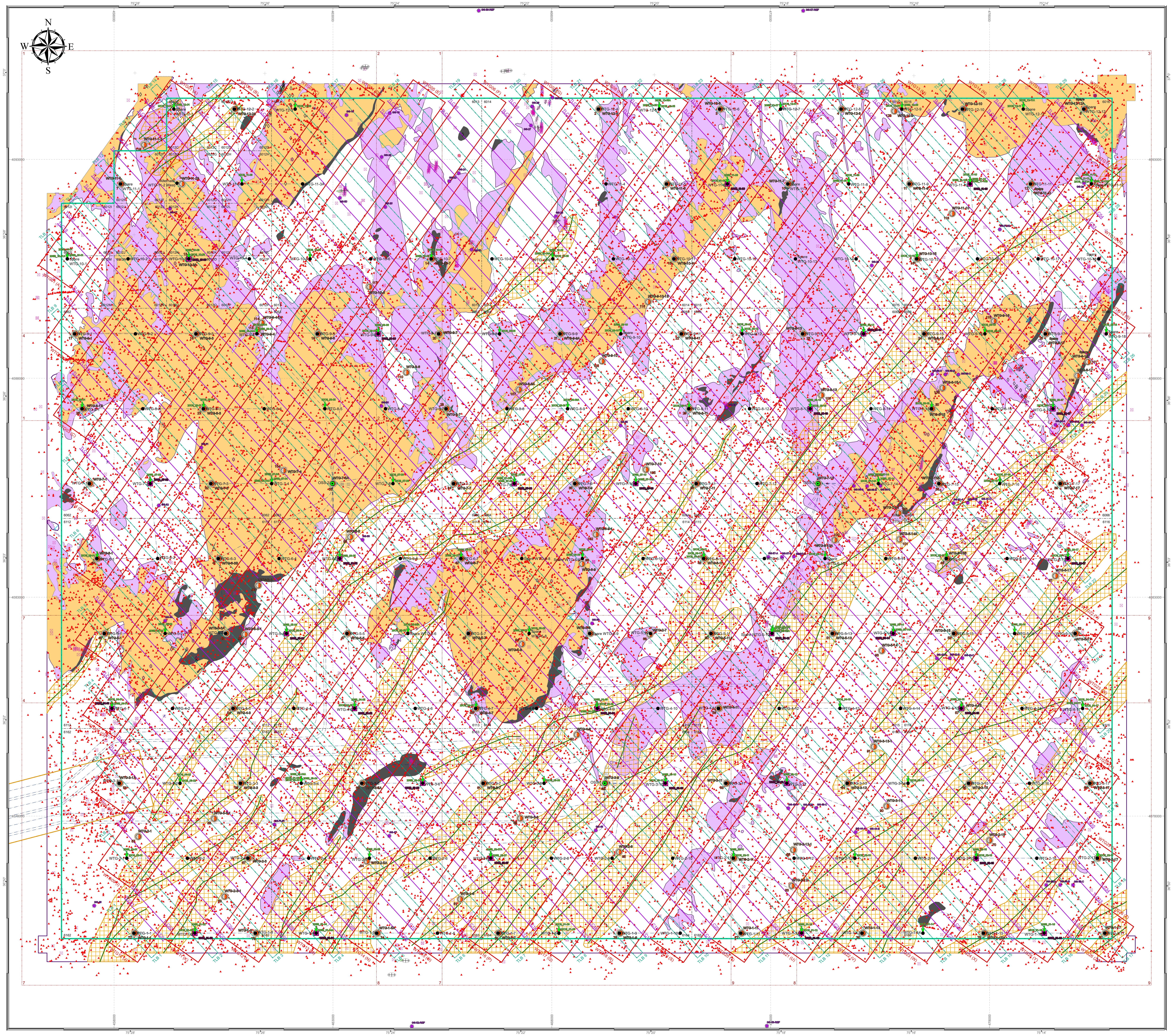

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Seabed Features

- Slope
- Flat
- Wreck
- Scour/Erosion Features
- Boulder/Boulderfield
- Linear Seabed Feature
- Seabed Feature Depression Point
- Trash Aggregation
- Depression

Seabed Morphology

- Ripple
- Megaripple
- Sediment Wavefield
- Sand Ridge Area
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- Side Scan Sonar Contact
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Note: Contact and anomaly labels are truncated.

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Seabed Feature Interpretation

Regions containing seabed features and hazards were identified and digitized from gridded multibeam, backscatter, sidescan, and slope gradient datasets.

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Morphology Interpretation

Morphological bedforms; Ripples, Megaripples, and/or Sand Waves were identified and digitized from gridded multibeam, backscatter, and sidescan data.

Digitized morphology was given classifications according to the Coastal Marine Ecological Classifcation Standard (CMECS) 2012.

Magnetometer Interpretation

Evaluation of the 10Hz gradiometric magnetometer data involved processing the total field of individual magnetometer readings and reducing them to a residual magnetic profile. A total of 28094 magnetic anomalies were interpreted within the survey area.

General Information

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Survey Vessels	M/V Marcelle[1]/M/V Sarah Bordelon[2]/ R/V Kommandor Iona[3]/ R/V Kommandor Stuart[4]/ M/V GO Discovery[5]/M/V Minerva Uno[6]
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USBL	: Sonardyne Ranger 2 (19-34 kHz)
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Magnetometer	: Geometrics G-882 (TVG)
Subbottom Profiler	: Innomar SES-2000 medium
Multi Channel Seismic[1,4,5]	: AAS-Boom and Geospark 200+400 and 96-Element Streamer
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Acquistion Software	: QINSy

TerraSond Personnel

Commercial Manager	: Scott Croft
Project Manager	: Don Ross
Project Manager	: James Hougham
Production Manager	: Kate Mildon
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Geophysical Manager	: Scott Hiller
Operations Manager	: William Busey
Party Chief	: Mark MacLean
Lead Surveyor	: Larry Andrews
Director HSEQ	: Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

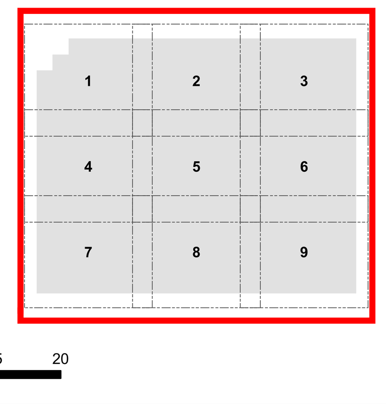
CRS Name	:NAD 1983 (2011) UTM Zone 18N
EPSG Code	:6347
Geodetic Datum	:North American 1983
Projection	:Universal Transverse Mercator
Units	:Meter

Vertical Coordinate Reference System

Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

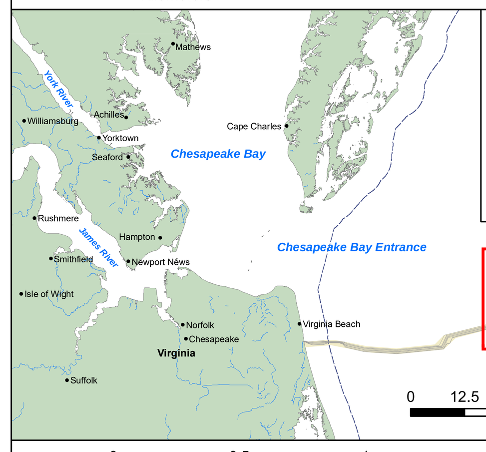
Tile Index Overview

- Current Tile
- BOEM Lease Block (OCS-A 0483)
- Tile Panel 1 - 9



Location Map

- City
- Proposed Cable Route
- Current Tile
- Submerged Lands Act Boundary
- Cable Corridor
- BOEM Lease Boundary
- State



0 0.5 1 2 Miles

0 0.5 1 2 3 4 Kilometers

1:27,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS®

Client: Dominion Energy®

Project Title: CVOW-C Geophysical Survey 2021

Chart Title:

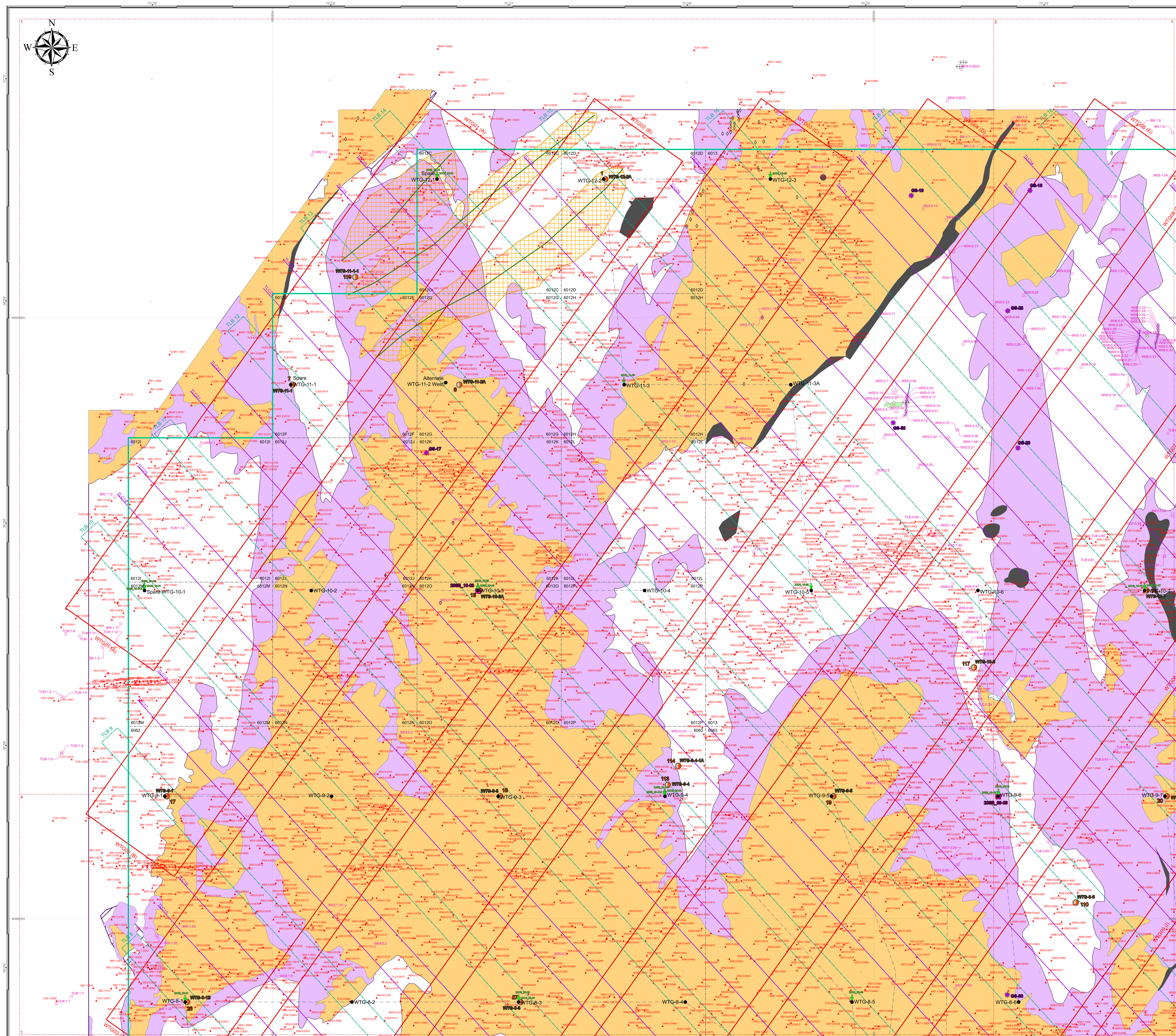
CHART 3c
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE SEABED FEATURES AND MORPHOLOGY (CMECS) OVERVIEW

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
06/21/21	Rev00	CLS	KDW	KMM
07/31/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/31/2021

File Name: Dominion_GeoSurfaceFeatures_FeaturesMorph_CMECS_Rev01_Chart_Overview.pdf



General Map Symbols

- Dominion Lease Boundary (OCS-A 0483)
- Proposed Cable Route ("Conceptual cables routes, Detailed re-routing/micro-siting will follow")
- TLC Planned Line
- TLB Corridor
- WTG Corridor
- Cable Corridor
- BOEM Lease Block (Main Chart, OCS-A 0483)
- Tile Panel 1 - 9 (Main Chart)
- WTG Location (Preliminary position/subject to change)
- OSS Location (Preliminary position/subject to change)
- Grab Sample
- Box Corer
- Geotechnical Boring
- Benthic Sample
- CPT
- Charted Shipwreck (Source: NOAA Office of Coast Survey)

Seabed Features

- Slope
- Flat
- Wreck
- Scour/Erosion Features
- Boulder/Boulderfield
- Linear Seabed Feature
- Seabed Feature Depression Point
- Trash Aggregation
- Depression

Seabed Morphology

- Ripple
- Megaripple
- Sediment Wavefield
- Sand Ridge Area
- Sand Ridge Crest
- Side Scan Sonar Contact
- Magnetic Anomaly

Note: Contact and anomaly labels are truncated.

Geologic Setting

The survey area lies along a portion of mid North Atlantic continental shelf that is subject to multiple concurrent processes that shape the overall geologic/stratigraphic framework of the region. These include glacio-eustatic sea level changes, variations in sediment supply from and proximity to the Chesapeake Bay drainage system, and storm related effects on sediment supply and distribution.

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Fluvial influence over the late quaternary has been investigated extensively by Chen et al.(1995), Oertel and Foyle (1995) and others. These investigations, based primarily on very shallow sub-bottom profiles, seek to establish a sequence stratigraphic framework and chronology for the numerous channel features imaged in the shallow subsurface proximal to the mouth of the Chesapeake Bay. However, these interpretations are extremely limited by the quality of data collected and are reflective of the state of technology at the time. The dominant bathymetric features within the survey area are pronounced sand ridges. These features, which create a "ridge and swale" topography, are present as a result of storm related sediment dynamics and hydrodynamic interactions with transgressive/regressive relict features such as beach ridges, etc. (Swift et al. 1973, 1986; Trowbridge 1995).

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Magnetometer Interpretation

Evaluation of the 10Hz gradiometric magnetometer data involved processing the total field of individual magnetometer readings and reducing them to a residual magnetic profile. A total of 28094 magnetic anomalies were interpreted within the survey area.

General Information

Equipment

Survey Vessels	M/V Marcelle[1]/M/V Sarah Bordelon[2]/ R/V Kommandor Iona[3]/ R/V Kommandor Stuart[4]/ M/V GO Discovery[5]/M/V Minerva Uno[6]
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Acquistion Software	: QINSy

TerraSond Personnel

Commercial Manager	: Scott Croft
Project Manager	: Don Ross
Project Manager	: James Hougham
Production Manager	: Kate Mildon
Technical Manager	: Chris McHugh
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Operations Manager	: William Busey
Party Chief	: Mark MacLean
Lead Surveyor	: Larry Andrews
Director HSEQ	: Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

CRS Name	:NAD 1983 (2011) UTM Zone 18N
EPSG Code	:6347
Geodetic Datum	:North American 1983
Projection	:Universal Transverse Mercator
Units	:Meter

Vertical Coordinate Reference System

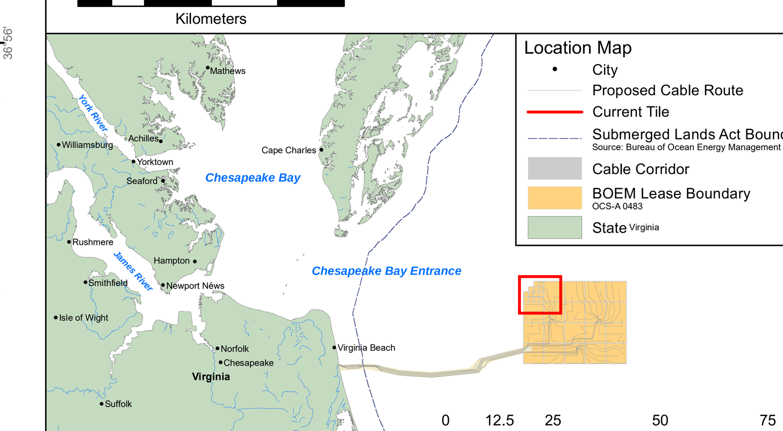
Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

Tile Index Overview

- Current Tile
- BOEM Lease Block (OCS-A 0483)
- Tile Panel 1 - 9

1 2 3
4 5 6
7 8 9

0 2.5 5 10 15 20 Kilometers



0 125 250 500 750 1,000 1,250 Meters

0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

Chart Title: CHART 3c

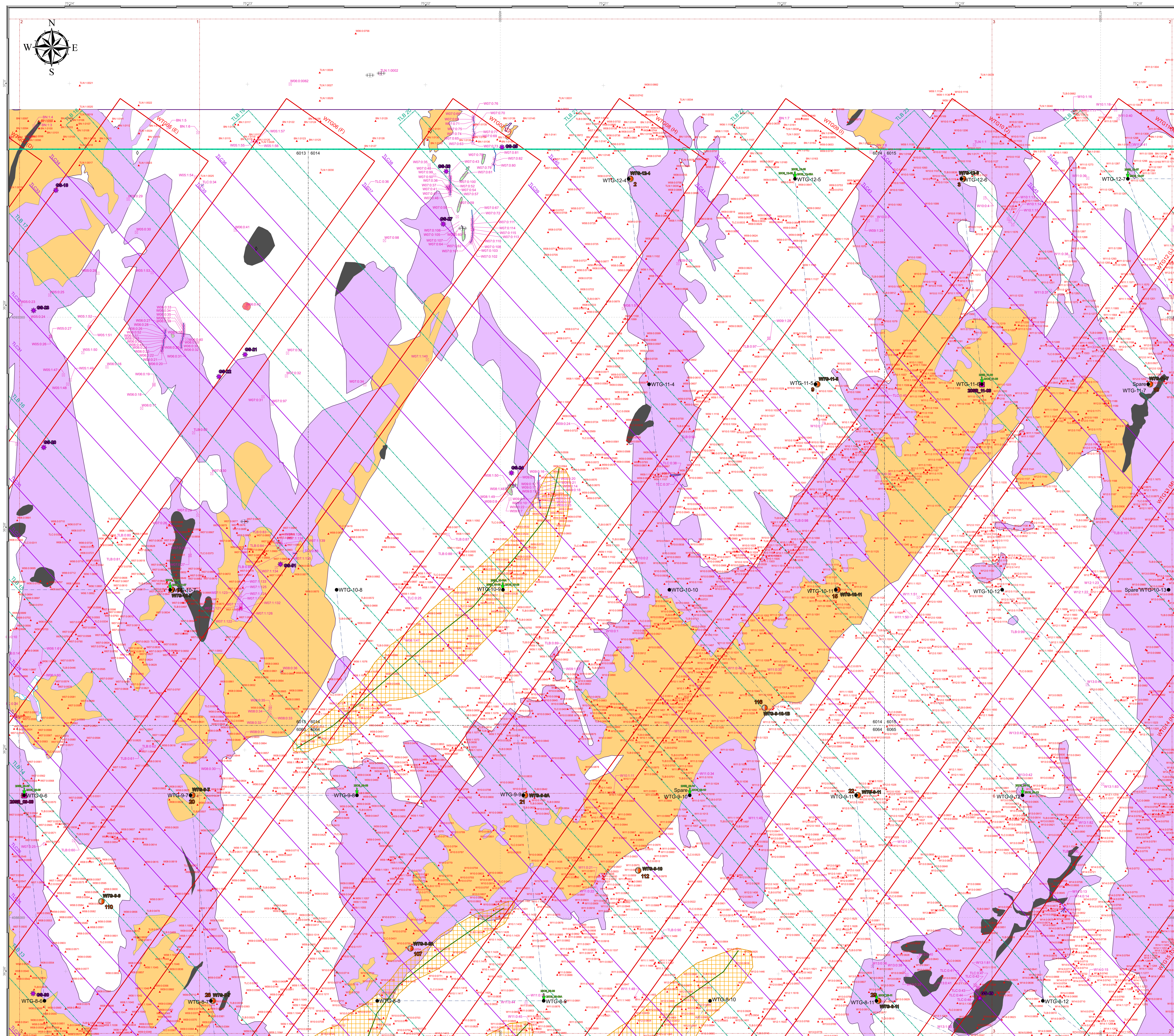
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE
SEABED FEATURES AND MORPHOLOGY (CMECS)
TILE 1 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
06/21/21	Rev00	CLS	KDW	KMM
07/30/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/31/2021

File Name: Dominion_GeoSurfaceFeatures_FeaturesMorph_CMECS_Rev01.pdf



General Map Symbols

- Dominion Lease Boundary
  OCS-A 0483
- Proposed Cable Route
  "Conceptual cables routes; Detailed re-routing/micro-siting will follow"
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- TLB Corridor
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  OCS-A 0483
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- WTG Location
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- OSS Location
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- Charted Shipwreck
  Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Seabed Features

- Slope
- Flat
- Wreck
- Scour/Erosion Features
- Boulder/Boulderfield
- Linear Seabed Feature
- Seabed Feature Depression Point
- Trash Aggregation
- Depression

Seabed Morphology

- Ripple
- Megaripple
- Sediment Wavefield
- Sand Ridge Area
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- Side Scan Sonar Contact
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Note: Contact and anomaly labels are truncated.

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This geophysical survey was conducted April 29th, 2020 through June13th, 2021

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Horizontal Coordinate Reference System

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Units :Meter

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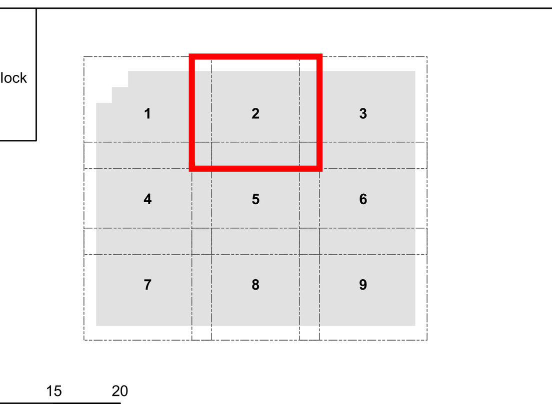
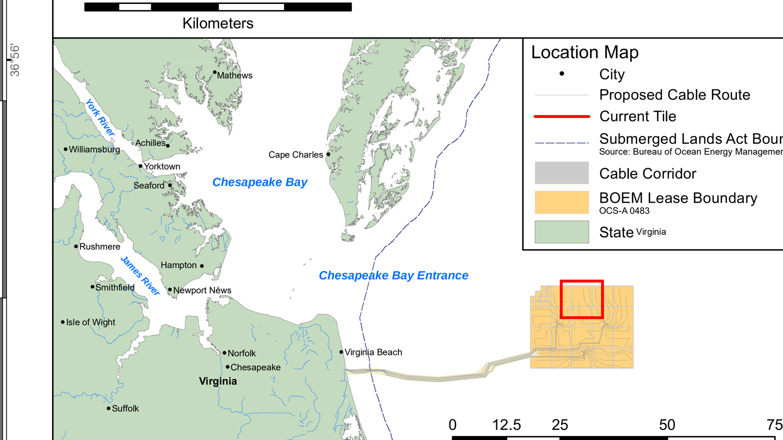
Datum :Mean Lower Low Water (MLLW)
Axis -down :Depth

Tile Index Overview

- Current Tile
- BOEM Lease Block
  OCS-A 0483
- Tile Panel 1 - 9





0 125 250 500 750 1,000 1,250 Meters

0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title:

CVOW-C Geophysical Survey 2021

Chart Title:

CHART 3c

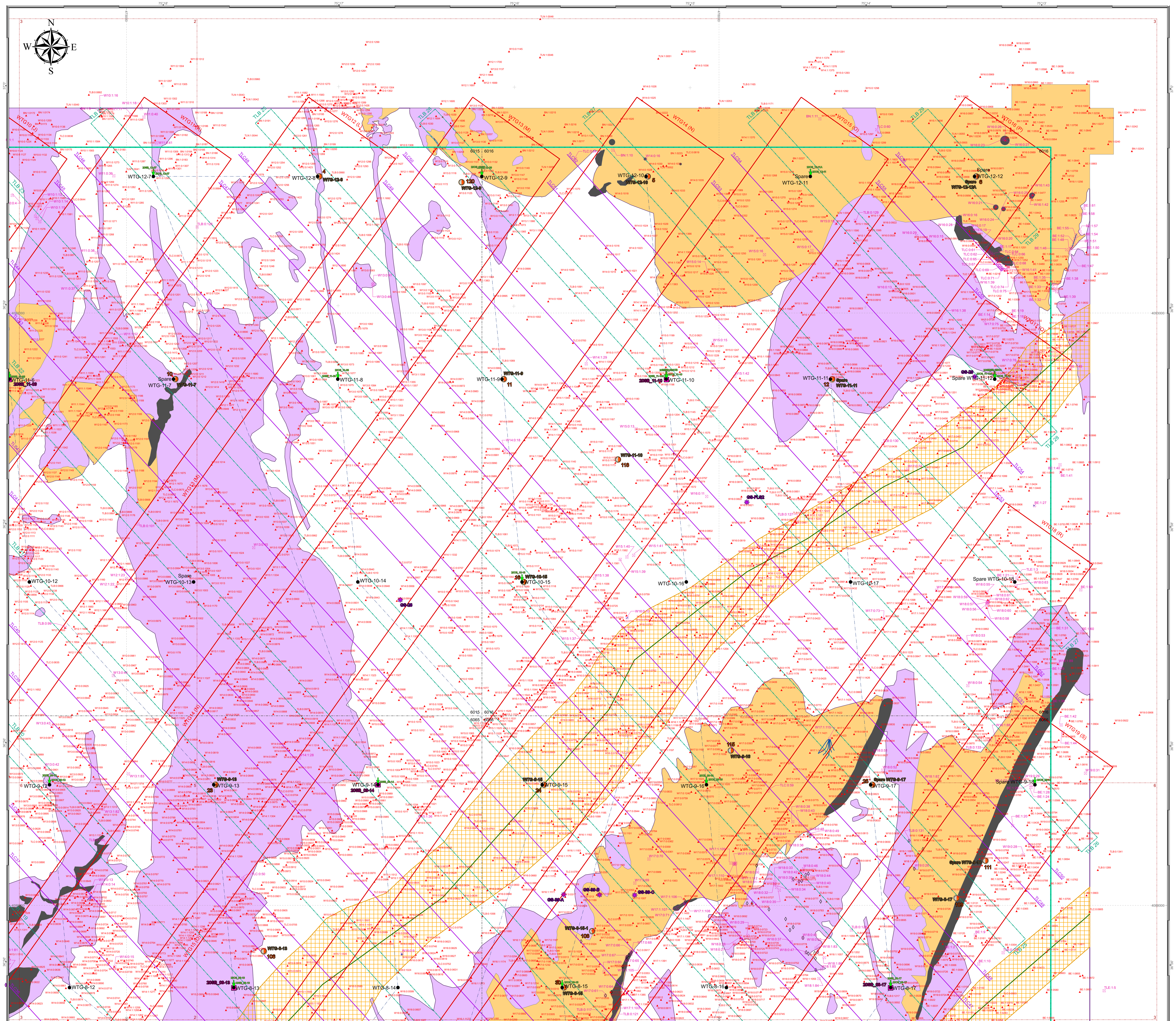
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE
SEABED FEATURES AND MORPHOLOGY (CMECS)
TILE 2 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
06/21/21	Rev00	CLS	KDW	KMM
07/30/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/31/2021

File Name: Dominion_GeoSurfaceFeatures_FeaturesMorph_CMECS_Rev01.pdf



General Map Symbols

- Dominion Lease Boundary — OCS-A 0483
- Proposed Cable Route — "Conceptual cables routes; Detailed re-routing/micro-siting will follow"
- TLC Planned Line
- TLB Corridor
- WTG Corridor
- Cable Corridor
- BOEM Lease Block Main Chart — OCS-A 0483
- Tile Panel 1 - 9 Main Chart
- WTG Location — Preliminary position/subject to change
- OSS Location — Preliminary position/subject to change
- Grab Sample
- Box Corer
- Geotechnical Boring
- Benthic Sample
- CPT
- Charted Shipwreck — Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Seabed Features

- Slope
- Flat
- Wreck
- Scour/Erosion Features
- Boulder/Boulderfield
- Trash Aggregation
- Depression
- Linear Seabed Feature
- Seabed Feature Depression Point

Seabed Morphology

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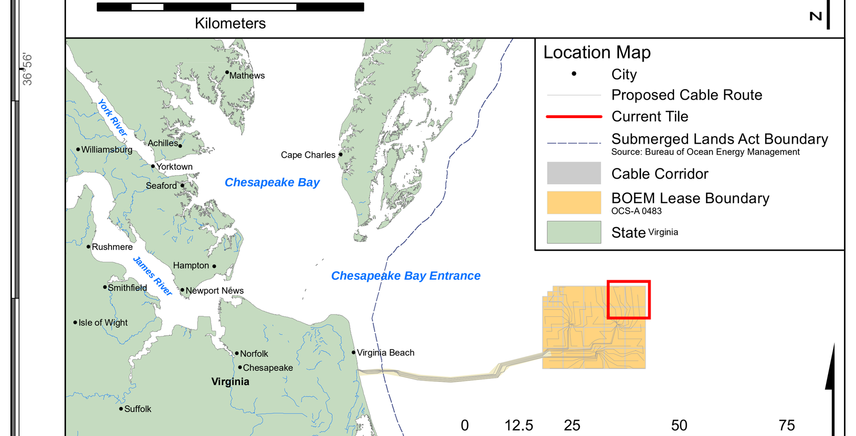
Tile Index Overview

- Current Tile
- BOEM Lease Block OCS-A 0483
- Tile Panel 1 - 9



0 125 250 500 750 1,000 1,250 Meters

0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS®

Client: Dominion Energy®

Project Title: CVOW-C Geophysical Survey 2021

Chart Title:

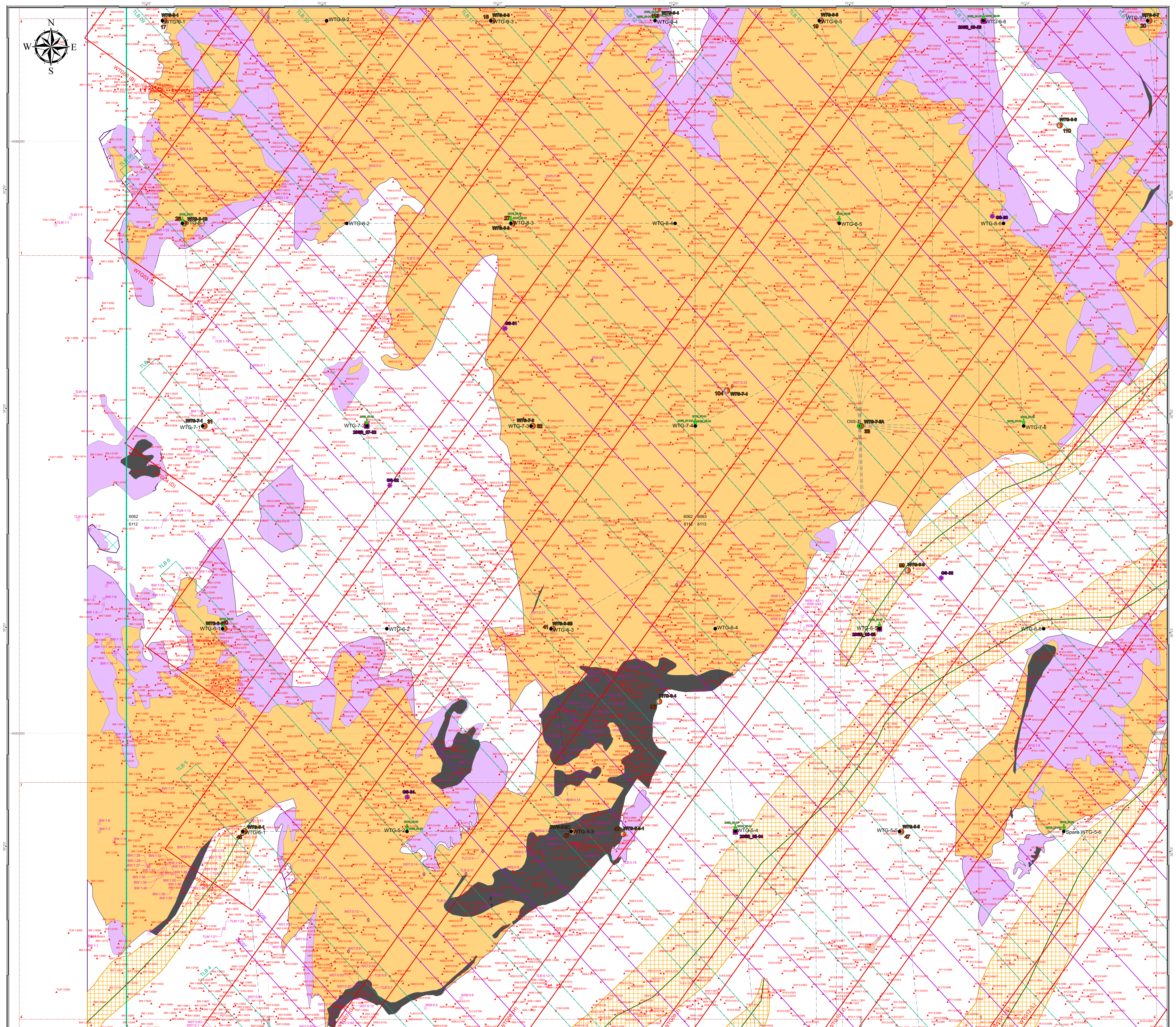
CHART 3c
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE SEABED FEATURES AND MORPHOLOGY (CMECS) TILE 3 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
06/21/21	Rev00	CLS	KDW	KMM
07/30/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/31/2021

File Name: Dominion_GeoSurfaceFeatures_FeaturesMorph_CMECS_Rev01.pdf



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- TLB Corridor
- WTG Corridor
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- BOEM Lease Block Main Chart OCS-A 0483
- Tile Panel 1 - 9 Main Chart
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- OSS Location Preliminary position/subject to change
- Grab Sample
- Box Corer
- Geotechnical Boring
- Benthic Sample
- CPT
- Charted Shipwreck Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Seabed Features

- Slope
- Flat
- Wreck
- Scour/Erosion Features
- Boulder/Boulderfield
- Trash Aggregation
- Depression
- Linear Seabed Feature
- Seabed Feature Depression Point

Seabed Morphology

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- Megaripple
- Sediment Wavefield
- Sand Ridge Area
- Sand Ridge Crest
- Side Scan Sonar Contact
- Magnetic Anomaly

Note: Contact and anomaly labels are truncated.

Geologic Setting

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General Information

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Commercial Manager	: Scott Croft
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This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

CRS Name	:NAD 1983 (2011) UTM Zone 18N
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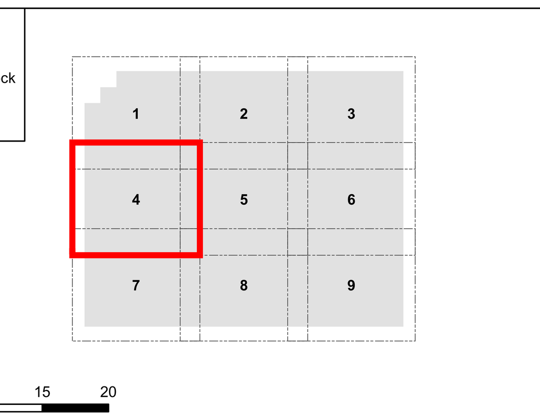
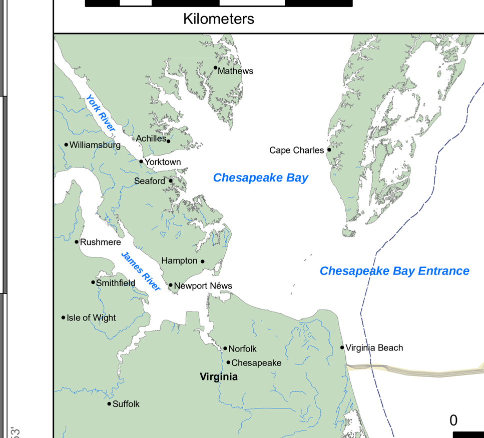
Vertical Coordinate Reference System

Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

Tile Index Overview

- Current Tile
- BOEM Lease Block OCS-A 0483
- Tile Panel 1 - 9





Location Map

- City
- Proposed Cable Route
- Current Tile
- Submerged Lands Act Boundary
- Cable Corridor
- BOEM Lease Boundary OCS-A 0483
- State Virginia

0 125 250 500 750 1,000 1,250 Meters

0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS®

Client: Dominion Energy®

Project Title:

CVOW-C Geophysical Survey 2021

Chart Title:

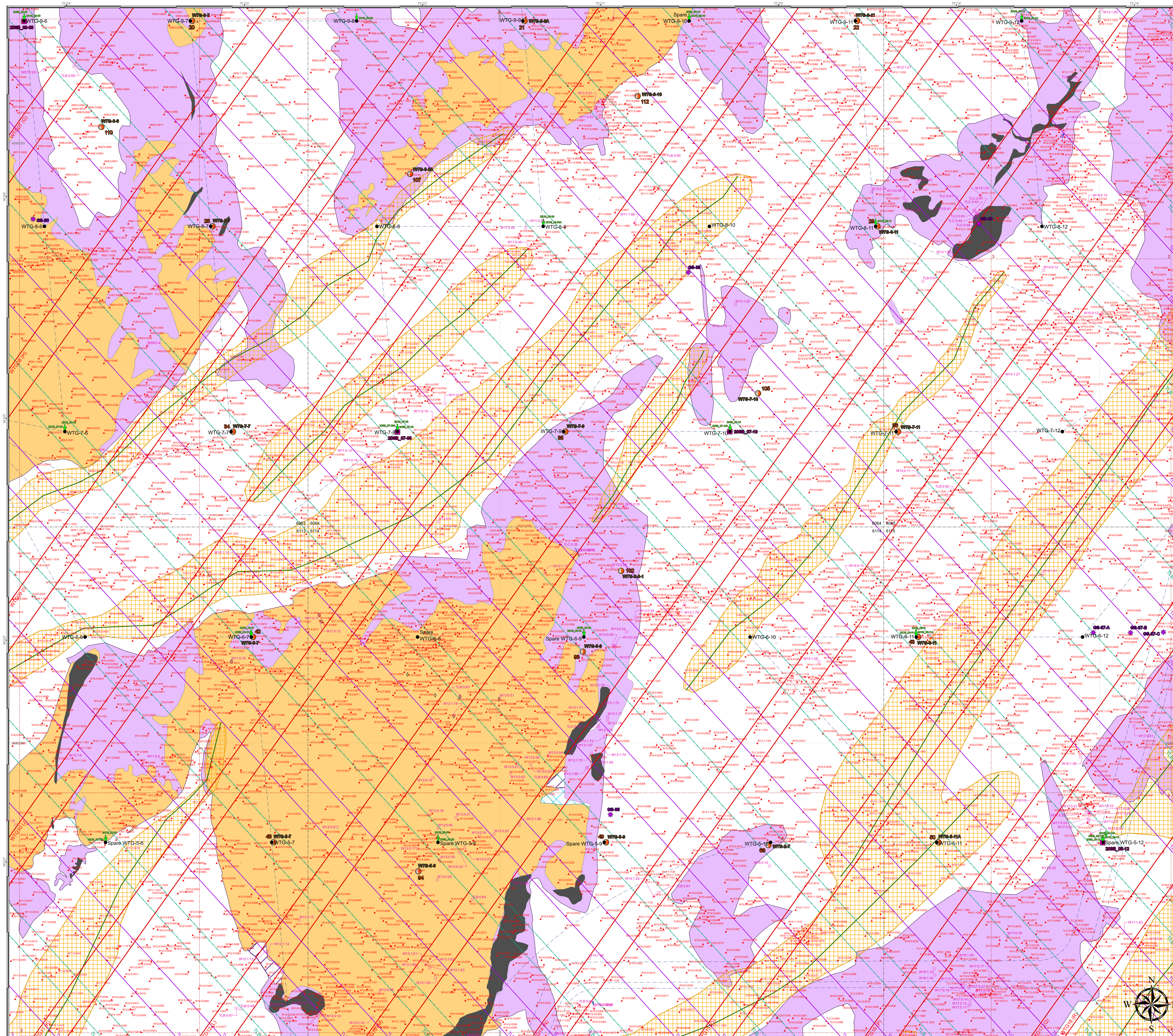
CHART 3c
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE SEABED FEATURES AND MORPHOLOGY (CMECS)
TILE 4 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
06/21/21	Rev00	CLS	KDW	KMM
07/30/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/31/2021

File Name: Dominion_GeoSurfaceFeatures_FeaturesMorph_CMECS_Rev01.pdf



General Map Symbols

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- Tile Panel 1 - 9 Main Chart
- WTG Location — Preliminary position/subject to change
- OSS Location — Preliminary position/subject to change
- Grab Sample
- Box Corer
- Geotechnical Boring
- Benthic Sample
- CPT
- Charted Shipwreck — Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Seabed Features

- Slope
- Flat
- Wreck
- Scour/Erosion Features
- Boulder/Boulderfield
- Trash Aggregation
- Depression
- Linear Seabed Feature
- Seabed Feature Depression Point

Seabed Morphology

- Ripple
- Megaripple
- Sediment Wavefield
- Sand Ridge Area
- Sand Ridge Crest
- Side Scan Sonar Contact
- Magnetic Anomaly

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Geologic Setting

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TerraSond Personnel

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This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

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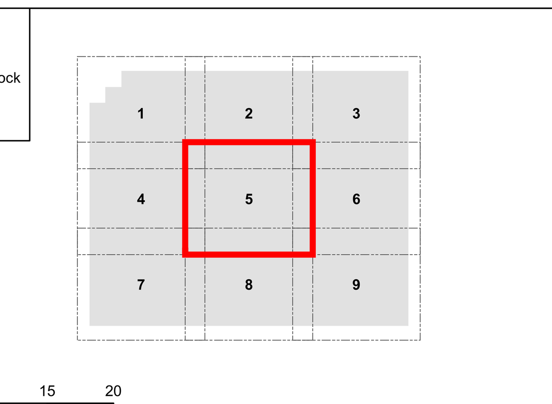
Units	:Meter

Vertical Coordinate Reference System

Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

Tile Index Overview

- Current Tile
- BOEM Lease Block — OCS-A 0483
- Tile Panel 1 - 9



Location Map

- City
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- Current Tile
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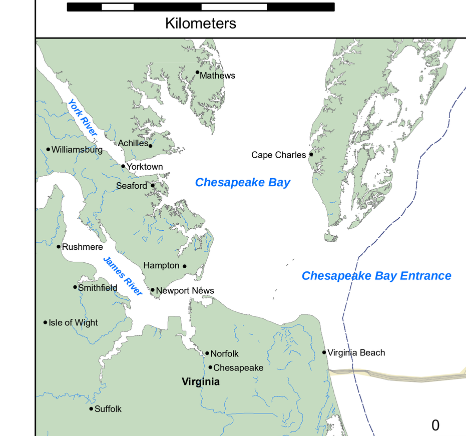
- State



0 125 250 500 750 1,000 1,250 Meters

0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

Chart Title:
CHART 3c
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE SEABED FEATURES AND MORPHOLOGY (CMECS)
TILE 5 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
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Rev01

Date: 7/31/2021

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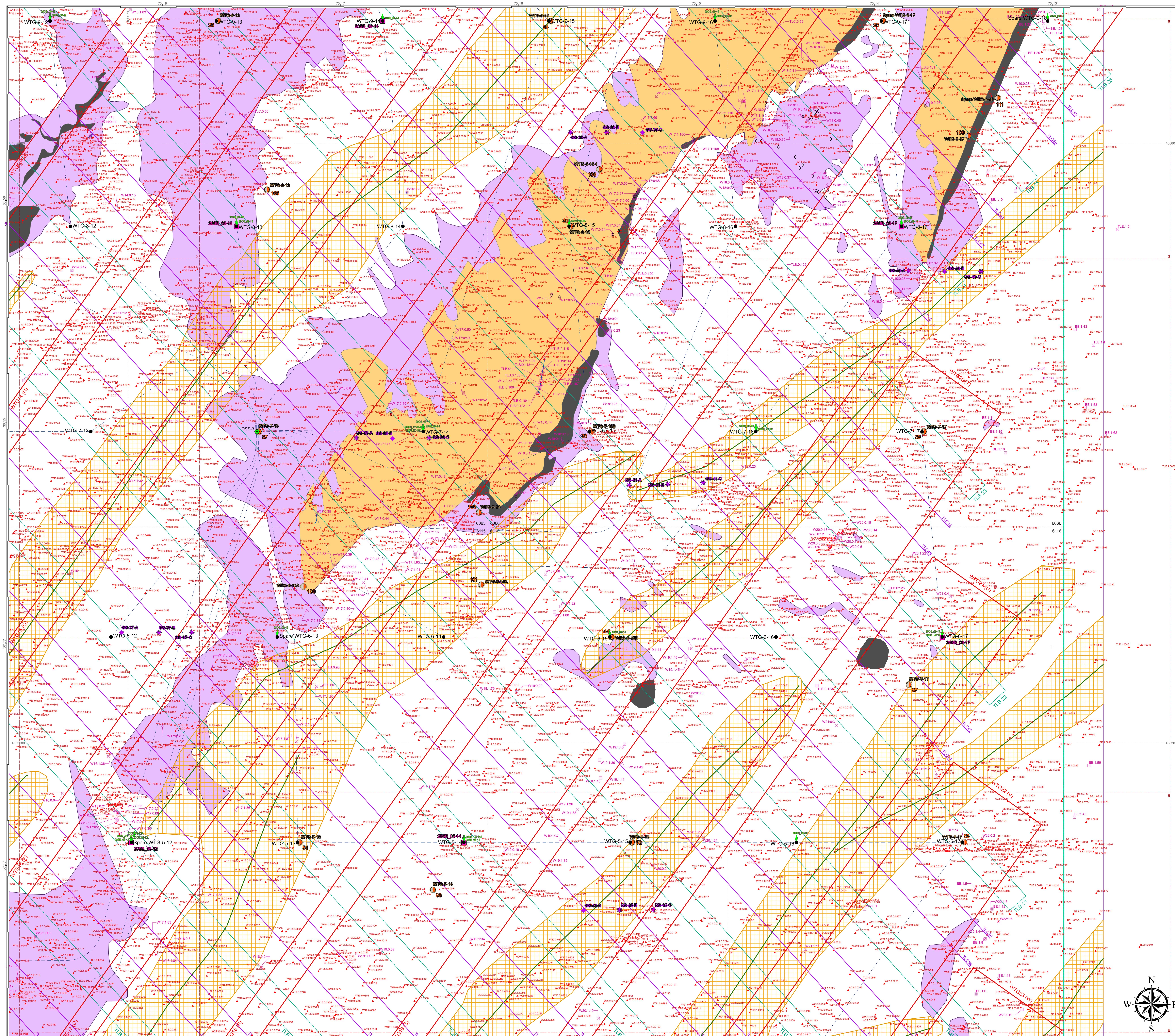

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- Charted Shipwreck — Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Seabed Features

- Slope
- Flat
- Wreck
- Scour/Erosion Features
- Boulder/Boulderfield
- Trash Aggregation
- Depression
- Linear Seabed Feature
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Seabed Morphology

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This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

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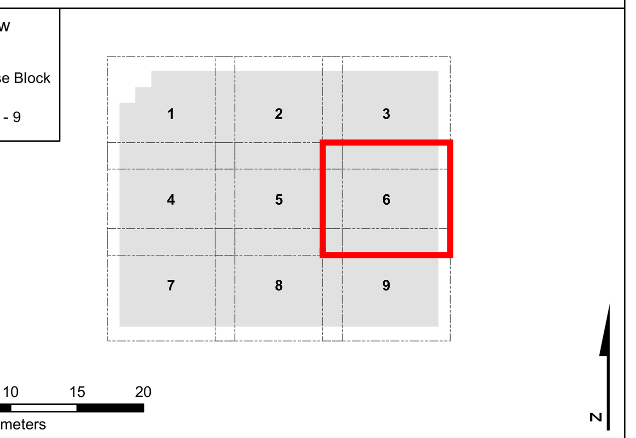
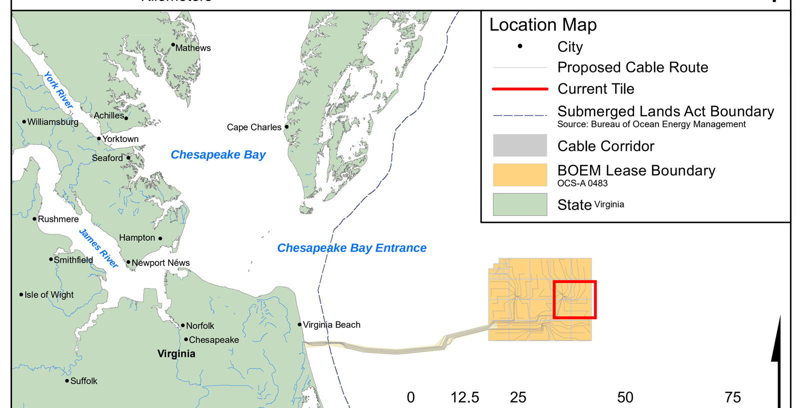
Tile Index Overview

- Current Tile
- BOEM Lease Block OCS-A 0483
- Tile Panel 1 - 9





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0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND — PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: **CVOW-C Geophysical Survey 2021**

Chart Title:

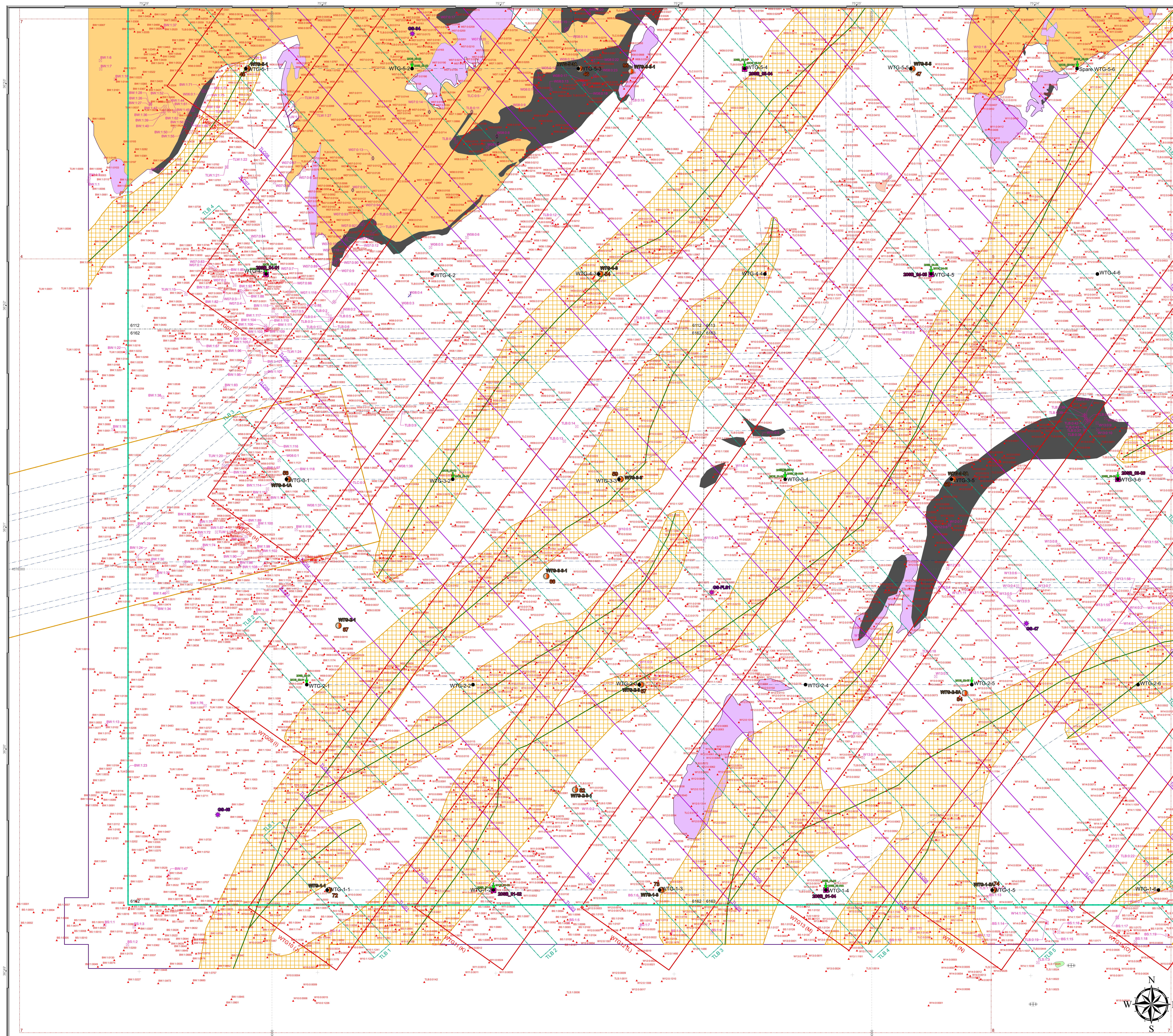
CHART 3c
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE
SEABED FEATURES AND MORPHOLOGY (CMECS)
TILE 6 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
06/21/21	Rev00	CLS	KDW	KMM
07/30/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/31/2021

File Name: Dominion_GeoSurfaceFeatures_FeaturesMorph_CMECS_Rev01.pdf



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- Flat
- Wreck
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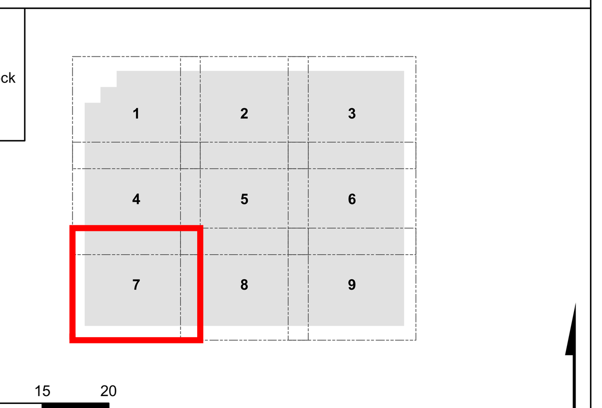

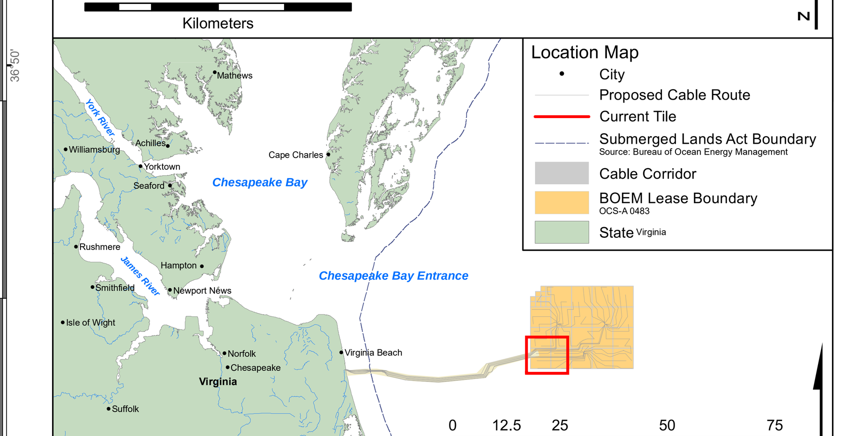

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0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title:

CVOW-C Geophysical Survey 2021

Chart Title:

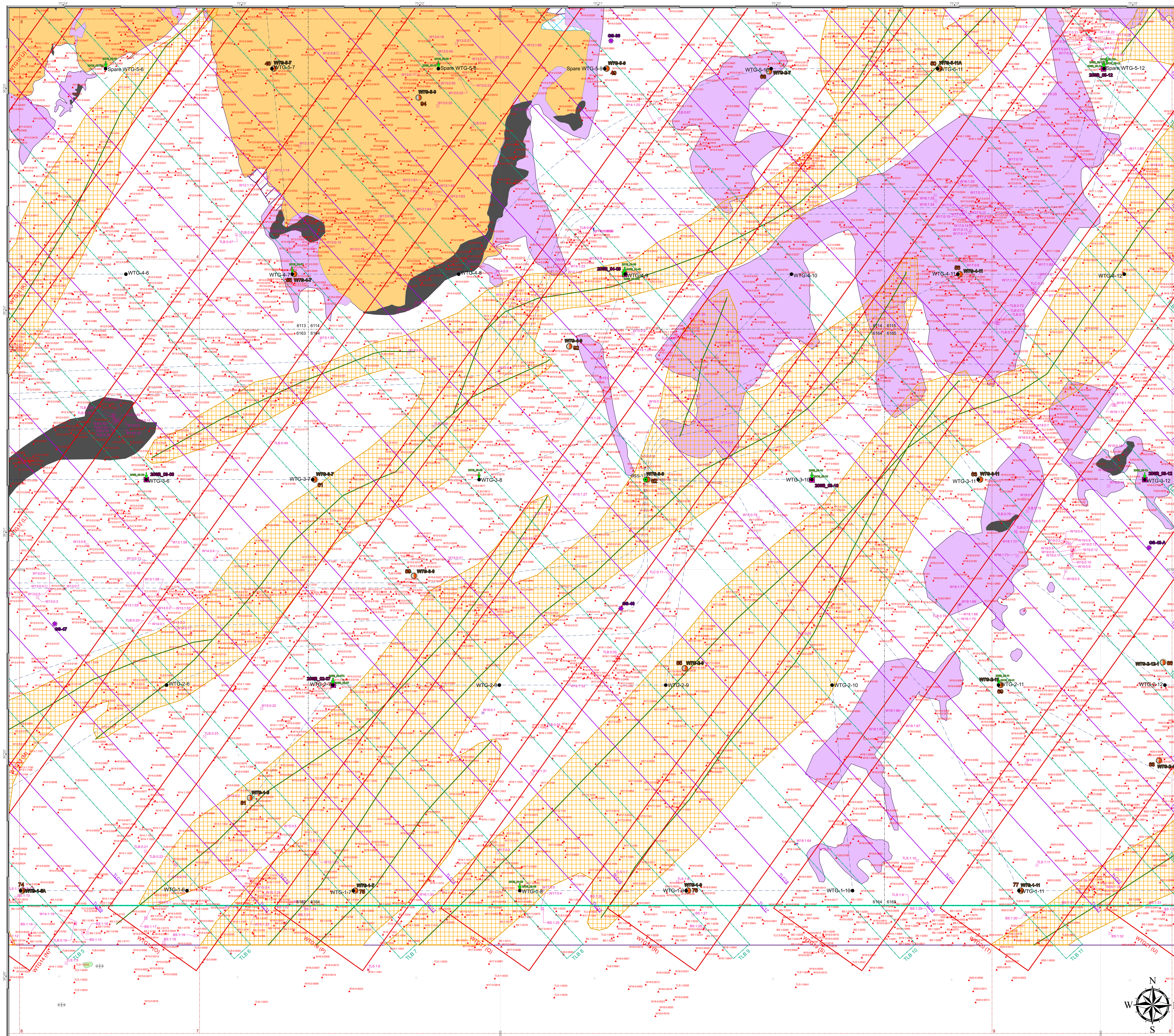
CHART 3c
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE SEABED FEATURES AND MORPHOLOGY (CMECS)
TILE 7 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
06/21/21	Rev00	CLS	KDW	KMM
07/30/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/31/2021

File Name: Dominion_GeoSurfaceFeatures_FeaturesMorph_CMECS_Rev01.pdf



General Map Symbols

- Dominion Lease Boundary OCS-A 0483
- Proposed Cable Route "Conceptual cables routes; Detailed re-routing/micro-siting will follow"
- TLC Planned Line
- TLB Corridor
- WTG Corridor
- Cable Corridor
- BOEM Lease Block Main Chart OCS-A 0483
- Tile Panel 1 - 9 Main Chart
- WTG Location Preliminary position/subject to change
- OSS Location Preliminary position/subject to change
- Grab Sample
- Box Corer
- Geotechnical Boring
- Benthic Sample
- CPT
- Charted Shipwreck Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Seabed Features

- Slope
- Flat
- Wreck
- Scour/Erosion Features
- Boulder/Boulderfield
- Linear Seabed Feature
- Seabed Feature Depression Point
- Trash Aggregation
- Depression

Seabed Morphology

- Ripple
- Megaripple
- Sediment Wavefield
- Sand Ridge Area
- Sand Ridge Crest
- Side Scan Sonar Contact
- Magnetic Anomaly

Note: Contact and anomaly labels are truncated.

Geologic Setting

The survey area lies along a portion of mid North Atlantic continental shelf that is subject to multiple concurrent processes that shape the overall geologic/stratigraphic framework of the region. These include glacio-eustatic sea level changes, variations in sediment supply from and proximity to the Chesapeake Bay drainage system, and storm related effects on sediment supply and distribution.

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Fluvial influence over the late quaternary has been investigated extensively by Chen et al.(1995), Oertel and Foyle (1995) and others. These investigations, based primarily on very shallow sub-bottom profiles, seek to establish a sequence stratigraphic framework and chronology for the numerous channel features imaged in the shallow subsurface proximal to the mouth of the Chesapeake Bay. However, these interpretations are extremely limited by the quality of data collected and are reflective of the state of technology at the time. The dominant bathymetric features within the survey area are pronounced sand ridges. These features, which create a "ridge and swale" topography, are present as a result of storm related sediment dynamics and hydrodynamic interactions with transgressive/regressive relict features such as beach ridges, etc. (Swift et al. 1973, 1986; Trowbridge 1995).

Seabed Feature Interpretation

Regions containing seabed features and hazards were identified and digitized from gridded multibeam, backscatter, sidescan, and slope gradient datasets.

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Morphological bedforms; Ripples, Megaripples, and/or Sand Waves were identified and digitized from gridded multibeam, backscatter, and sidescan data.

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Evaluation of the 10Hz gradiometric magnetometer data involved processing the total field of individual magnetometer readings and reducing them to a residual magnetic profile. A total of 28094 magnetic anomalies were interpreted within the survey area.

General Information

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Survey Vessels	M/V Marcelle[1]/M/V Sarah Bordelon[2]/ R/V Kommandor Iona[3]/ R/V Kommandor Stuart[4]/ M/V GO Discovery[5]/M/V Minerva Uno[6]
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Magnetometer	: Geometrics G-882 (TVG)
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Project Manager	: Don Ross
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Technical Manager	: Chris McHugh
Geophysical Manager	: Scott Hiller
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Director HSEQ	: Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

CRS Name	:NAD 1983 (2011) UTM Zone 18N
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Datum	:Mean Lower Low Water (MLLW)
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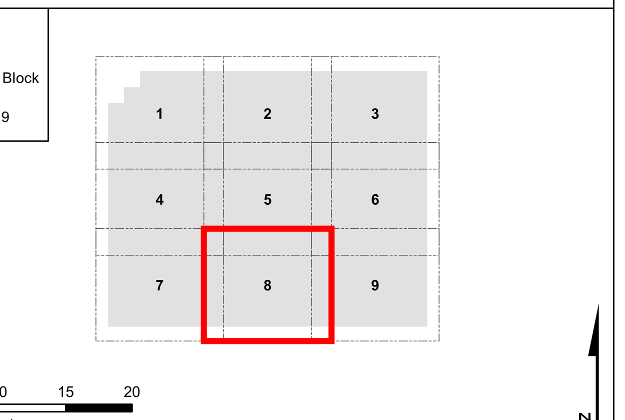
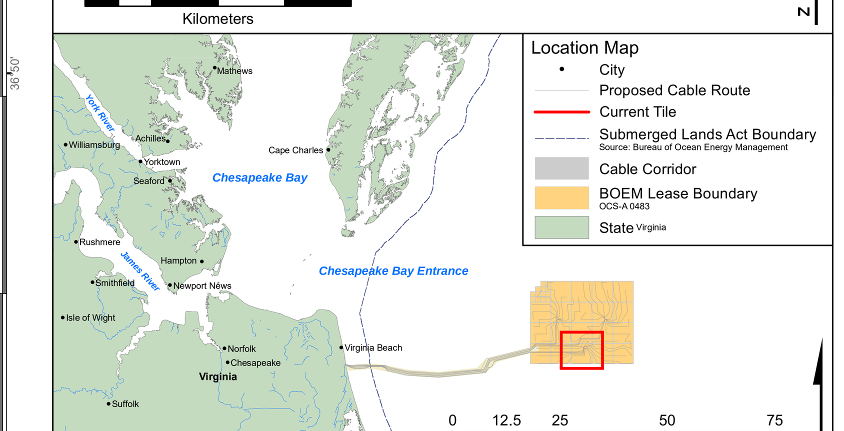
Tile Index Overview

- Current Tile
- BOEM Lease Block OCS-A 0483
- Tile Panel 1 - 9





0 125 250 500 750 1,000 1,250 Meters

0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS®

Client: Dominion Energy®

Project Title: **CVOW-C Geophysical Survey 2021**

Chart Title:

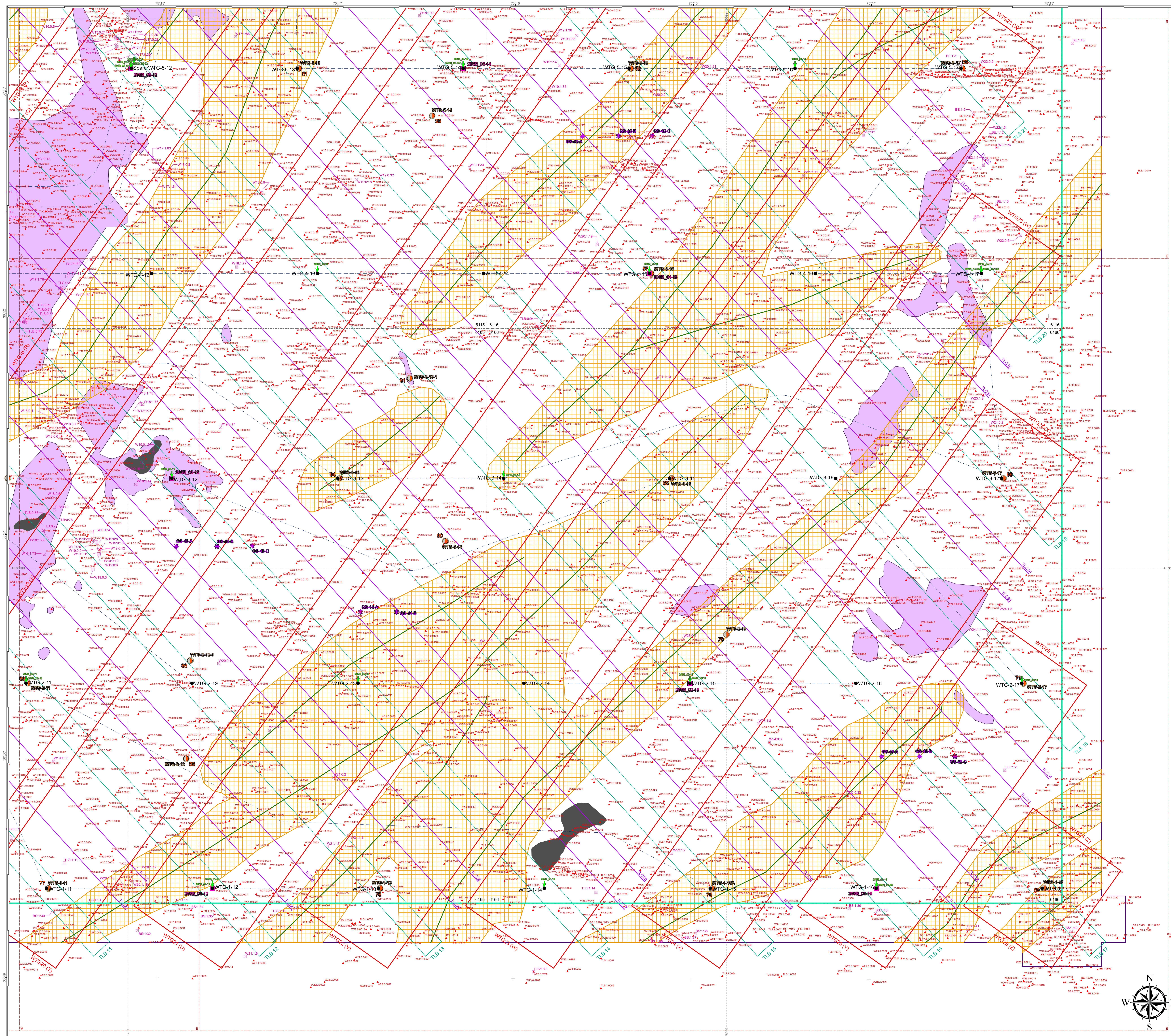
CHART 3c
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE
SEABED FEATURES AND MORPHOLOGY (CMECS)
TILE 8 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
06/21/21	Rev00	CLS	KDW	KMM
07/30/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/31/2021

File Name: Dominion_GeoSurfaceFeatures_FeaturesMorph_CMECS_Rev01.pdf



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Note: Contact and anomaly labels are truncated.

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USBL	: Sonardyne Ranger 2 (19-34 kHz)
Multibeam Echosounder	: Teledyne T50 (200-400 kHz) R2Sonic 2024 (200-400 kHz)[6]
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Magnetometer	: Geometrics G-882 (TVG)
Subbottom Profiler	: Innomar SES-2000 medium
Multi Channel Seismic[1,4,5]	: AAS-Boom and Geospark 200+400 and 96-Element Streamer
Single Channel Seismic[2,5,6]	: AAS-Boom and SCS Streamer
Sparker[3]	: Geospark 200+400 and 96-Element Streamer
Sound Velocity Profiler	: AML MVP30/MVP200[3]
Acquistion Software	: QINSy

TerraSond Personnel

Commercial Manager	: Scott Croft
Project Manager	: Don Ross
Project Manager	: James Hougham
Production Manager	: Kate Mildon
Technical Manager	: Chris McHugh
Geophysical Manager	: Scott Hiller
Operations Manager	: William Busey
Party Chief	: Mark MacLean
Lead Surveyor	: Larry Andrews
Director HSEQ	: Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

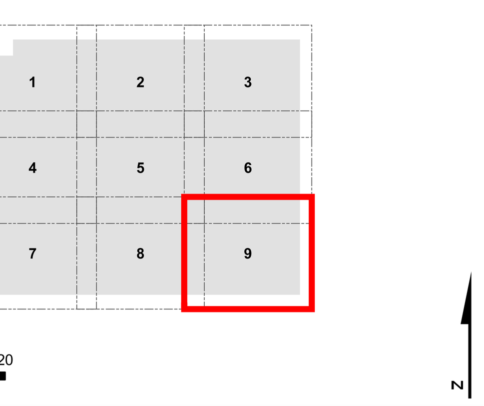
CRS Name	:NAD 1983 (2011) UTM Zone 18N
EPSG Code	:6347
Geodetic Datum	:North American 1983
Projection	:Universal Transverse Mercator
Units	:Meter

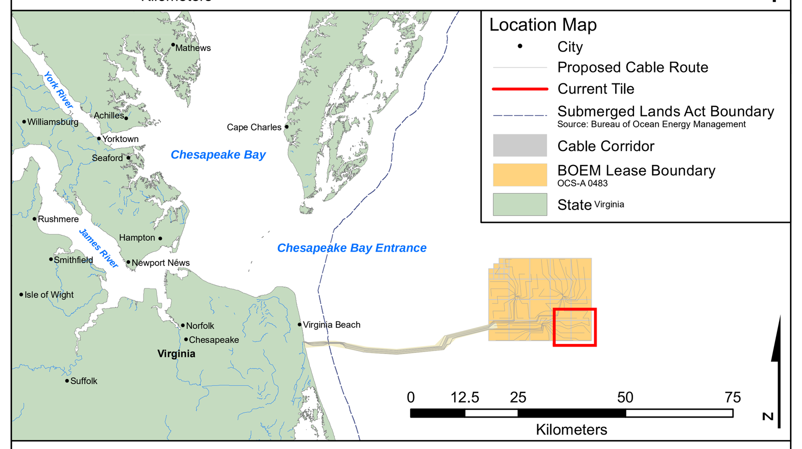
Vertical Coordinate Reference System

Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

Tile Index Overview

- Current Tile
- BOEM Lease Block OCS-A 0483
- Tile Panel 1 - 9





0 125 250 500 750 1,000 1,250 Meters

0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

Chart Title:

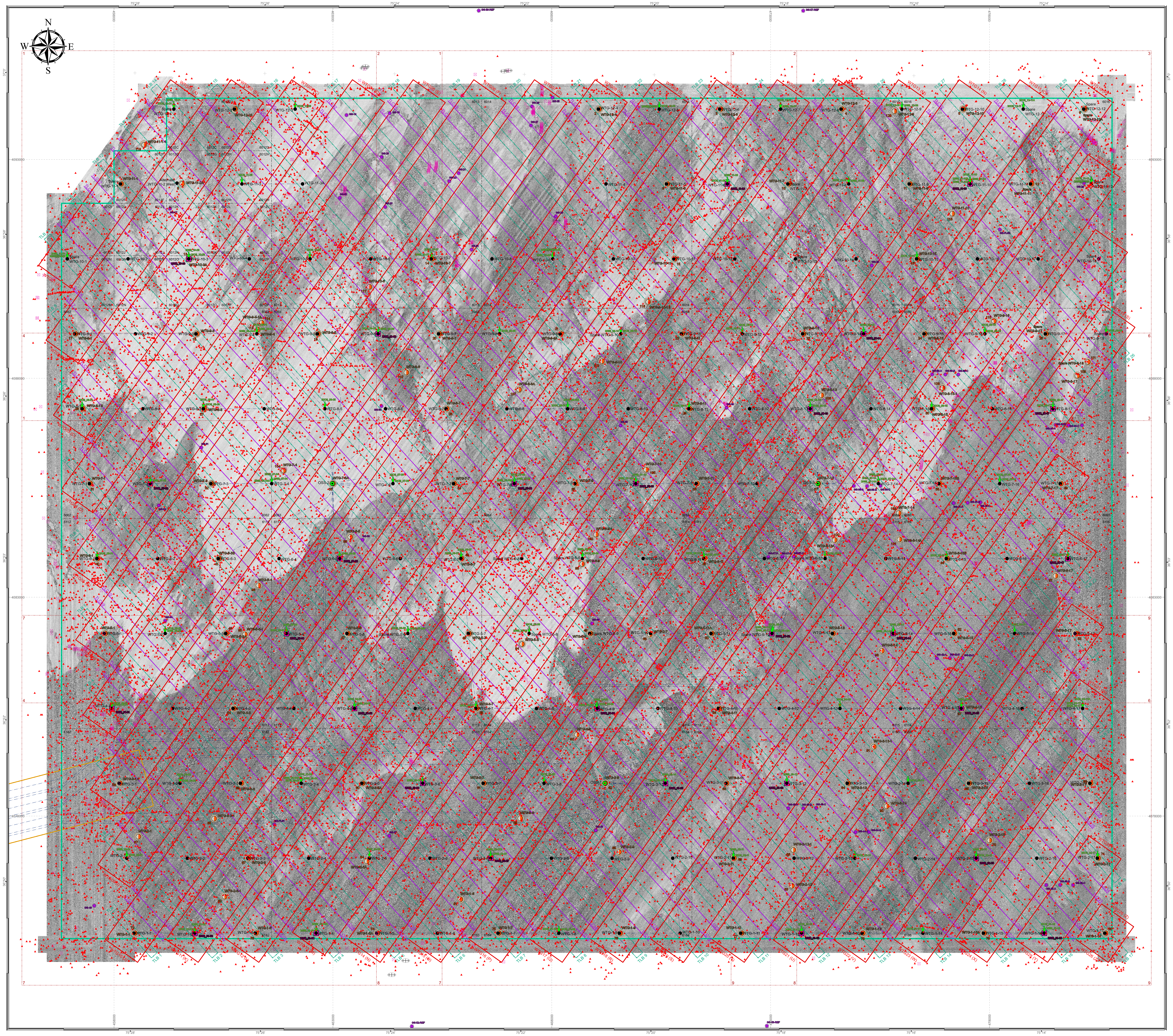
CHART 3c
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURE SEABED FEATURES AND MORPHOLOGY (CMECS)
TILE 9 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
06/21/21	Rev00	CLS	KDW	KMM
07/30/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/31/2021

File Name: Dominion_GeoSurfaceFeatures_FeaturesMorph_CMECS_Rev01.pdf



General Map Symbols

- Dominion Lease Boundary — OCS-A 0483
- Proposed Cable Route — "Conceptual cables routes; Detailed re-routing/micro-siting will follow"
- TLC Planned Line
- TLB Corridor
- WTG Corridor
- Cable Corridor
- BOEM Lease Block (Main Chart) — OCS-A 0483
- Tile Panel 1 - 9 (Main Chart)
- WTG Location — Preliminary position/subject to change
- OSS Location — Preliminary position/subject to change
- Grab Sample
- Box Corer
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- Charted Shipwreck — Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Relative Reflectivity: Low – Side Scan Mosaic – High

Side Scan Sonar Contact
Note: Mainline SSS Contact labels are truncated to the WTG and the last four of contact ID. Reported anomaly ID: WTG##-M20-####
Tieline SSS Contact labels are truncated to the TL and the last four of contact ID. Reported anomaly ID: TL#-M20-####

Magnetic Anomaly
Note: Magnetic Anomaly labels are truncated to the last four of anomaly ID. Reported anomaly ID: WTG##-M20-####

High Frequency Sidescan Mosaic (600 kHz)

Side Scan Sonar Processing Notes

Side scan sonar data were processed using SonarWiz 7 V7.05.008.

Data Import and Navigation

Ultra-Short Baseline (USBL) acoustic positioning system was employed for side scan sonar navigation. Positioning was set to 2 Hz refresh rate with under two meters of positional accuracy. Where USBL positioning exceeded two meters, SSS cable layback was utilized by verifying cable out values and aligning seafloor features with adjacent lines, where possible. JSF files were imported using project defined coordinate system, NAD83 UTM18N (EPSG: 6347). Upon import each file was inspected for erroneous navigation, ensuring the data met the positioning specification.

Altitude

Data were slant range corrected (SRC). SRC identified the first amplitude return, set the altitude and removed the water column of each record. SRC was performed using the automated bottom tracking algorithm in SonarWiz. After the automated SRC was complete the processors evaluated the results and performed manual edits where needed.

Signal Processing

Signal processing was conducted utilizing Empirical Gain Normalization (EGN). EGN tables were generated for each transect to sum and average the amplitudes based on transducer, altitude, and range. The EGN table results were applied to side scan sonar data to adjust the beam pattern and apply gains to each file to obtain a homogeneous color scale across each transect mosaic. Static gain was applied to all the data acquired by the Marcelle Bordelon. Mapping range was manually set to the minimum value at 0 and maximum value at 200 for high frequency and minimum value at 0 and maximum at 2000 for low frequency. Transect mosaics were combined and exported with a 25cm resolution.

General Information

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Datum	:Mean Lower Low Water (MLLW)
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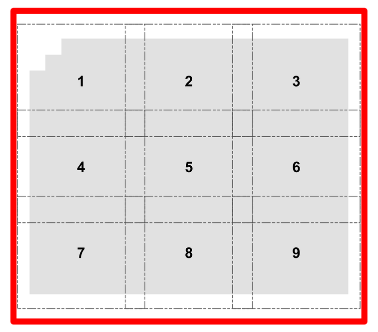
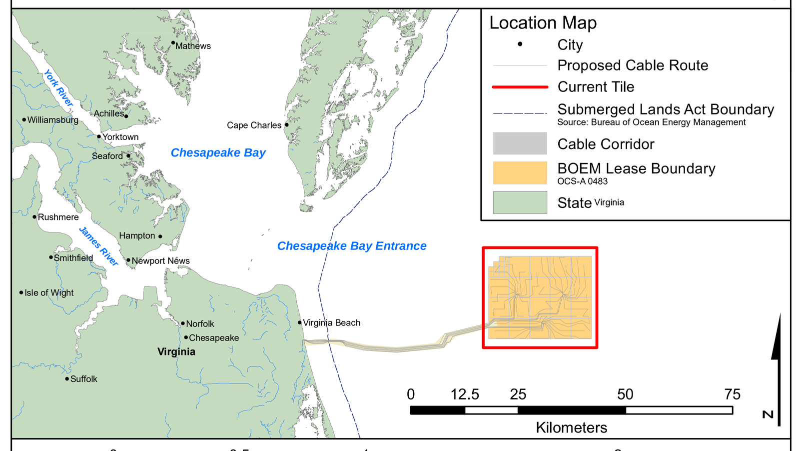
Tile Index Overview
- Current Tile
- BOEM Lease Block OCS-A 0483
- Tile Panel 1 - 9





Scale: 0 – 0.5 – 1 – 2 Miles; 0 – 0.5 – 1 – 2 – 3 – 4 Kilometers
1:27,000

Survey Contractor: TERRASOND — PRECISION GEOSPATIAL SOLUTIONS
Client: Dominion Energy

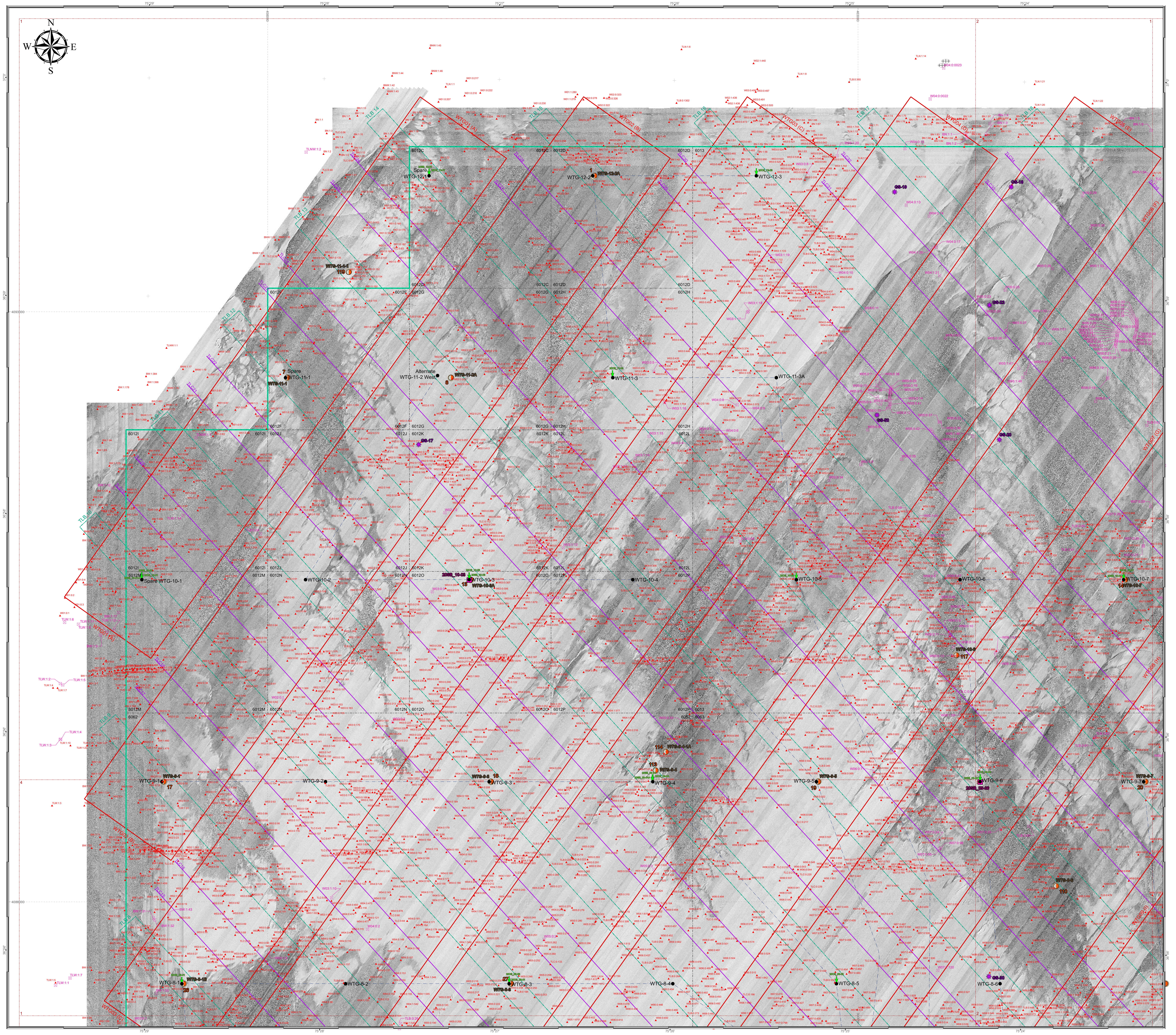
Project Title: CVOW-C Geophysical Survey 2021

Chart Title: CHART 4
HIGH FREQUENCY SIDE SCAN MOSAIC OVERVIEW

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	DRAFT	CLS	KMM	KMM
06/15/21	Rev00	CLS	KDW	KMM
07/31/21	Rev01	CLS	KDW	KMM

Rev01
Date: 7/31/2021

File Name: Dominion_SSS_Mosaic_Rev01_Chart_Overview.pdf



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WTG Location	Preliminary position/subject to change
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High Frequency Sidescan Mosaic (600 kHz)

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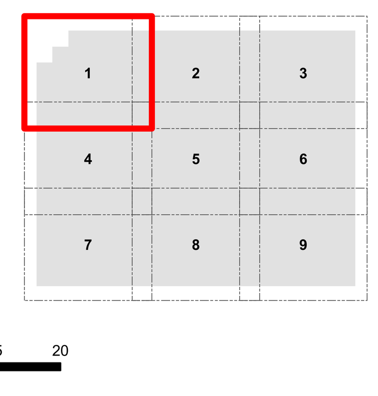

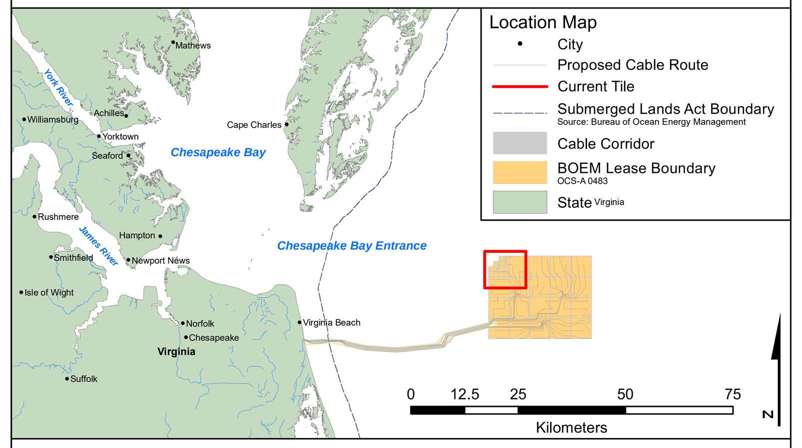

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Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

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Project Title: CVOW-C Geophysical Survey 2021

Chart Title:
CHART 4
HIGH FREQUENCY SIDE SCAN MOSAIC
TILE 1 of 9

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06/08/21	Rev00	CLS	KDW	KMM
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Rev01
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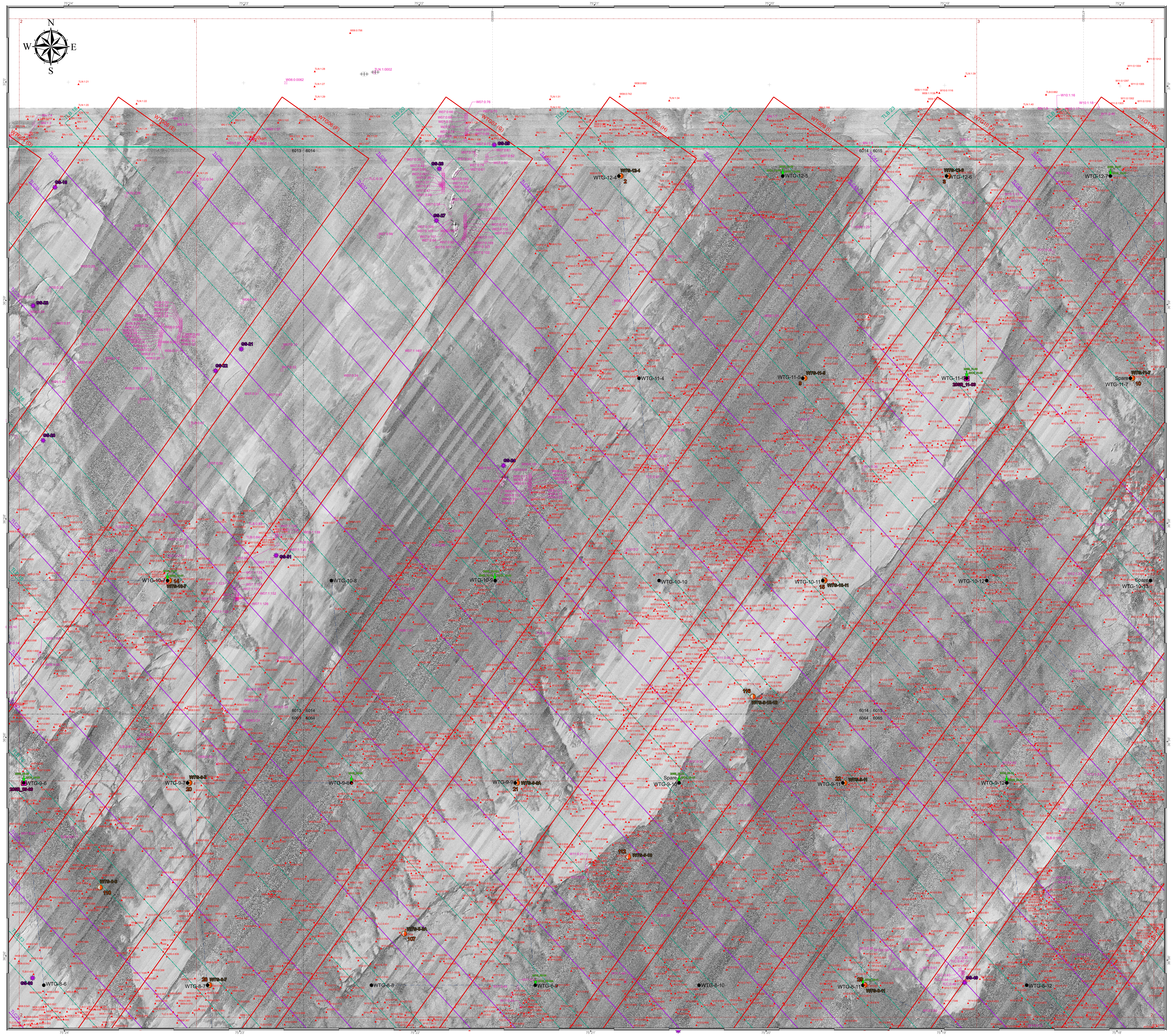
File Name: Dominion_SSS_Mosaic_Rev01.pdf



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- TLC Planned Line
- TLB Corridor
- WTG Corridor
- Cable Corridor
- BOEM Lease Block Main Chart — OCS-A 0483
- Tile Panel 1 - 9 Main Chart
- WTG Location — Preliminary position/subject to change
- OSS Location — Preliminary position/subject to change
- Grab Sample
- Box Corer
- Geotechnical Boring
- Benthic Sample
- CPT
- Charted Shipwreck — Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Relative Reflectivity: Low – Side Scan Mosaic – High

Side Scan Sonar Contact
Note: Mainline SSS Contact labels are truncated to the WTG and the last four of contact ID.
Reported anomaly ID: WTG##-M20-####
Tieline SSS Contact labels are truncated to the TL and the last four of contact ID.
Reported anomaly ID: TL#-M20-####

Magnetic Anomaly
Note: Magnetic Anomaly labels are truncated to the last four of anomaly ID.
Reported anomaly ID: WTG##-M20-####

High Frequency Sidescan Mosaic (600 kHz)

Side Scan Sonar Processing Notes

Side scan sonar data were processed using SonarWiz 7 V7.05.008.

Data Import and Navigation

Ultra-Short Baseline (USBL) acoustic positioning system was employed for side scan sonar navigation. Positioning was set to 2 Hz refresh rate with under two meters of positional accuracy. Where USBL positioning exceeded two meters, SSS cable layback was utilized by verifying cable out values and aligning seafloor features with adjacent lines, where possible. JSF files were imported using project defined coordinate system, NAD83 UTM18N (EPSG: 6347). Upon import each file was inspected for erroneous navigation, ensuring the data met the positioning specification.

Altitude

Data were slant range corrected (SRC). SRC identified the first amplitude return, set the altitude and removed the water column of each record. SRC was performed using the automated bottom tracking algorithm in SonarWiz. After the automated SRC was complete the processors evaluated the results and performed manual edits where needed.

Signal Processing

Signal processing was conducted utilizing Empirical Gain Normalization (EGN). EGN tables were generated for each transect to sum and average the amplitudes based on transducer, altitude, and range. The EGN table results were applied to side scan sonar data to adjust the beam pattern and apply gains to each file to obtain a homogeneous color scale across each transect mosaic. Static gain was applied to all the data acquired by the Marcelle Bordelon. Mapping range was manually set to the minimum value at 0 and maximum value at 200 for high frequency and minimum value at 0 and maximum at 2000 for low frequency. Transect mosaics were combined and exported with a 25cm resolution.

General Information

Equipment

Survey Vessels	M/V Marcelle[1]/M/V Sarah Bordelon[2]/ R/V Kommandor Iona[3]/ R/V Kommandor Stuart[4]/ M/V GO Discovery[5]/M/V Minerva Uno[6]
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USBL	: Sonardyne Ranger 2 (19-34 kHz)
Multibeam Echosounder	: Teledyne T50 (200-400 kHz) R2Sonic 2024 (200-400 kHz)[6]
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Subbottom Profiler	: Innomar SES-2000 medium
Multi Channel Seismic[1,4,5]	: AAS-Boom and Geospark 200+400 and 96-Element Streamer
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Sparker[3]	: Geospark 200+400 and 96-Element Streamer
Sound Velocity Profiler	: AML MVP30/MVP200[3]
Acquistion Software	: QINSy

TerraSond Personnel

Commercial Manager	: Scott Croft
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Project Manager	: James Hougham
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Operations Manager	: William Busey
Party Chief	: Mark MacLean
Lead Surveyor	: Larry Andrews
Director HSEQ	: Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

CRS Name	:NAD 1983 (2011) UTM Zone 18N
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Geodetic Datum	:North American 1983
Projection	:Universal Transverse Mercator
Units	:Meter

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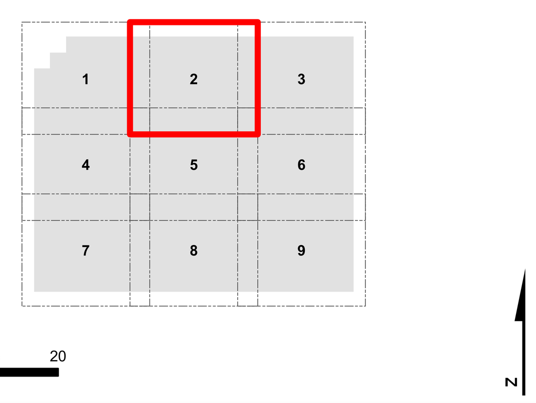
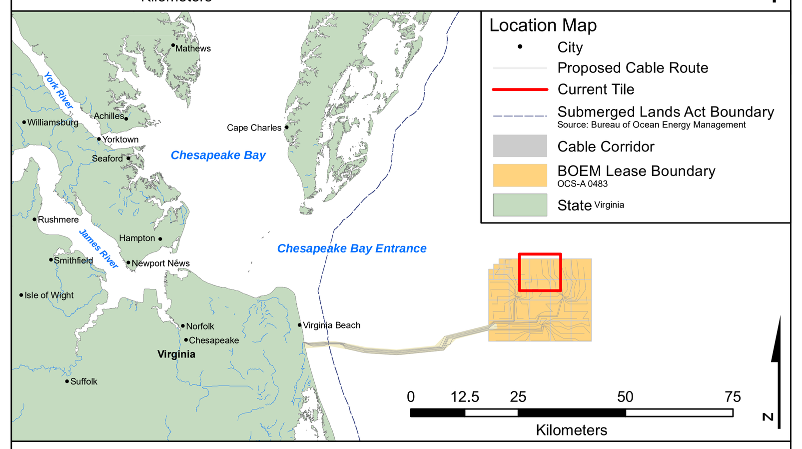
Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

Tile Index Overview
- Current Tile
- BOEM Lease Block — OCS-A 0483
- Tile Panel 1 - 9





0 125 250 500 750 1,000 1,250 Meters

0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS®

Client: Dominion Energy®

Project Title: CVOW-C Geophysical Survey 2021

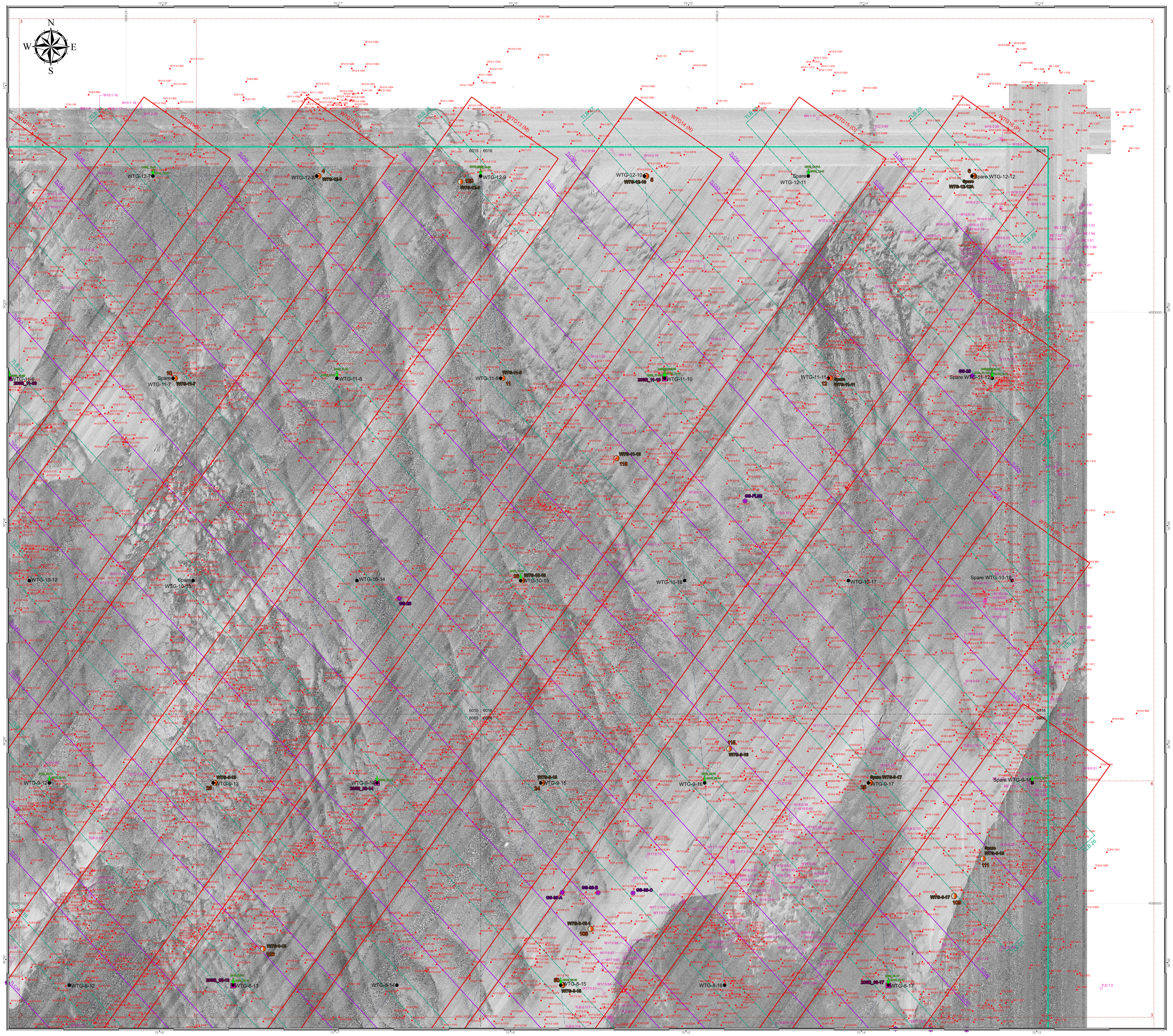
Chart Title:

CHART 4
HIGH FREQUENCY SIDE SCAN MOSAIC
TILE 2 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	Rev00	CLS	KDW	KMM
06/14/21	Rev01	CLS	KDW	KMM
07/31/21	Rev01	CLS	KDW	KMM

Rev01
Date: 7/31/2021

File Name: Dominion_SSS_Mosaic_Rev01.pdf



General Map Symbols

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Relative Reflectivity: Low – Side Scan Mosaic – High

Side Scan Sonar Contact
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Magnetic Anomaly
Note: Magnetic Anomaly labels are truncated to the last four of anomaly ID. Reported anomaly ID: WTG##-M20-####

High Frequency Sidescan Mosaic (600 kHz)

Side Scan Sonar Processing Notes

Side scan sonar data were processed using SonarWiz 7 V7.05.008.

Data Import and Navigation

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Acquistion Software	: QINSy

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Project Manager	: James Hougham
Production Manager	: Kate Mildon
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Lead Surveyor	: Larry Andrews
Director HSEQ	: Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

CRS Name	:NAD 1983 (2011) UTM Zone 18N
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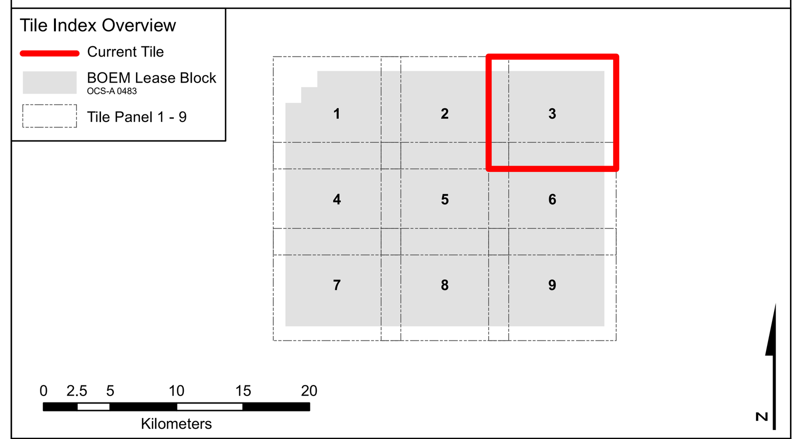
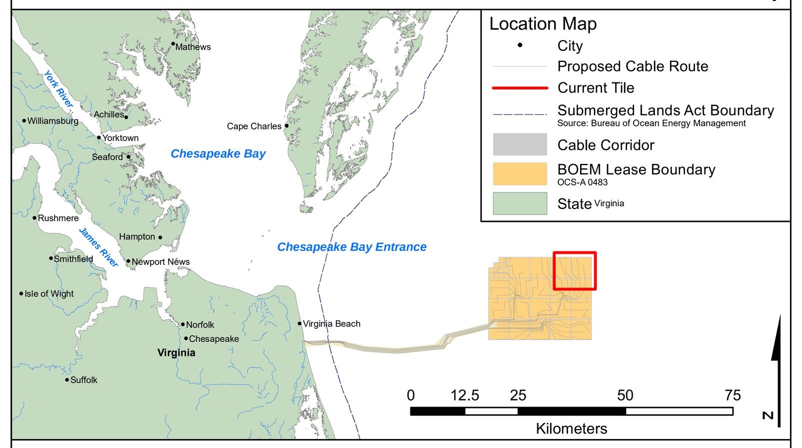
Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

Tile Index Overview

- Current Tile
- BOEM Lease Block OCS-A 0483
- Tile Panel 1 - 9





0 125 250 500 750 1,000 1,250 Meters

0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

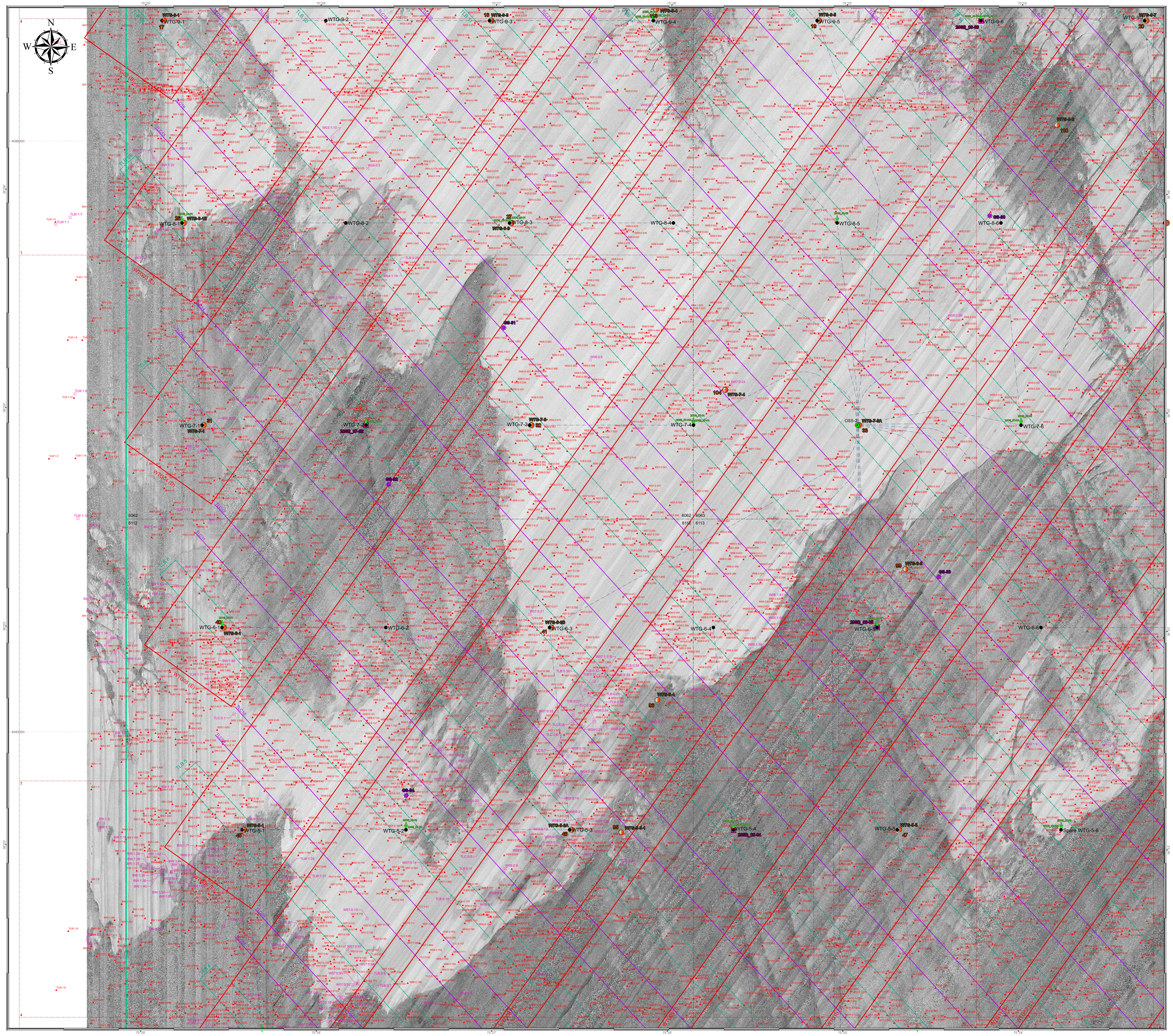
Project Title: CVOW-C Geophysical Survey 2021

Chart Title: CHART 4
HIGH FREQUENCY SIDE SCAN MOSAIC
TILE 3 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	Rev00	CLS	KDW	KMM
06/14/21	Rev01	CLS	KDW	KMM
07/31/21	Rev01	CLS	KDW	KMM

Rev01
Date: 7/31/2021

File Name: Dominion_SSS_Mosaic_Rev01.pdf



General Map Symbols

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- WTG Corridor
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Relative Reflectivity: Low — Side Scan Mosaic — High

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Magnetic Anomaly
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Reported anomaly ID: WTG##-M20-####

High Frequency Sidescan Mosaic (600 kHz)

Side Scan Sonar Processing Notes

Side scan sonar data were processed using SonarWiz 7 V7.05.008.

Data Import and Navigation

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General Information

Equipment

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TerraSond Personnel

Commercial Manager	: Scott Croft
Project Manager	: Don Ross
Project Manager	: James Hougham
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Operations Manager	: William Busey
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This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

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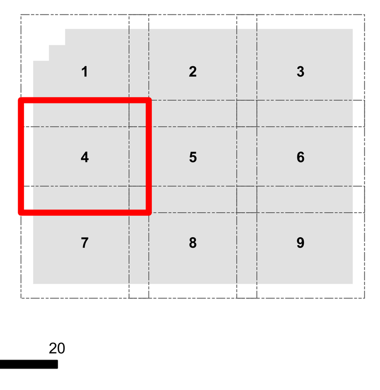
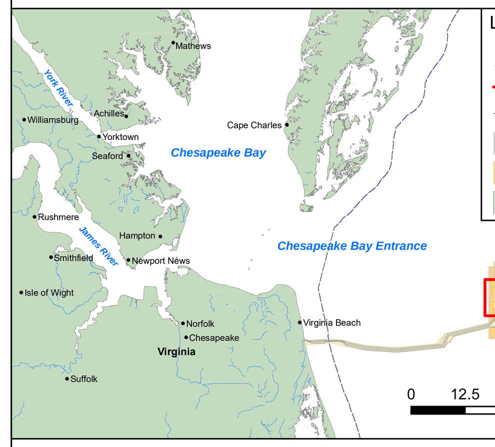
Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

Tile Index Overview
- Current Tile
- BOEM Lease Block OCS-A 0483
- Tile Panel 1 - 9



Location Map



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1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: **CVOW-C Geophysical Survey 2021**

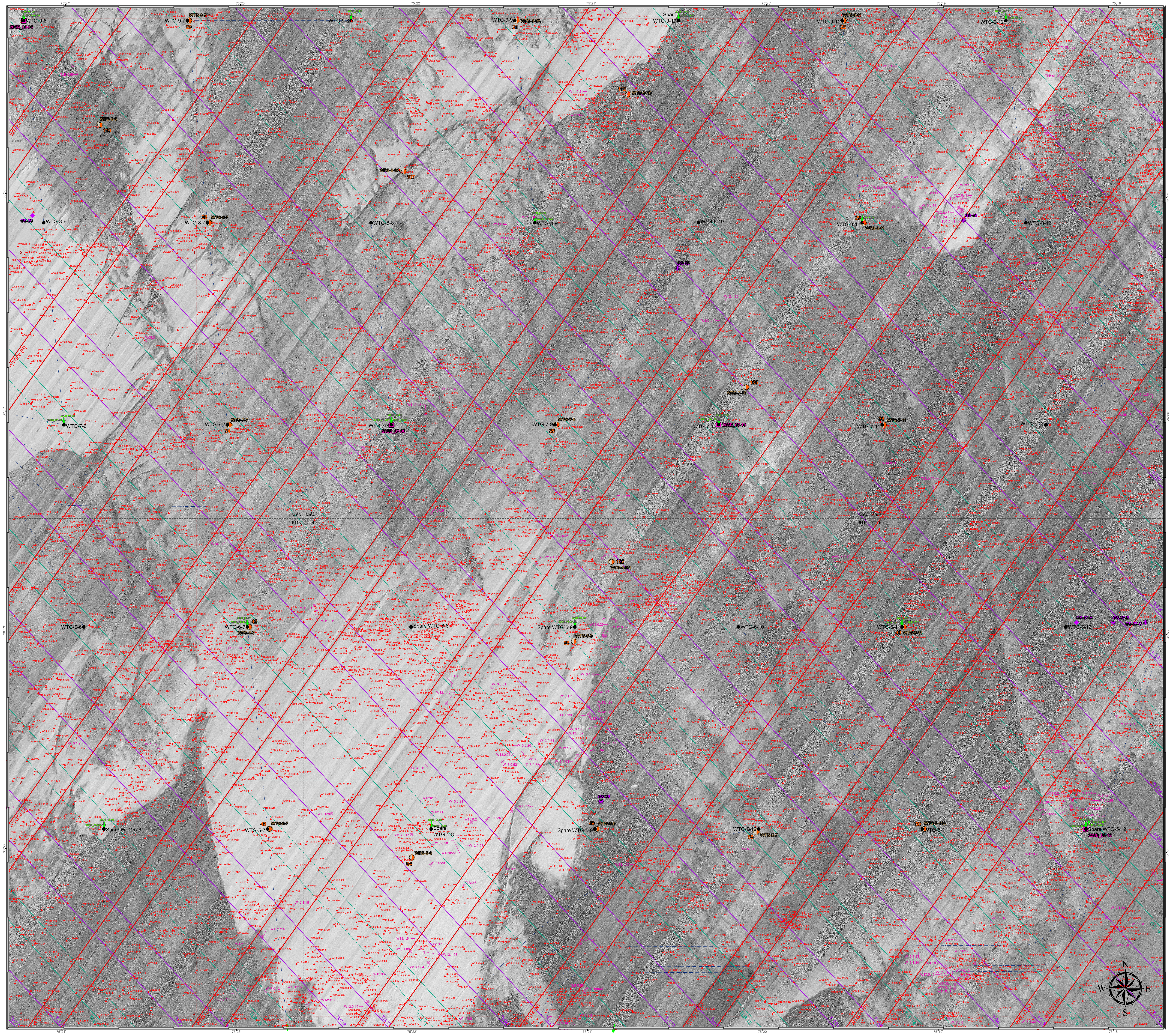
Chart Title: **CHART 4 HIGH FREQUENCY SIDE SCAN MOSAIC TILE 4 of 9**

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	Rev00	CLS	KDW	KMM
06/14/21	Rev01	CLS	KDW	KMM
07/31/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/31/2021

File Name: Dominion_SSS_Mosaic_Rev01.pdf



General Map Symbols

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Relative Reflectivity: Low – Side Scan Mosaic – High

Side Scan Sonar Contact
Note: Mainline SSS Contact labels are truncated to the WTG and the last four of contact ID. Reported anomaly ID: WTG##-M20-####
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Magnetic Anomaly
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High Frequency Sidescan Mosaic (600 kHz)

Side Scan Sonar Processing Notes

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Data Import and Navigation

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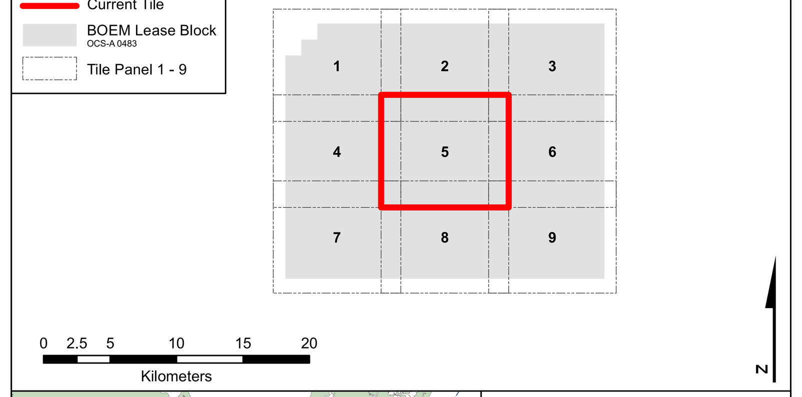

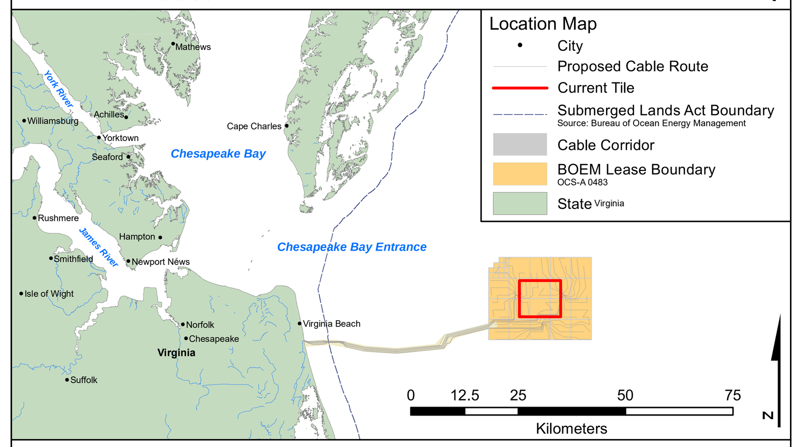

Location Map
- City
- Proposed Cable Route
- Current Tile
- Submerged Lands Act Boundary — Source: Bureau of Ocean Energy Management
- Cable Corridor
- BOEM Lease Boundary — OCS-A 0483
- State Virginia

Meters: 0, 125, 250, 500, 750, 1,000, 1,250
Feet: 0, 500, 1,000, 2,000, 3,000, 4,000, 5,000
1:10,000

Survey Contractor: TERRASOND — PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: **CVOW-C Geophysical Survey 2021**

Chart Title:

CHART 4
HIGH FREQUENCY SIDE SCAN MOSAIC
TILE 5 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	Rev00	CLS	KDW	KMM
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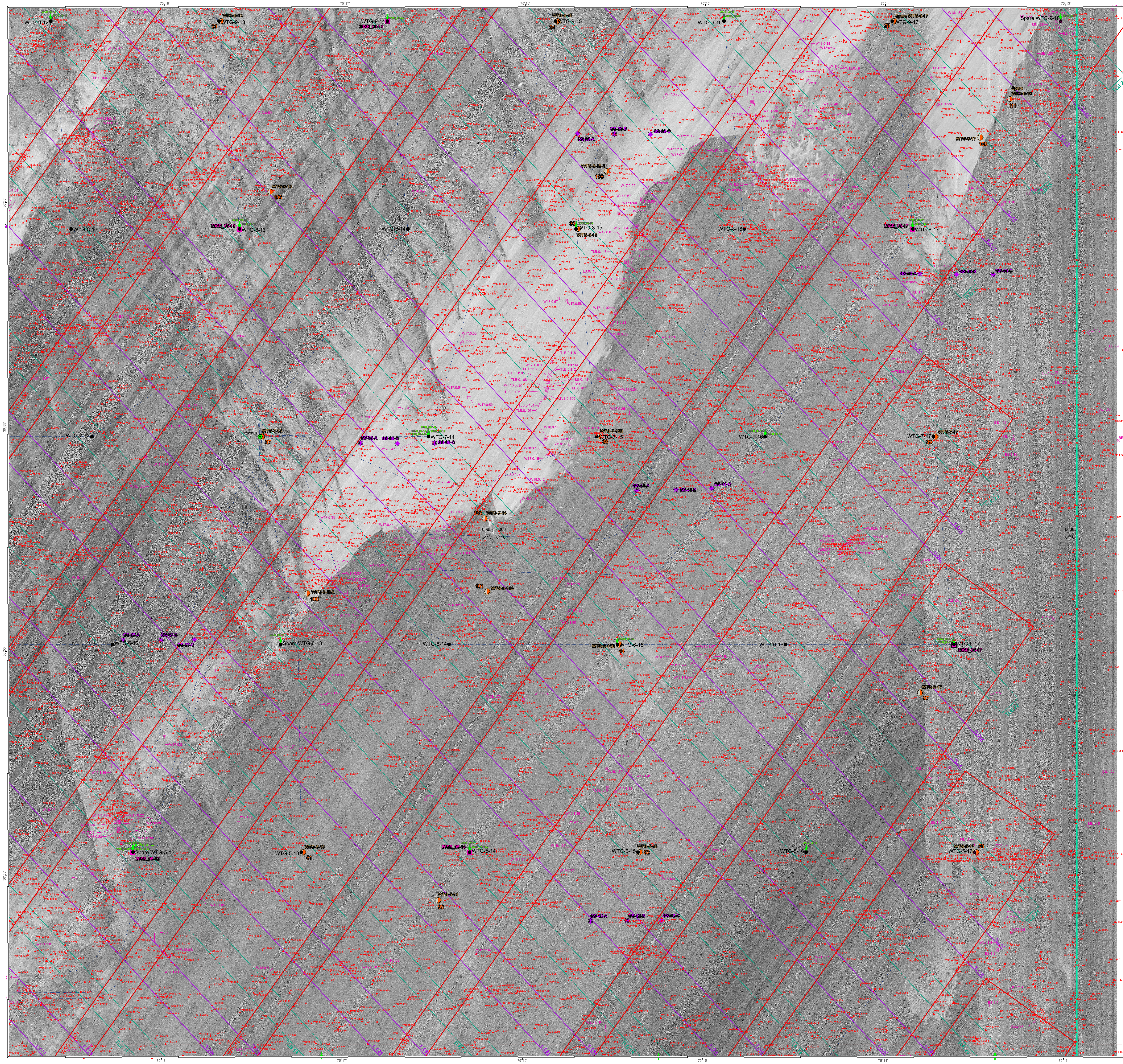
Rev01
Date: 7/31/2021

File Name: Dominion_SSS_Mosaic_Rev01.pdf



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High Frequency Sidescan Mosaic (600 kHz)

Side Scan Sonar Processing Notes

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Sidescan Sonar	: EdgeTech 4200 (300/600 kHz)
Magnetometer	: Geometrics G-882 (TVG)
Subbottom Profiler	: Innomar SES-2000 medium
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Single Channel Seismic[2,5,6]	: AAS-Boom and SCS Streamer
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Production Manager	: Kate Mildon
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Geophysical Manager	: Scott Hiller
Operations Manager	: William Busey
Party Chief	: Mark MacLean
Lead Surveyor	: Larry Andrews
Director HSEQ	: Forrest Davis

This geophysical survey was conducted April 29th, 2020 through June13th, 2021

Coordinate Reference System

Horizontal Coordinate Reference System

CRS Name	:NAD 1983 (2011) UTM Zone 18N
EPSG Code	:6347
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Units	:Meter

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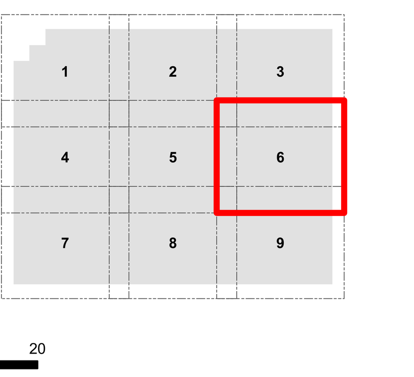
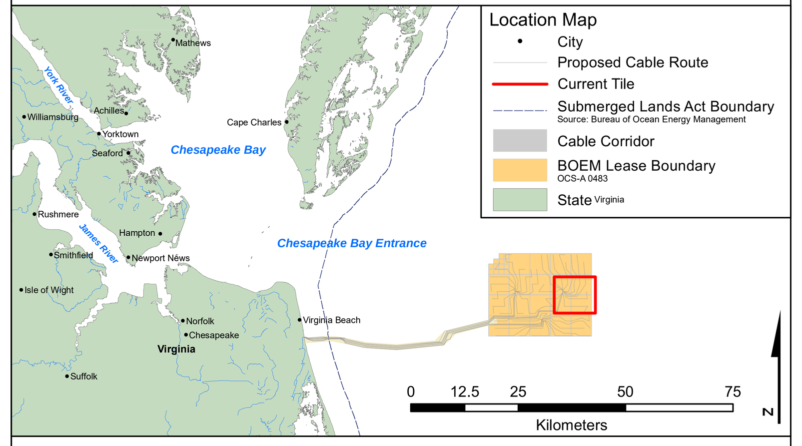
Datum	:Mean Lower Low Water (MLLW)
Axis -down	:Depth

Tile Index Overview
- Current Tile
- BOEM Lease Block — OCS-A 0483
- Tile Panel 1 - 9



Kilometers



Meters / Feet — 1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

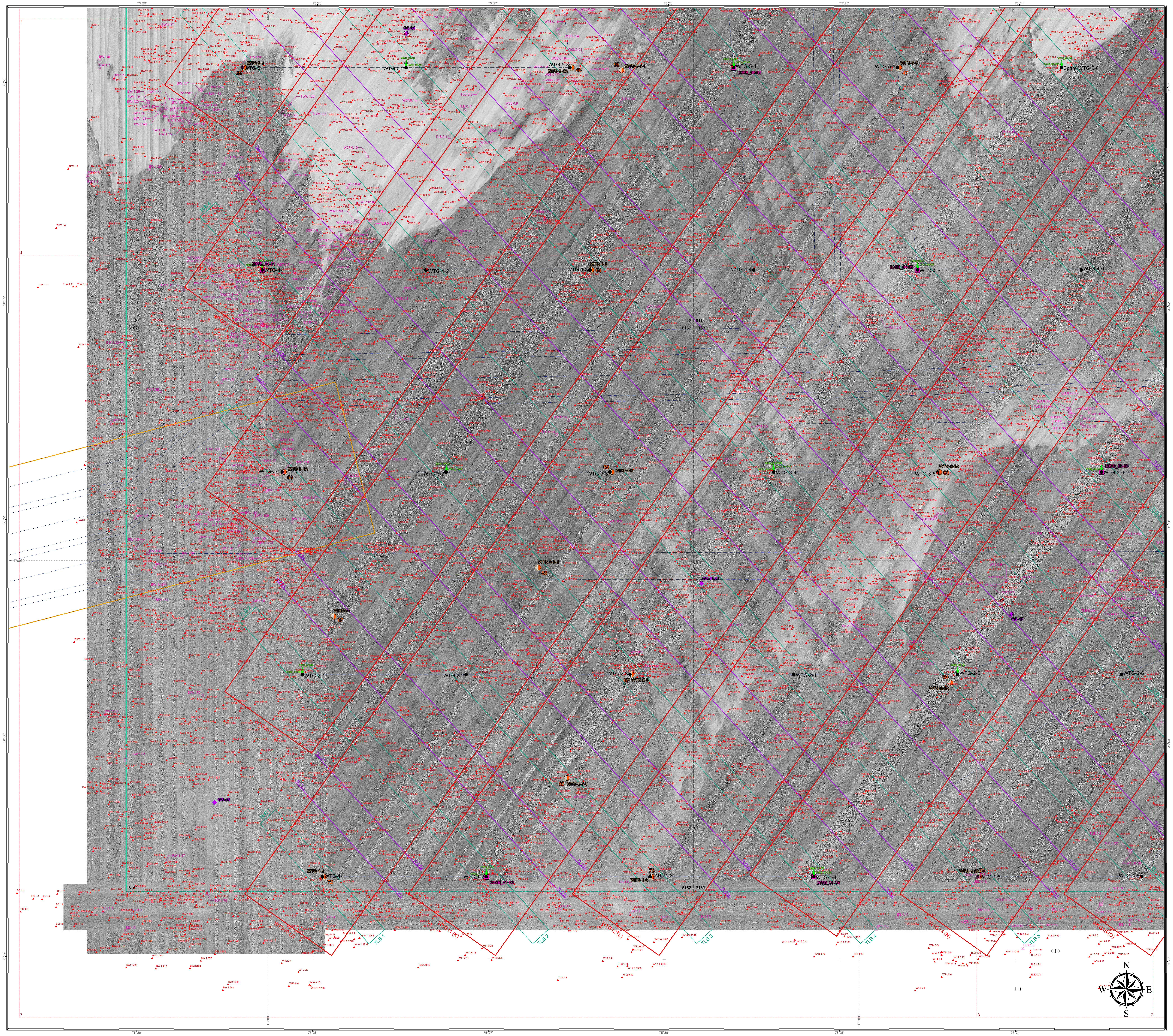
Chart Title: CHART 4
HIGH FREQUENCY SIDE SCAN MOSAIC
TILE 6 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	Rev00	CLS	KDW	KMM
06/14/21	Rev01	CLS	KDW	KMM
07/31/21	Rev01	CLS	KDW	KMM

Rev01

Date: 7/31/2021

File Name: Dominion_SSS_Mosaic_Rev01.pdf



General Map Symbols

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- TLB Corridor
- WTG Corridor
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- BOEM Lease Block Main Chart OCS-A 0483
- Tile Panel 1 - 9 Main Chart
- WTG Location Preliminary position/subject to change
- OSS Location Preliminary position/subject to change
- Grab Sample
- Box Corer
- Geotechnical Boring
- Benthic Sample
- CPT
- Charted Shipwreck Source: NOAA Office of Coast Survey

USA State and Cities Geographic Data: download from ESRI
Sources: Esri, TomTom North America, Inc., U.S. Census Bureau, U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Relative Reflectivity: Low – Side Scan Mosaic – High

Side Scan Sonar Contact
Note: Mainline SSS Contact labels are truncated to the WTG and the last four of contact ID. Reported anomaly ID: WTG##-M20-####
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Magnetic Anomaly
Note: Magnetic Anomaly labels are truncated to the last four of anomaly ID. Reported anomaly ID: WTG##-M20-####

High Frequency Sidescan Mosaic (600 kHz)

Side Scan Sonar Processing Notes

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Data Import and Navigation

Ultra-Short Baseline (USBL) acoustic positioning system was employed for side scan sonar navigation. Positioning was set to 2 Hz refresh rate with under two meters of positional accuracy. Where USBL positioning exceeded two meters, SSS cable layback was utilized by verifying cable out values and aligning seafloor features with adjacent lines, where possible. JSF files were imported using project defined coordinate system, NAD83 UTM18N (EPSG: 6347). Upon import each file was inspected for erroneous navigation, ensuring the data met the positioning specification.

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Tile Index Overview

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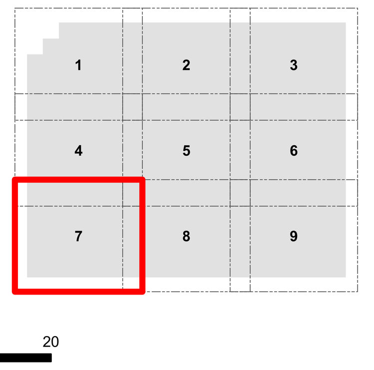
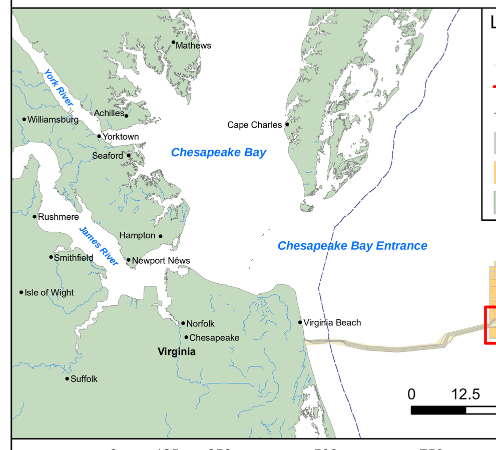
- Tile Panel 1 - 9





0 125 250 500 750 1,000 1,250 Meters

0 500 1,000 2,000 3,000 4,000 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

Chart Title:

CHART 4
HIGH FREQUENCY SIDE SCAN MOSAIC
TILE 7 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	Rev00	CLS	KDW	KMM
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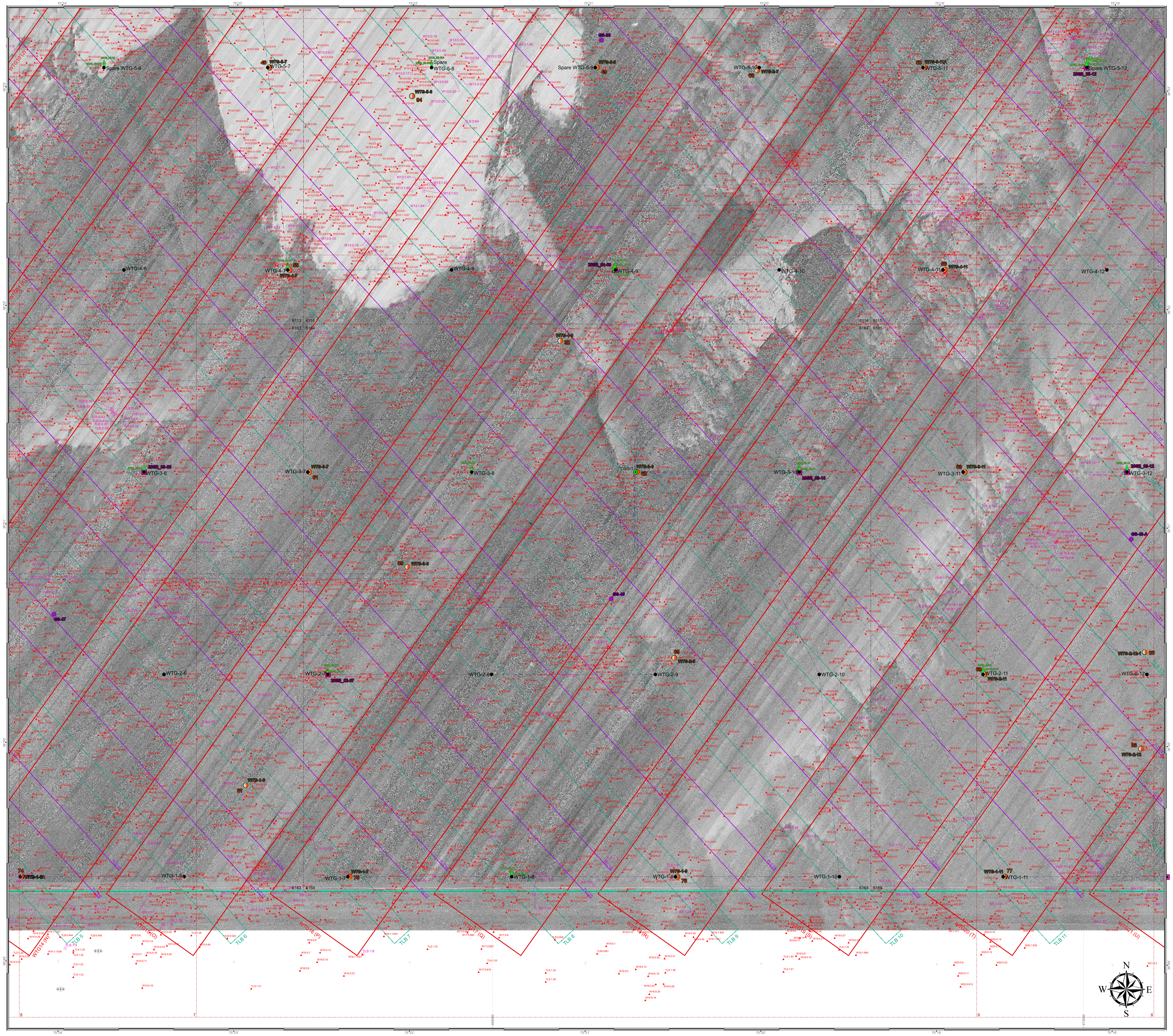
Rev01

Date: 7/31/2021

File Name: Dominion_SSS_Mosaic_Rev01.pdf



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USA State and Cities Geographic Data: download from ESRI
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High Frequency Sidescan Mosaic (600 kHz)

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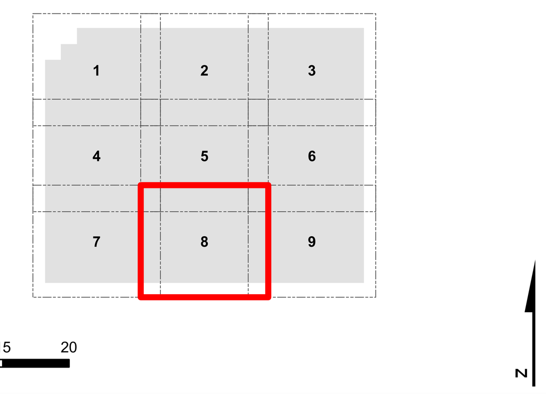

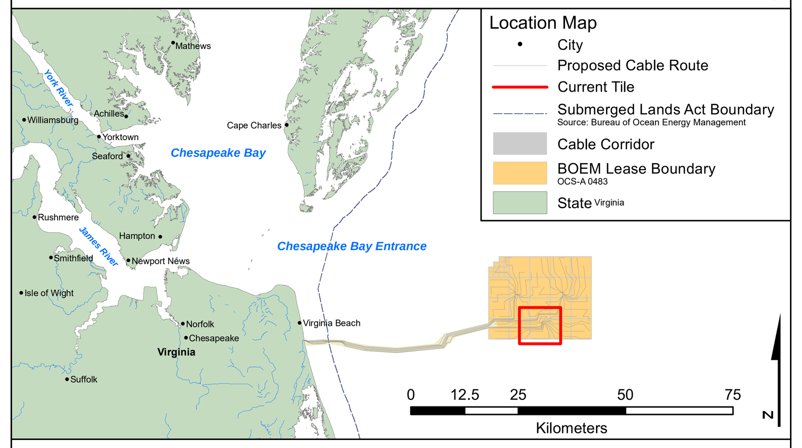

0 125 250 500 750 1,000 1,250 Meters

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1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

Chart Title: CHART 4 HIGH FREQUENCY SIDE SCAN MOSAIC TILE 8 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	Rev00	CLS	KDW	KMM
06/14/21	Rev01	CLS	KDW	KMM
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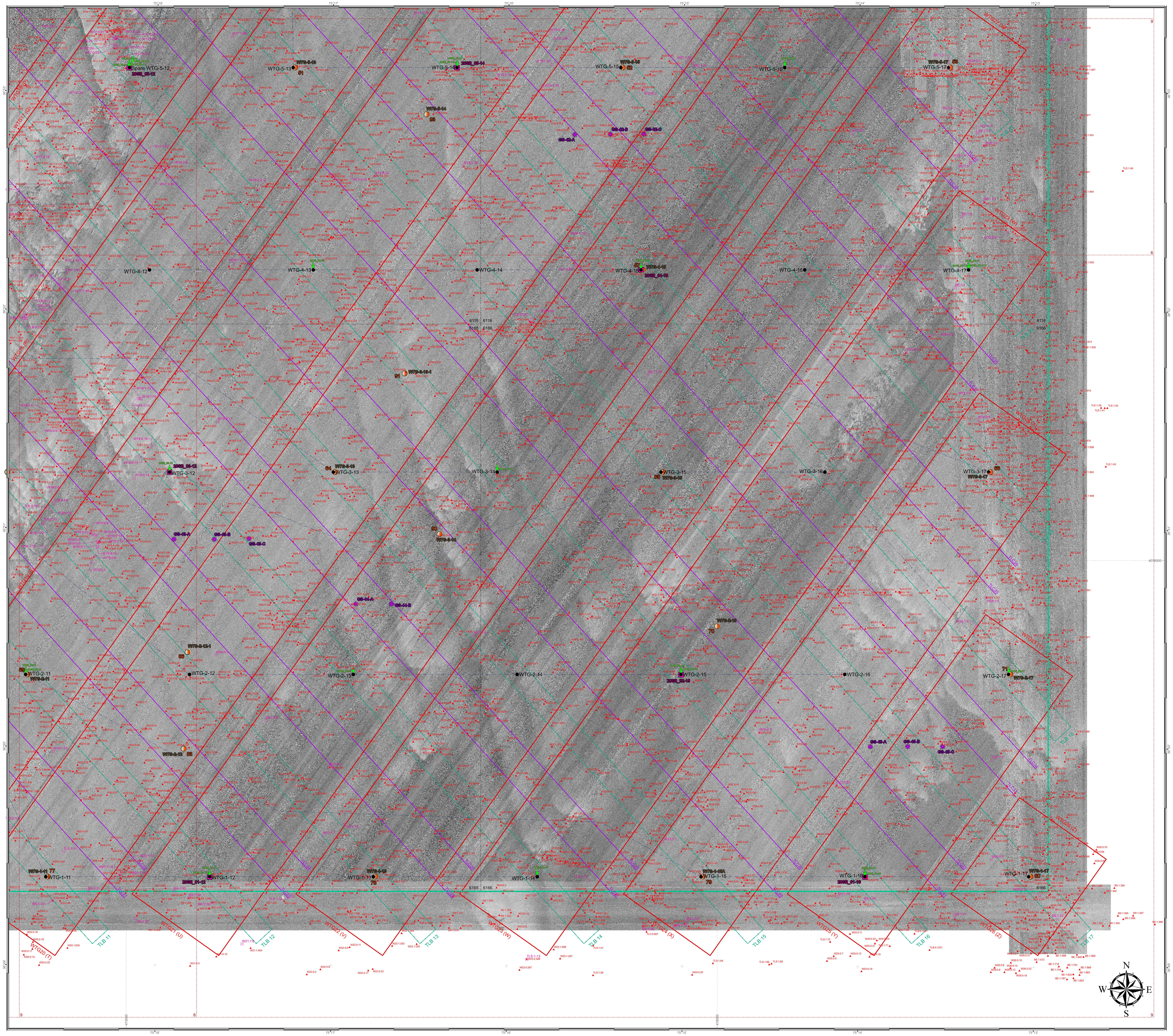
Rev01

Date: 7/31/2021

File Name: Dominion_SSS_Mosaic_Rev01.pdf



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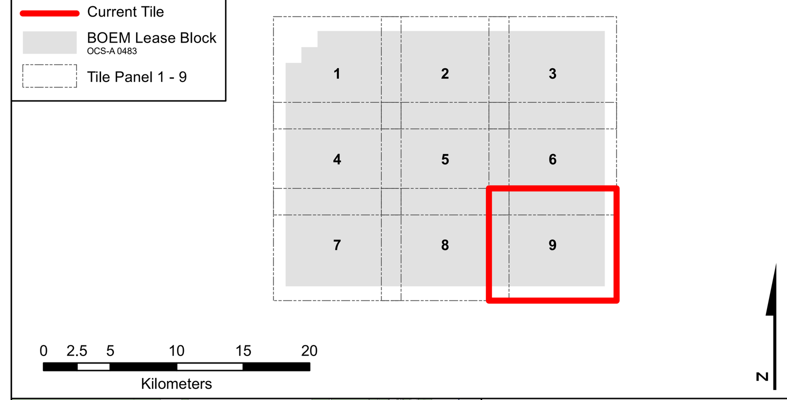
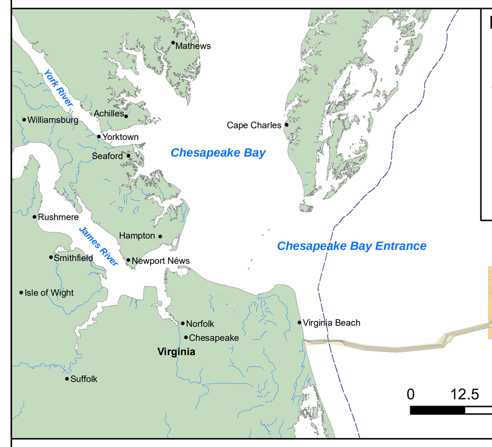


Location Map
- City
- Proposed Cable Route
- Current Tile
- Submerged Lands Act Boundary
- Cable Corridor
- BOEM Lease Boundary
- State



Scale: 0 – 1,250 Meters; 0 – 5,000 Feet

1:10,000

Survey Contractor: TERRASOND PRECISION GEOSPATIAL SOLUTIONS

Client: Dominion Energy

Project Title: CVOW-C Geophysical Survey 2021

Chart Title: CHART 4 HIGH FREQUENCY SIDE SCAN MOSAIC TILE 9 of 9

DATE	NOTE	AUTHOR	CHKD	APPD
06/08/21	Rev00	CLS	KDW	KMM
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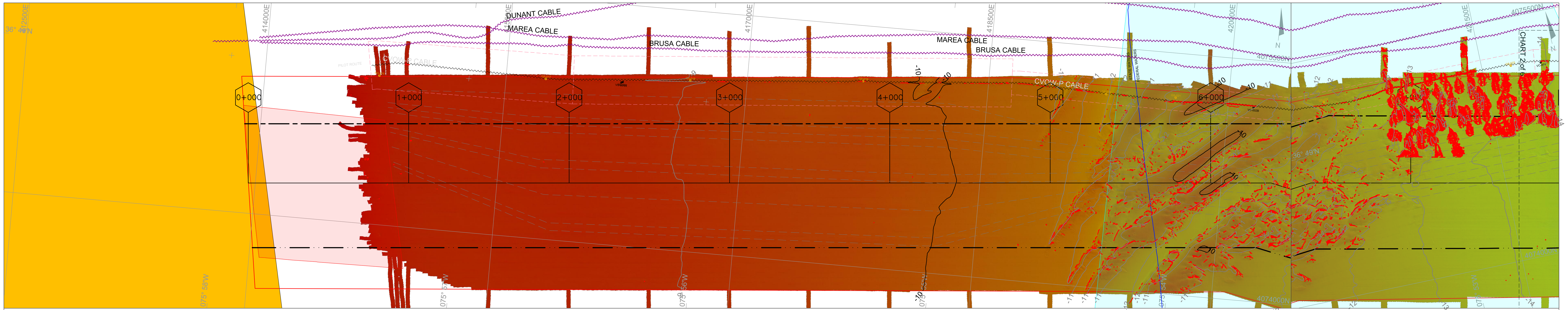
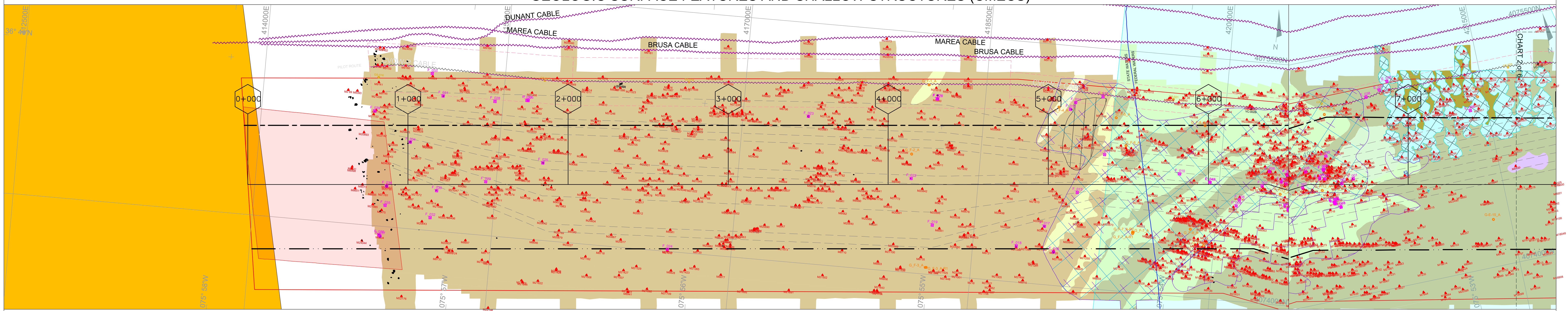
Rev01
Date: 7/31/2021

File Name: Dominion_SSS_Mosaic_Rev01.pdf

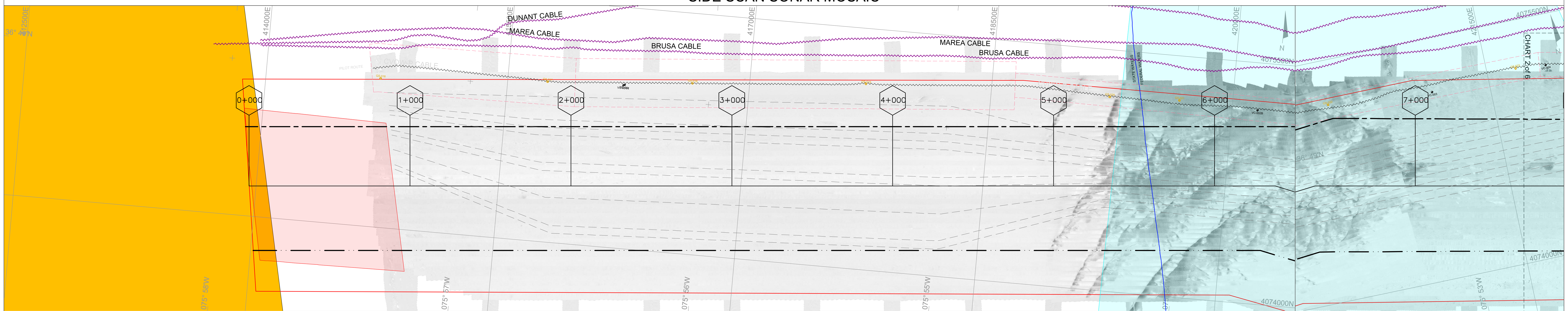
BATHYMETRIC CONTOURS AND SLOPES GREATER THAN 5°



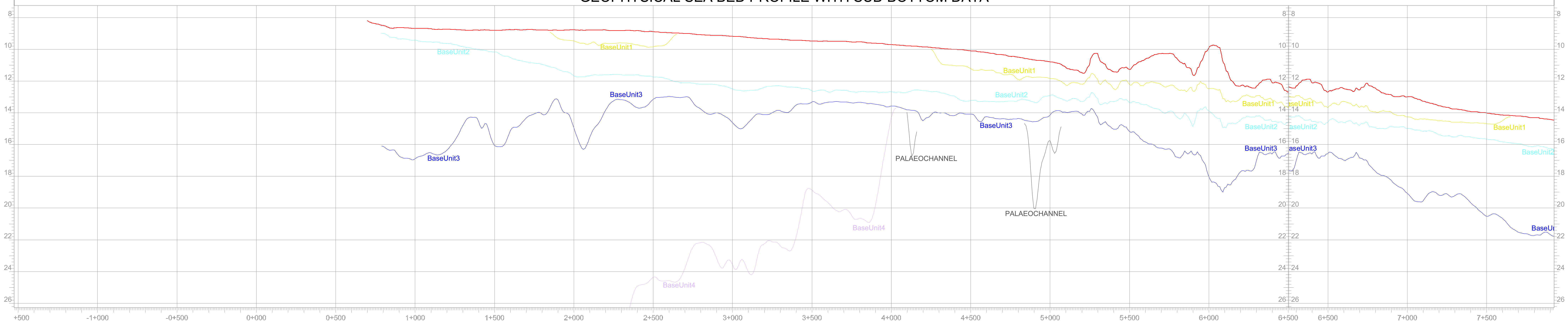
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURES (CMECS)



SIDE SCAN SONAR MOSAIC



GEOPHYSICAL SEA BED PROFILE WITH SUB-BOTTOM DATA



LEGEND

DISTANCE POST (KILOMETERS) 1+234
NORTH ROUTE
CENTER ROUTE
SOUTH ROUTE
ROUTE*
CONCEPTUAL CABLE ROUTE (DETAILED RE-ROUTING/MICRO-SITING WILL FOLLOW)*
DIGITIZED SHORE *
PILOT ROUTE CORRIDOR
CVOW-P HVDC CABLE
STATE / FEDERAL WATERS BOUNDARY *
SURVEY AREA LIMITS *
DAM NECK OCEAN DISPOSAL SITE *
VA BEACH EXPLOSIVES DUMPING GROUNDS
BOEM LEASE AREA *
SUB-MARINE CABLE *
D.O.D. BOUNDARY

BATHYMETRY LEGEND

MAJOR BATHYMETRY CONTOUR - MBES - @ 5m INTERVAL
MINOR BATHYMETRY CONTOUR - MBES - @ 1m INTERVAL
SLOPES EQUAL 5° OR GREATER

BATHYMETRIC COLOR SCALE KEY

-7.8 -10.0 -12.5 -15.0 -17.5 -20.0 -22.5 -25.0 -27.5 -29.0

OBSERVED SOUNDINGS HAVE BEEN REDUCED TO THE MLLW TIDAL DATUM.
THE BATHYMETRY CHART USES THE AVERAGE VALUES, GRID CELL SIZE 50cm BY 50cm. SUN ILLUMINATION FROM 45° AZIMUTH AND 45°ELEVATION WITH VERTICAL EXAGERRATION OF 1.0.

SURFACE FEATURES & SHALLOW STRUCTURES LEGEND

SEA BED CLASSIFICATION - CONSTRUCTION HASH
SEA BED FEATURE - SAND WAVES
SEA BED CLASSIFICATION - FINE SAND
SEA BED FEATURE - DEPRESSION LOCATION
SEA BED CLASSIFICATION - FINE TO MEDIUM SAND
SEA BED FEATURE - DEPRESSION AREA
SEA BED CLASSIFICATION - COARSE TO VERY COARSE SAND
SEA BED FEATURE - MEGARIPPLES
SEA BED CLASSIFICATION - GRAVELLY SAND
SEA BED FEATURE - RIPPLES
SEA BED CLASSIFICATION - MUD
SEA BED FEATURE - SCAR
SEA BED CLASSIFICATION - MUDDY SAND
CABLES (INTERPRETED POSITION)
SEA BED CLASSIFICATION - SANDY GRAVEL
G_C-34_A GRAB SAMPLE LOCATION - ALPINE 2020
SEA BED FEATURE - SAND BANK
G_C-34_A GRAB SAMPLE LOCATION - TETRA TECH 2013*
SIDE SCAN SONAR TARGET & ID
G_C-34_A GRAB SAMPLE LOCATION - TETRA TECH 2020*
MAGNETOMETER TARGET & ID
VC-005 VIBROCORE SAMPLE LOCATION - TETRA TECH 2013*
20CS_A22 2020 CPT AND/OR BOREHOLE SAMPLE LOCATION & ID* - GEOQUIP
21CS_A22 2021 CPT AND/OR BOREHOLE SAMPLE LOCATION & ID* - GEOQUIP

SIDE SCAN SONAR MOSAIC LEGEND

THE RESOLUTION OF THE CHARTED SIDE SCAN SONAR MOSAIC IS 1mpp. ONLY LOW FREQUENCY (APPROXIMATELY 233kHz) SIDE SCAN SONAR LINES ARE INCLUDED IN THE MOSAIC. ALL LINES WERE ACQUIRED USING A RANGE OF 50m.

HIGH LOW

GEOPHYSICAL PROFILE LEGEND

SEABED SURFACE
BASE UNIT 1
BASE UNIT 3
PALAEOCHANNEL
BASE UNIT 2
BASE UNIT 4
BASE QUATERNARY CHANNEL INFILL SEDIMENTS

20CS_A22
SEABED 0.000
SAND 4.320
GRAVEL 5.120
CLAY 7.420
(MPa) 0 20 40

* CPT LOCATION & ID w/ SEDIMENT TYPES, THICKNESS', & CPT TIP RESISTIVITY CURVE (2020 SAMPLES/2021 SAMPLES)

GENERAL NOTES:

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3. HORIZONTAL DATUM: UTM83-18 (m)
   VERTICAL DATUM: MLLW (m)

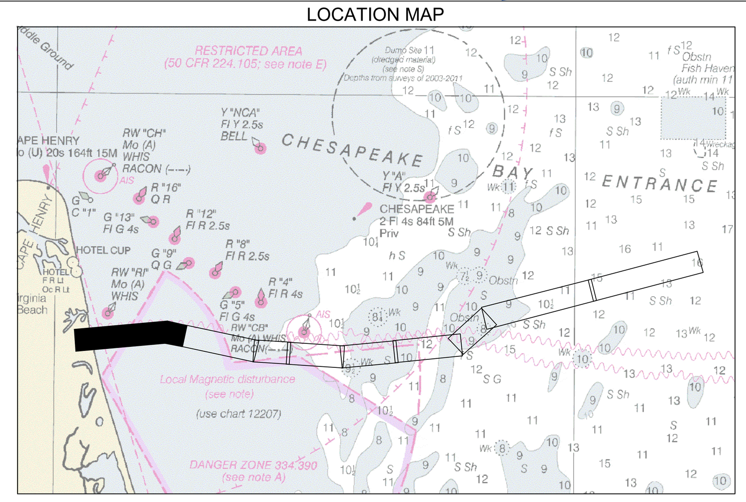
*INFORMATION PROVIDED BY CLIENT

LIST OF SURVEY EQUIPMENT

Item	RV Shearwater	RV Minerva Uno (2020 / 2021)
Positioning	Applanix POS MV OceanMaster CNAV 3050	Applanix POS MV OceanMaster CNAV 5000
SVP	AML Moving Vessel Profiler AML Plus SVP/CTD	AML Moving Vessel Profiler 350 AML Minos X
USBL	Sonardyne Scout Plus	Sonardyne Scout / Ranger
MBES	R2 Sonic 2024	R2 Sonic 2024
SSS	Edgetech 4200 (300–600kHz)	Edgetech 4200 (300–600kHz)
TVG	2 x Geometrics 882 Cesium Vapor	2 x Geometrics 882 Cesium Vapor
SBP	Innomar Medium SES 2000	Innomar Medium SES 2000
S-UHRS	AA301 Boomer Single-Channel 8 Element Hydrophone Streamer	AA301 / Geomarine Boomer Single-Channel 8 Element Hydrophone Streamer
Grab Sampler	N/A	Harmon Surficial Day Grab Sampler

Dominion Energy, Inc.
8th & Main Building, 707 East Main St
Richmond, VA 23219

LOCATION MAP



Coastal Virginia Offshore Wind Commercial (CVOW-C) Export Cable Route Corridor

CENTERLINE ALIGNMENT CHART

kp 0+000 to kp 7+925

HORIZONTAL SCALE 1:10,000 (1cm = 100m = 328.1ft)
0 100 200 400 800
0 1 2 4 8
VERTICAL SCALE 1:100 (1cm = 1m = 3.3ft)

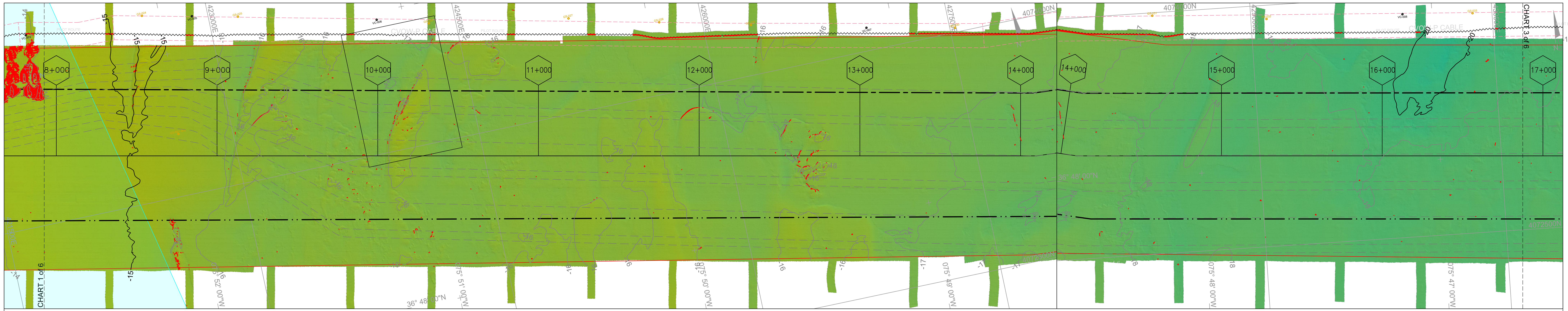
GEODETIC INFORMATION
DATUM : NAD83 (2011)
VERTICAL : MLLW (m)
PROJECTION : UTM83-18N

Drawing Name:	ALIGNMENT CENTERLINE-001
Vessel:	Minerva Uno / Shearwater
Approved By:	JB
Interp. By:	KR
Party Chief:	DW/TK
Drawn By:	BE
Revision:	3 18-Aug-2021
Issue Date:	08-Feb-2021
Survey Date:	May - Nov 2020 & Jan - May 2021
Chart Num :	1 of 6

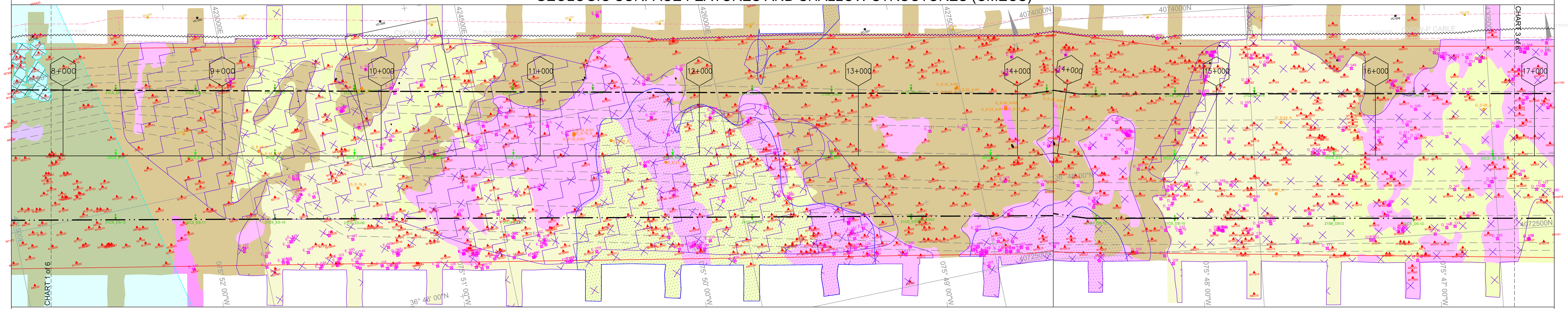
Alpine

ALPINE OCEAN SEISMIC SURVEY INC 155 Hudson Ave Norwood New Jersey 07648 Tel 201-768-8000 Fax 201-768-5750 www.alpineocean.com

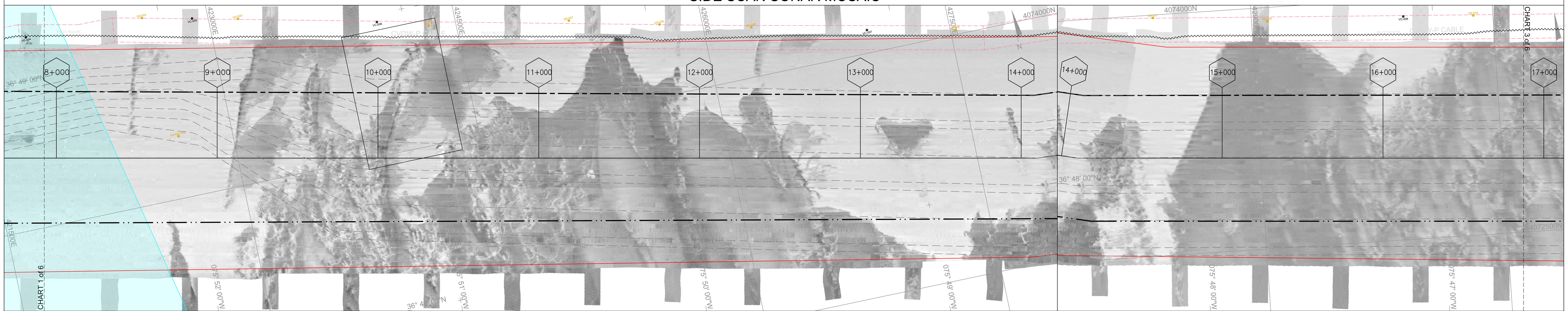
BATHYMETRIC CONTOURS AND SLOPES GREATER THAN 5°



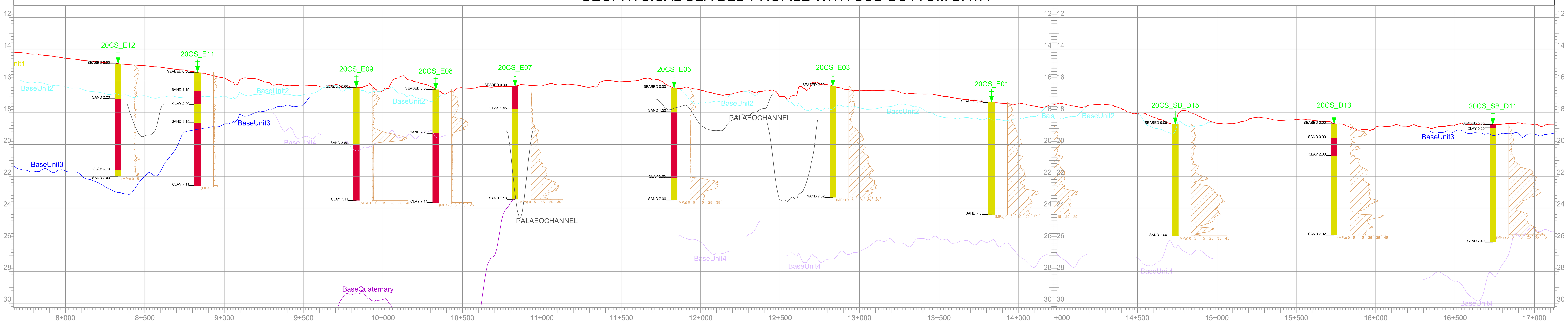
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURES (CMECS)



SIDE SCAN SONAR MOSAIC



GEOPHYSICAL SEA BED PROFILE WITH SUB-BOTTOM DATA



LEGEND

DISTANCE POST (KILOMETERS) 1+234
NORTH ROUTE
CENTER ROUTE
SOUTH ROUTE
ROUTE*
CONCEPTUAL CABLE ROUTE (DETAILED RE-ROUTING/MICRO-SITING WILL FOLLOW)*
DIGITIZED SHORE *
PILOT ROUTE CORRIDOR CVOW-P HVDC CABLE
STATE / FEDERAL WATERS BOUNDARY *
SURVEY AREA LIMITS *
DAM NECK OCEAN DISPOSAL SITE *
VA BEACH EXPLOSIVES DUMPING GROUNDS
BOEM LEASE AREA *
SUB-MARINE CABLE *
D.O.D. BOUNDARY

BATHYMETRY LEGEND

MAJOR BATHYMETRY CONTOUR - MBES - @ 5m INTERVAL
MINOR BATHYMETRY CONTOUR - MBES - @ 1m INTERVAL
SLOPES EQUAL 5° OR GREATER

BATHYMETRIC COLOR SCALE KEY

-7.8 | -10.0 | -12.5 | -15.0 | -17.5 | -20.0 | -22.5 | -25.0 | -27.5 | -29.0

OBSERVED SOUNDINGS HAVE BEEN REDUCED TO THE MLLW TIDAL DATUM.
THE BATHYMETRY CHART USES THE AVERAGE VALUES, GRID CELL SIZE 50cm BY 50cm. SUN ILLUMINATION FROM 45° AZIMUTH AND 45°ELEVATION WITH VERTICAL EXAGERRATION OF 1.0.

SURFACE FEATURES & SHALLOW STRUCTURES LEGEND

SEA BED CLASSIFICATION - CONSTRUCTION HASH
SEA BED FEATURE - SAND WAVES
SEA BED CLASSIFICATION - FINE SAND
SEA BED FEATURE - DEPRESSION LOCATION
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SEA BED CLASSIFICATION - COARSE TO VERY COARSE SAND
SEA BED FEATURE - MEGARIPPLES
SEA BED CLASSIFICATION - GRAVELLY SAND
SEA BED FEATURE - RIPPLES
SEA BED CLASSIFICATION - MUD
SEA BED FEATURE - SCAR
SEA BED CLASSIFICATION - MUDDY SAND
CABLES (INTERPRETED POSITION)
SEA BED CLASSIFICATION - SANDY GRAVEL
G_C-34_A GRAB SAMPLE LOCATION - ALPINE 2020
SEA BED FEATURE - SAND BANK
G_C-34_A GRAB SAMPLE LOCATION - TETRA TECH 2013*
G_C-34_A GRAB SAMPLE LOCATION - TETRA TECH 2020*
SIDE SCAN SONAR TARGET & ID
MAGNETOMETER TARGET & ID
VC-005 VIBROCORE SAMPLE LOCATION - TETRA TECH 2013*
20CS_A22 2020 CPT AND/OR BOREHOLE SAMPLE LOCATION & ID* - GEOQUIP
21CS_A22 2021 CPT AND/OR BOREHOLE SAMPLE LOCATION & ID* - GEOQUIP

SIDE SCAN SONAR MOSAIC LEGEND

THE RESOLUTION OF THE CHARTED SIDE SCAN SONAR MOSAIC IS 1mpp. ONLY LOW FREQUENCY (APPROXIMATELY 233kHz) SIDE SCAN SONAR LINES ARE INCLUDED IN THE MOSAIC. ALL LINES WERE ACQUIRED USING A RANGE OF 50m.

HIGH — LOW

GEOPHYSICAL PROFILE LEGEND

SEABED SURFACE
PALAEOCHANNEL
BASE UNIT 1
BASE UNIT 2
BASE UNIT 3
BASE UNIT 4
BASE QUATERNARY CHANNEL INFILL SEDIMENTS

20CS_A22
SEABED 0.000
SAND 4.320
GRAVEL 5.120
CLAY 7.420
(MPa) 0 20 40

* CPT LOCATION & ID w/ SEDIMENT TYPES, THICKNESS', & CPT TIP RESISTIVITY CURVE (2020 SAMPLES/2021 SAMPLES)

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*INFORMATION PROVIDED BY CLIENT

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SVP	AML Moving Vessel Profiler AML Plus SVP/CTD	AML Moving Vessel Profiler 350 AML Minos X
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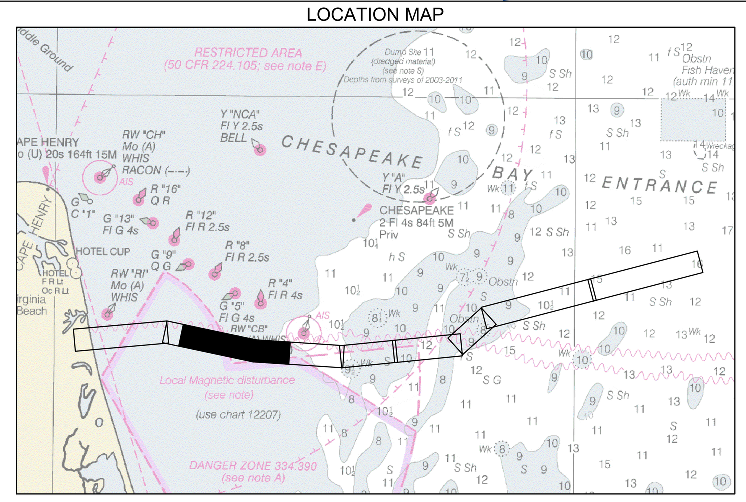
Grab Sampler	N/A	Harmon Surficial Day Grab Sampler

Dominion Energy, Inc.
8th & Main Building, 707 East Main St
Richmond, VA 23219

LOCATION MAP



Coastal Virginia Offshore Wind Commercial (CVOW-C) Export Cable Route Corridor

CENTERLINE ALIGNMENT CHART

kp 7+675 to kp 17+125

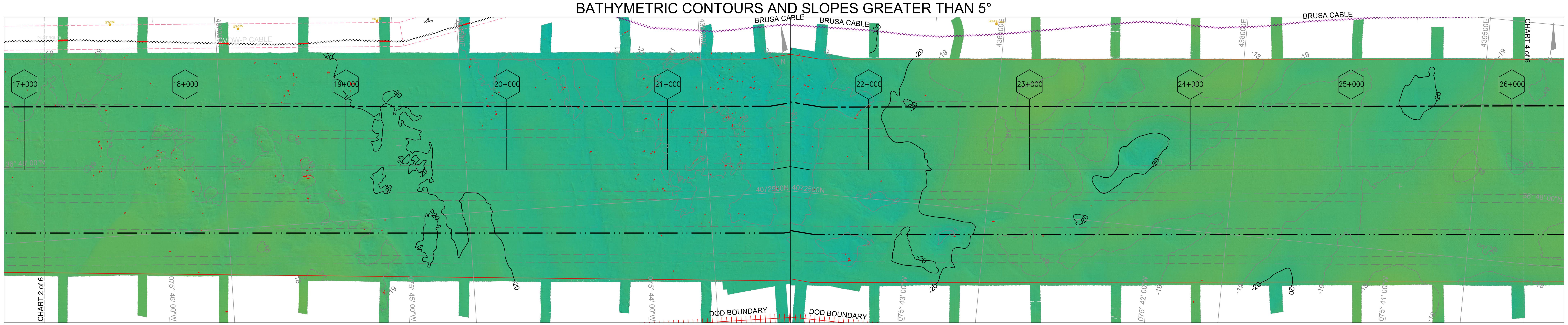
HORIZONTAL SCALE 1:10,000 (1cm = 100m = 328.1ft)
0 100 200 400 800
0 1 2 4 8
VERTICAL SCALE 1:100 (1cm = 1m = 3.3ft)

GEODETIC INFORMATION	
DATUM :	NAD83 (2011)
VERTICAL :	MLLW (m)
PROJECTION :	UTM83-18N

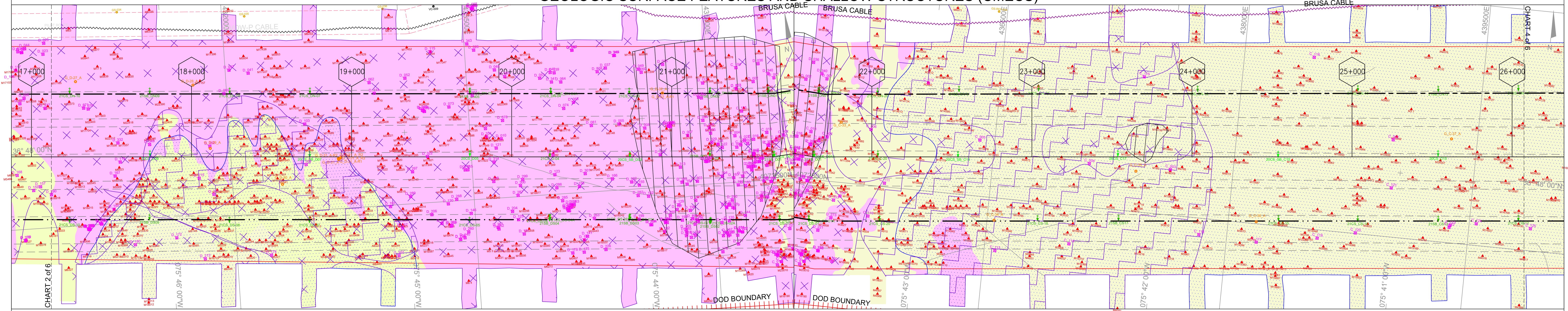
Drawing Name:	ALIGNMENT CENTERLINE-001
Vessel:	Minerva Uno / Shearwater
Approved By:	JB
Interp. By:	KR
Party Chief:	DW/TK
Drawn By:	BE
Revision:	3 18-Aug-2021
Issue Date:	08-Feb-2021
Survey Date:	May - Nov 2020 & Jan - May 2021
Chart Num :	2 of 6

ALPINE OCEAN SEISMIC SURVEY INC 155 Hudson Ave Norwood New Jersey 07648 Tel 201-768-8000 Fax 201-768-5750 www.alpineocean.com

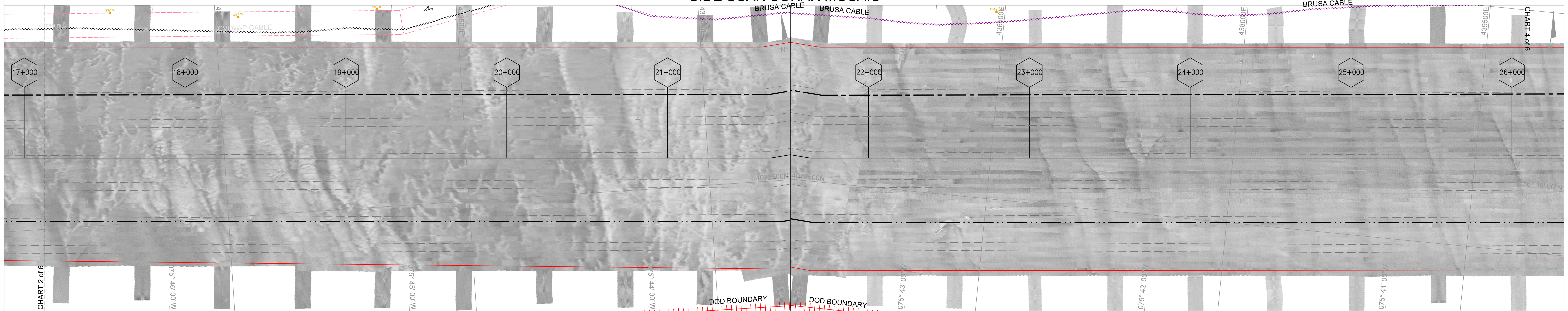
BATHYMETRIC CONTOURS AND SLOPES GREATER THAN 5°



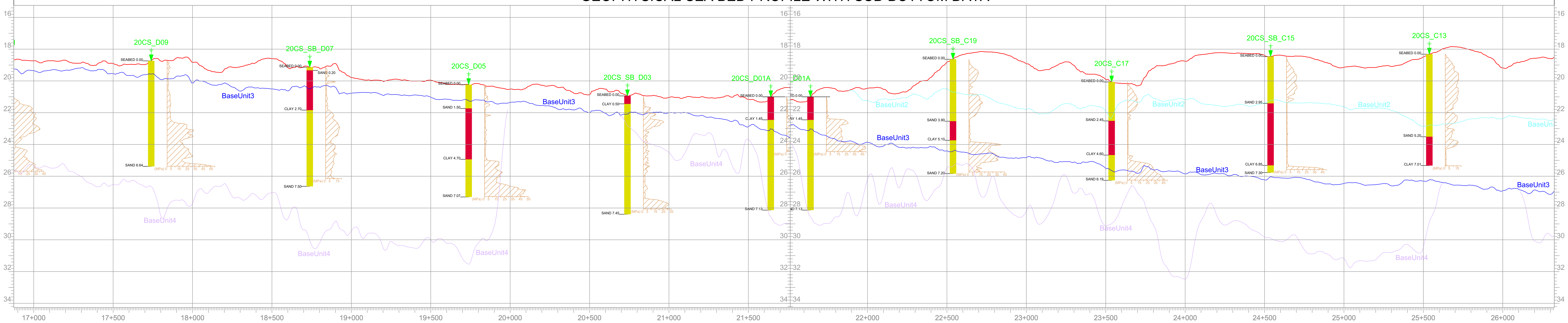
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURES (CMECS)



SIDE SCAN SONAR MOSAIC



GEOPHYSICAL SEA BED PROFILE WITH SUB-BOTTOM DATA



LEGEND

- DISTANCE POST (KILOMETERS) 1+234
- NORTH ROUTE
- CENTER ROUTE
- SOUTH ROUTE
- ROUTE*
- CONCEPTUAL CABLE ROUTE (DETAILED RE-ROUTING/MICRO-SITING WILL FOLLOW)*
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- VA BEACH EXPLOSIVES DUMPING GROUNDS
- BOEM LEASE AREA *
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- D.O.D. BOUNDARY

BATHYMETRY LEGEND

- 20 MAJOR BATHYMETRY CONTOUR - MBES - @ 5m INTERVAL
- MINOR BATHYMETRY CONTOUR - MBES - @ 1m INTERVAL
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HIGH — LOW

GEOPHYSICAL PROFILE LEGEND

- SEABED SURFACE
- PALAEOCHANNEL
- BASE UNIT 1
- BASE UNIT 2
- BASE UNIT 3
- BASE UNIT 4
- BASE QUATERNARY CHANNEL INFILL SEDIMENTS

20CS_A22
SEABED 0.000
SAND 4.320
GRAVEL 5.120
CLAY 7.420
(MPa) 0 20 40

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Dominion Energy, Inc.
8th & Main Building, 707 East Main St
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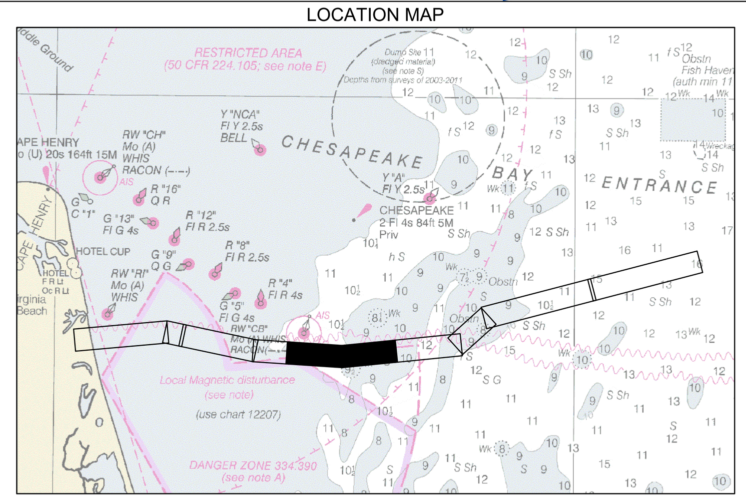
LOCATION MAP



Coastal Virginia Offshore Wind Commercial (CVOW-C) Export Cable Route Corridor

CENTERLINE ALIGNMENT CHART

kp 16+875 to kp 26+324

HORIZONTAL SCALE 1:10,000 (1cm = 100m = 328.1ft)
0 100 200 400 800
0 1 2 4 8
VERTICAL SCALE 1:100 (1cm = 1m = 3.3ft)

GEODETIC INFORMATION
DATUM : NAD83 (2011)
VERTICAL : MLLW (m)
PROJECTION : UTM83-18N

Drawing Name:	ALIGNMENT CENTERLINE-001
Vessel:	Minerva Uno / Shearwater
Approved By:	JB
Interp. By:	KR
Party Chief:	DW/TK
Drawn By:	BE
Revision:	3 18-Aug-2021
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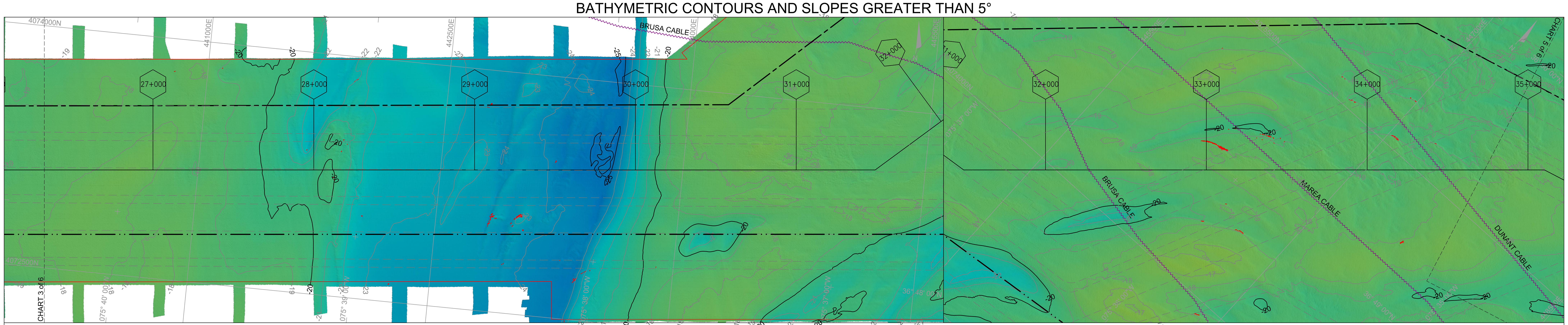
Chart Num :	3 of 6

BATHYMETRIC CONTOURS AND SLOPES GREATER THAN 5°



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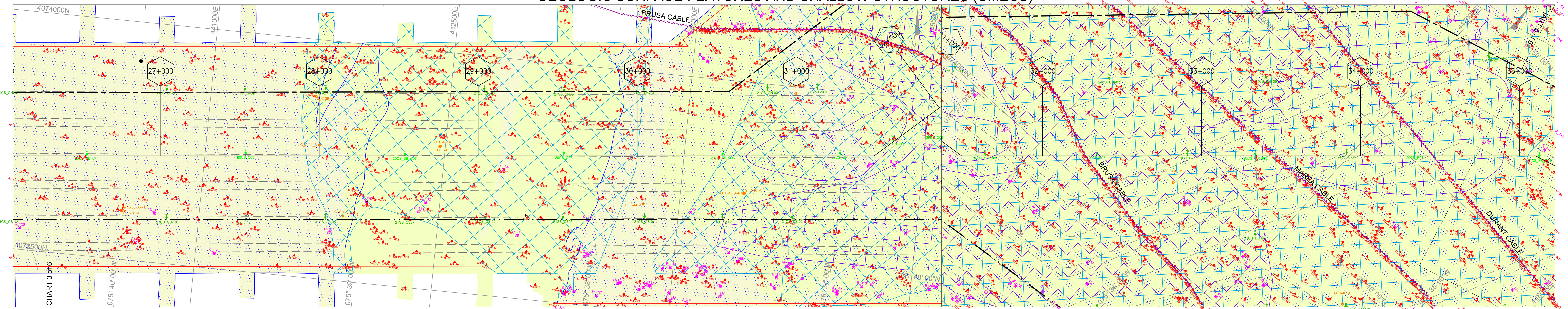
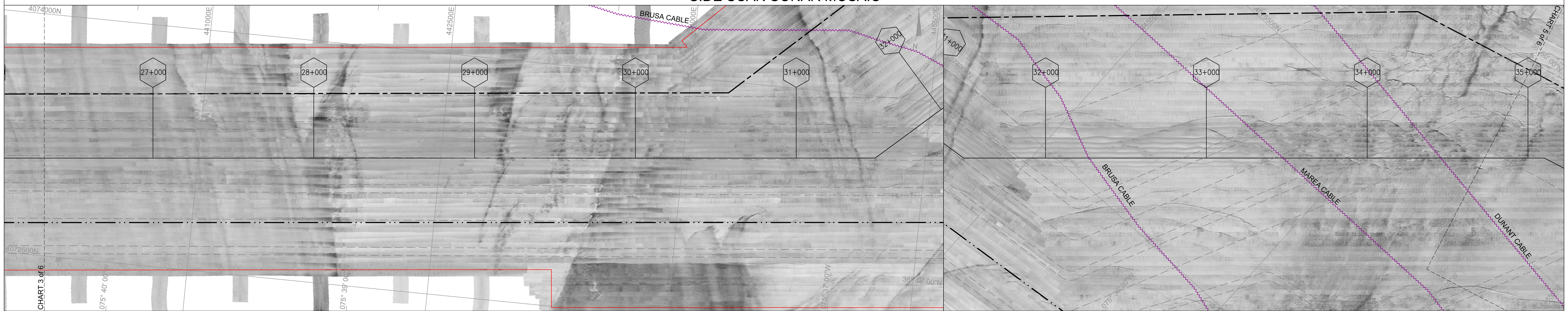
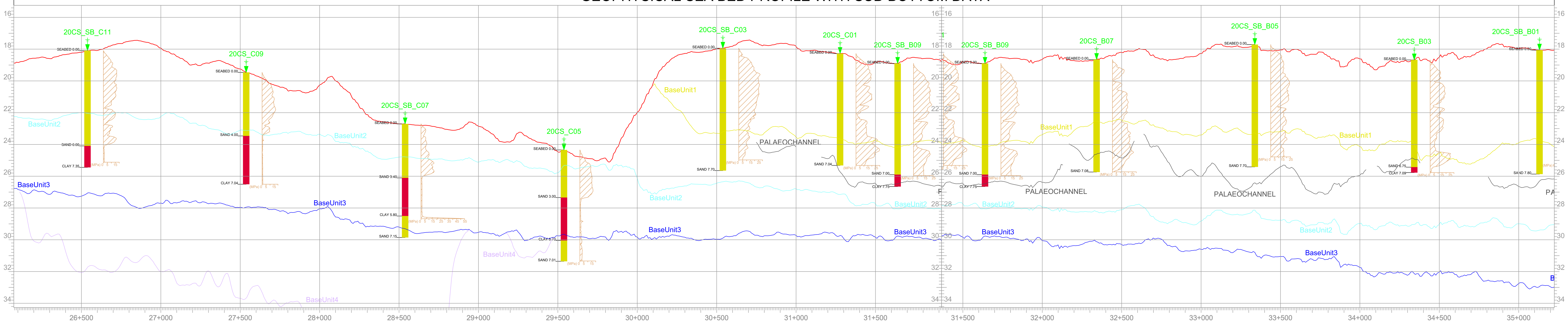


SIDE SCAN SONAR MOSAIC



GEOPHYSICAL SEA BED PROFILE WITH SUB-BOTTOM DATA



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HIGH — LOW

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PALAEOCHANNEL
BASE UNIT 1
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BASE QUATERNARY CHANNEL INFILL SEDIMENTS

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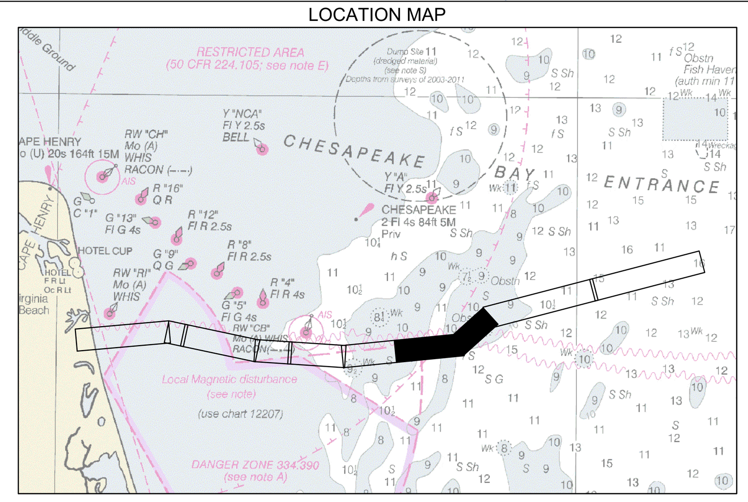


Coastal Virginia Offshore Wind Commercial (CVOW-C) Export Cable Route Corridor

CENTERLINE ALIGNMENT CHART

kp 26+074 to kp 35+224

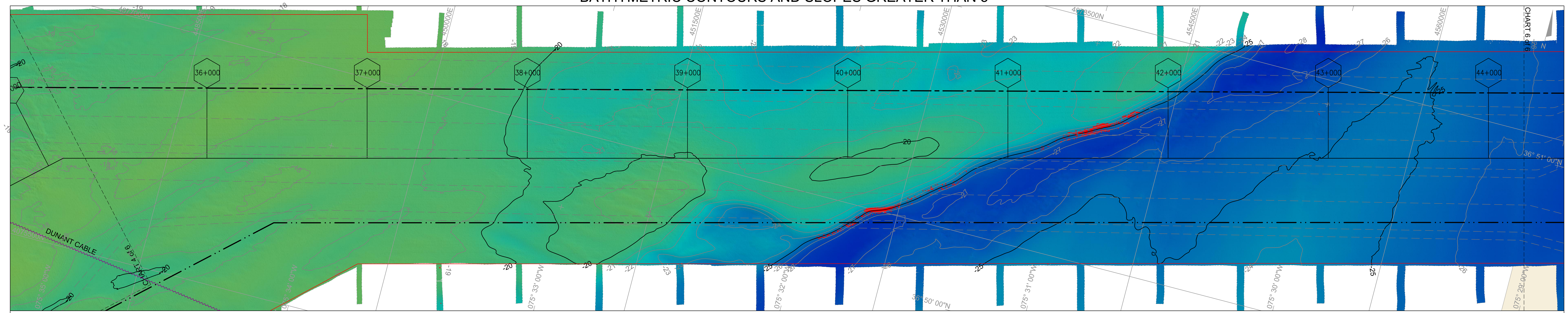
HORIZONTAL SCALE 1:10,000 (1cm = 100m = 328.1ft) — 0, 100, 200, 400, 800
VERTICAL SCALE 1:100 (1cm = 1m = 3.3ft) — 0, 1, 2, 4, 8

GEODETIC INFORMATION
DATUM : NAD83 (2011)
VERTICAL : MLLW (m)
PROJECTION : UTM83-18N

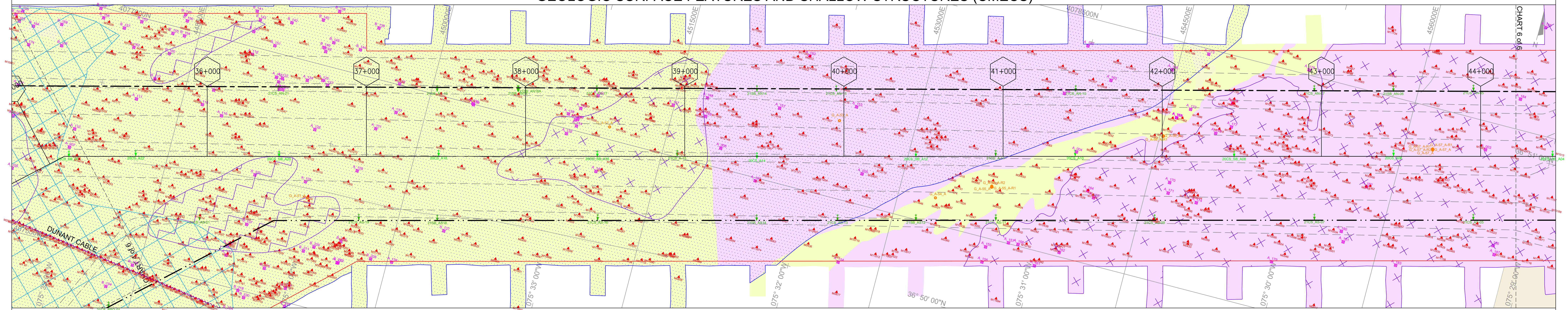
Drawing Name:	ALIGNMENT CENTERLINE-002
Vessel:	Minerva Uno / Shearwater
Approved By:	JB
Interp. By:	KR
Party Chief:	DW/TK
Drawn By:	BE
Revision:	3 18-Aug-2021
Issue Date:	08-Feb-2021
Survey Date:	May - Nov 2020 & Jan - May 2021
Chart Num :	4 of 6

ALPINE OCEAN SEISMIC SURVEY INC 155 Hudson Ave Norwood New Jersey 07648 Tel 201-768-8000 Fax 201-768-5750 www.alpineocean.com

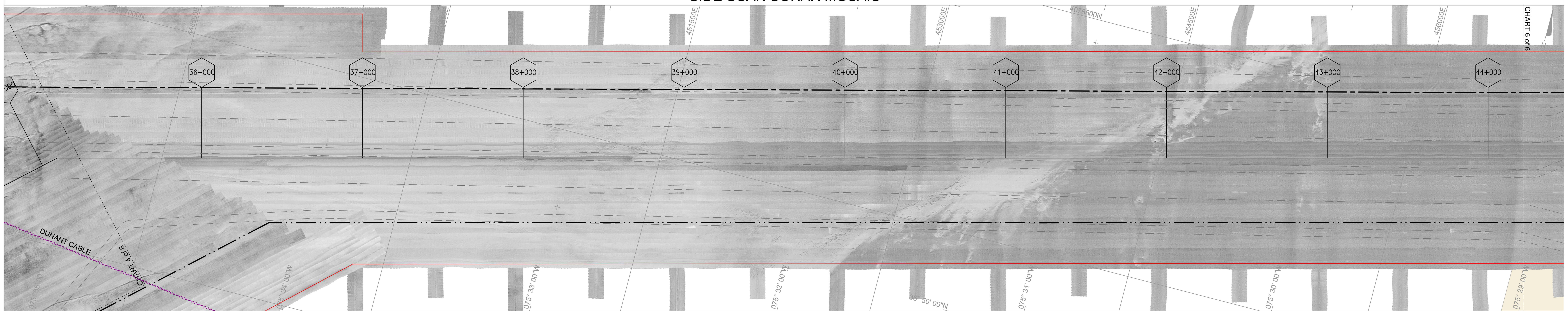
BATHYMETRIC CONTOURS AND SLOPES GREATER THAN 5°



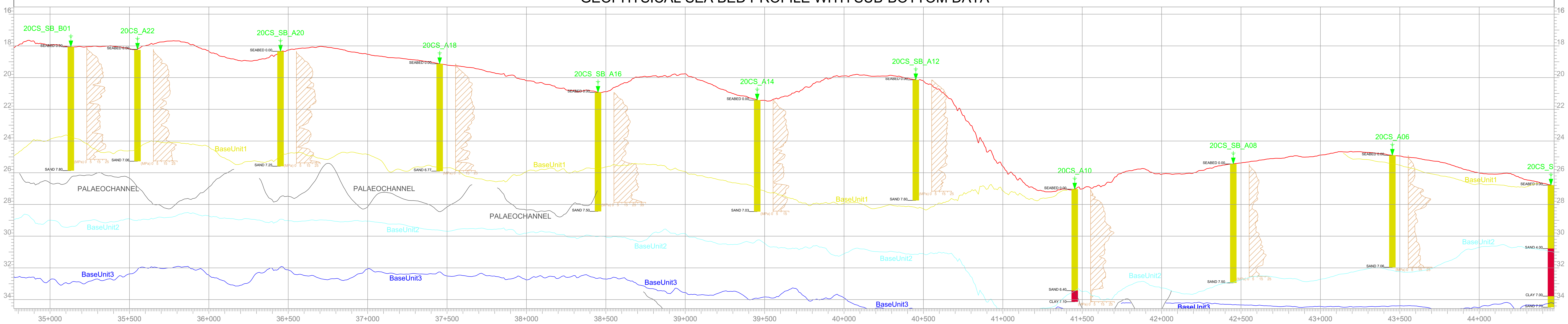
GEOLOGIC SURFACE FEATURES AND SHALLOW STRUCTURES (CMECS)



SIDE SCAN SONAR MOSAIC



GEOPHYSICAL SEA BED PROFILE WITH SUB-BOTTOM DATA



LEGEND

DISTANCE POST (KILOMETERS) 1+234
NORTH ROUTE
CENTER ROUTE
SOUTH ROUTE
ROUTE*
CONCEPTUAL CABLE ROUTE (DETAILED RE-ROUTING/MICRO-SITING WILL FOLLOW)*
DIGITIZED SHORE *
PILOT ROUTE CORRIDOR
CVOW-P HVDC CABLE
STATE / FEDERAL WATERS BOUNDARY *
SURVEY AREA LIMITS *
DAM NECK OCEAN DISPOSAL SITE *
VA BEACH EXPLOSIVES DUMPING GROUNDS
BOEM LEASE AREA *
SUB-MARINE CABLE *
D.O.D. BOUNDARY

BATHYMETRY LEGEND

MAJOR BATHYMETRY CONTOUR - MBES - @ 5m INTERVAL
MINOR BATHYMETRY CONTOUR - MBES - @ 1m INTERVAL
SLOPES EQUAL 5° OR GREATER

BATHYMETRIC COLOR SCALE KEY

-7.8 -10.0 -12.5 -15.0 -17.5 -20.0 -22.5 -25.0 -27.5 -29.0

OBSERVED SOUNDINGS HAVE BEEN REDUCED TO THE MLLW TIDAL DATUM.
THE BATHYMETRY CHART USES THE AVERAGE VALUES, GRID CELL SIZE 50cm BY 50cm. SUN ILLUMINATION FROM 45° AZIMUTH AND 45°ELEVATION WITH VERTICAL EXAGERRATION OF 1.0.

SURFACE FEATURES & SHALLOW STRUCTURES LEGEND

SEA BED CLASSIFICATION - CONSTRUCTION HASH
SEA BED FEATURE - SAND WAVES
SEA BED CLASSIFICATION - FINE SAND
SEA BED FEATURE - DEPRESSION LOCATION
SEA BED CLASSIFICATION - FINE TO MEDIUM SAND
SEA BED FEATURE - DEPRESSION AREA
SEA BED CLASSIFICATION - COARSE TO VERY COARSE SAND
SEA BED FEATURE - MEGARIPPLES
SEA BED CLASSIFICATION - GRAVELLY SAND
SEA BED FEATURE - RIPPLES
SEA BED CLASSIFICATION - MUD
SEA BED FEATURE - SCAR
SEA BED CLASSIFICATION - MUDDY SAND
CABLES (INTERPRETED POSITION)
SEA BED CLASSIFICATION - SANDY GRAVEL
G_C-34_A GRAB SAMPLE LOCATION - ALPINE 2020
SEA BED FEATURE - SAND BANK
G_C-34_A GRAB SAMPLE LOCATION - TETRA TECH 2013*
SIDE SCAN SONAR TARGET & ID
G_C-34_A GRAB SAMPLE LOCATION - TETRA TECH 2020*
MAGNETOMETER TARGET & ID
VC-005 VIBROCORE SAMPLE LOCATION - TETRA TECH 2013*
20CS_A22 2020 CPT AND/OR BOREHOLE SAMPLE LOCATION & ID* - GEOQUIP
21CS_A22 2021 CPT AND/OR BOREHOLE SAMPLE LOCATION & ID* - GEOQUIP

SIDE SCAN SONAR MOSAIC LEGEND

THE RESOLUTION OF THE CHARTED SIDE SCAN SONAR MOSAIC IS 1mpp. ONLY LOW FREQUENCY (APPROXIMATELY 233kHz) SIDE SCAN SONAR LINES ARE INCLUDED IN THE MOSAIC. ALL LINES WERE ACQUIRED USING A RANGE OF 50m.

HIGH LOW

GEOPHYSICAL PROFILE LEGEND

SEABED SURFACE
PALAEOCHANNEL
BASE UNIT 1
BASE UNIT 2
BASE UNIT 3
BASE UNIT 4
BASE QUATERNARY CHANNEL INFILL SEDIMENTS

20CS_A22
SEABED 0.000
SAND 4.320
GRAVEL 5.120
CLAY 7.420
(MPa) 0 20 40

* CPT LOCATION & ID w/ SEDIMENT TYPES, THICKNESS', & CPT TIP RESISTIVITY CURVE (2020 SAMPLES/2021 SAMPLES)

GENERAL NOTES:

1. THE SURVEY DATA DEPICTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED ON THE DATES LISTED BELOW AND CAN ONLY BE CONSIDERED TO INDICATE THE GENERAL CONDITIONS EXISTING AT THAT TIME.
2. ANY BACKGROUND IMAGERY USED IS FROM MICROSOFT CORP. EARTHSTAR GEOGRAPHICS SIO BING.
3. HORIZONTAL DATUM: UTM83-18 (m)
   VERTICAL DATUM: MLLW (m)

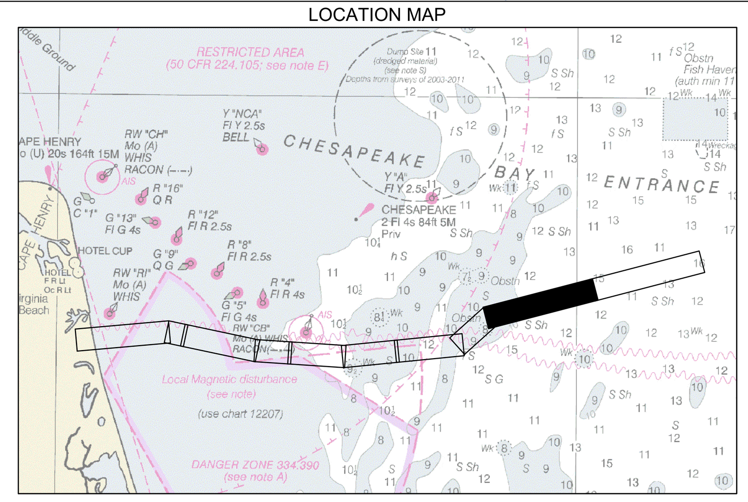
*INFORMATION PROVIDED BY CLIENT

LIST OF SURVEY EQUIPMENT

Item	RV Shearwater	RV Minerva Uno (2020 / 2021)
Positioning	Applanix POS MV OceanMaster CNAV 3050	Applanix POS MV OceanMaster CNAV 5000
SVP	AML Moving Vessel Profiler AML Plus SVP/CTD	AML Moving Vessel Profiler 350 AML Minos X
USBL	Sonardyne Scout Plus	Sonardyne Scout / Ranger
MBES	R2 Sonic 2024	R2 Sonic 2024
SSS	Edgetech 4200 (300–600kHz)	Edgetech 4200 (300–600kHz)
TVG	2 x Geometrics 882 Cesium Vapor	2 x Geometrics 882 Cesium Vapor
SBP	Innomar Medium SES 2000	Innomar Medium SES 2000
S-UHRS	AA301 Boomer Single-Channel 8 Element Hydrophone Streamer	AA301 / Geomarine Boomer Single-Channel 8 Element Hydrophone Streamer
Grab Sampler	N/A	Harmon Surficial Day Grab Sampler

Dominion Energy, Inc.
8th & Main Building, 707 East Main St
Richmond, VA 23219

LOCATION MAP



Coastal Virginia Offshore Wind Commercial (CVOW-C) Export Cable Route Corridor

CENTERLINE ALIGNMENT CHART

kp 34+772 to kp 44+472

HORIZONTAL SCALE 1:10,000 (1cm = 100m = 328.1ft)
0 100 200 400 800
0 1 2 4 8
VERTICAL SCALE 1:100 (1cm = 1m = 3.3ft)

GEODETIC INFORMATION

DATUM :	NAD83 (2011)
VERTICAL :	MLLW (m)
PROJECTION :	UTM83-18N

Drawing Name:	ALIGNMENT CENTERLINE-002	
Vessel:	Minerva Uno / Shearwater	
Approved By:	JB	
Interp. By:	KR	
Party Chief:	DW/TK	
Drawn By:	BE	
Revision:	3	18-Aug-2021
Issue Date:	08-Feb-2021	
Survey Date:	May - Nov 2020 & Jan - May 2021	
Chart Num :	5 of 6	

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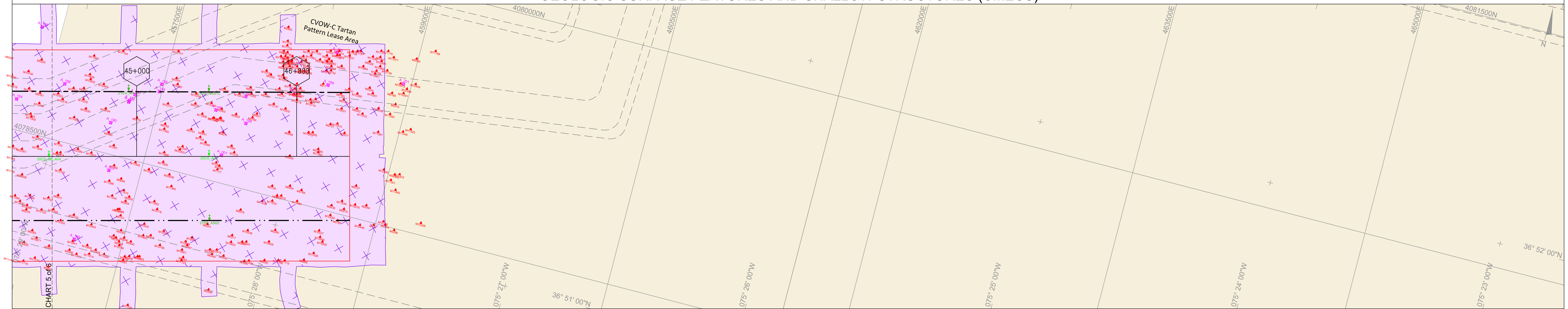

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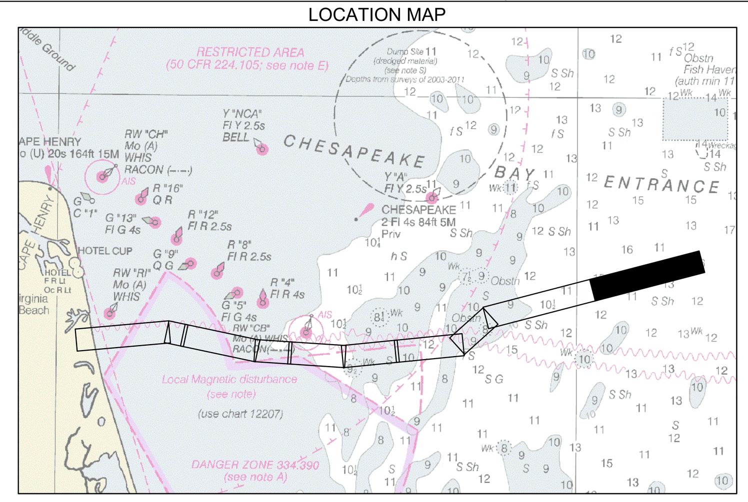

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Drawing Name:	ALIGNMENT CENTERLINE-002
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Approved By:	JB
Interp. By:	KR
Party Chief:	DW/TK
Drawn By:	BE
Revision:	3 18-Aug-2021
Issue Date:	08-Feb-2021
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