NATIONAL AERONAUTICS AND SPACE ADMINISTRATION WALLOPS FLIGHT FACILITY SHORELINE RESTORATION AND INFRASTRUCTURE PROTECTION PROGRAM: CULTURAL RESOURCE REMOTE SENSING SURVEY OF TWO PROPOSED OFFSHORE SAND BORROW LOCATIONS IN FEDERAL WATERS

Prepared for:

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ABSTRACT

This report presents results of a cultural resources remote sensing survey of two proposed sand borrow areas located off of Wallops Island, Virginia as part of the National Aeronautics and Space Administration (NASA) Shoreline Restoration and Infrastructure Protection Program (SRIPP). URS Group, Inc. (URS) conducted this work to assist WFF with compliance with Section 106 of the National Historic Preservation Act of 1966, as amended; with the Abandoned Shipwreck Act of 1987; and with the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 et seq.) of 1970. NASA is the lead agency preparing an Environmental Impact Statement under NEPA for their SRIPP at WFF; the U.S. Army Corps of Engineers and the Minerals Management Service are cooperating agencies on the EIS and other SRIPP-related compliance including Section 106 of the National Historic Preservation Act of 1966, as amended and the Abandoned Shipwreck Act of 1987. This investigation and report were completed in accordance with guidelines established in the Mineral Management Service (MMS) Notice to Lessees (NTL) 2005-G07, entitled *Archaeological Resource Surveys and Reports*, and with the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation* (Federal Register 48, No 190, 1983). MMS regulates activities on the portions of the Outer Continental Shelf that contain these proposed sand borrow areas. WFF and URS consulted with MMS staff during 2008 and 2009 to ensure that the requirements set forth in NTL 2005-G07 would apply to the current project.

The primary objective of this study was to identify maritime related cultural resources, particularly submerged watercraft, and buried prehistoric sites within the survey areas. Archival research and a remote sensing survey were used to accomplish these tasks. Research indicated a moderate potential to encounter submerged historic resources, and a relatively low potential to encounter buried prehistoric resources within the project area. Review of the National Oceanic and Atmospheric Administrations Automated Wreck and Obstruction System (AWOIS) and other pertinent sources suggests a total of 12 shipwrecks within a 13-mile (21 kilometer) radius of Wallops Island.

The survey array consisted of a Hemisphere Crescent R130 Digital Positioning System (DGPS), a Geometrics G882 marine cesium magnetometer, an ODEM Hydrotrac digital echo sounder, a Benthos Chirp 3 Sub Bottom Profiler and a 600 kHz Marine Sonics side scan sonar system. Survey control and data quality control were achieved with Hypack's *Hypack 2009a* ® survey software.

A total of five target groups were identified as representing modern debris. None of the five target clusters have the potential to represent significant submerged cultural resources. They are instead consistent with modern fishing and dumping activities. No further work is recommended for the five targets identified during this survey.

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1.0 INTRODUCTION

This report presents results of the cultural resources remote sensing survey of two proposed sand borrow areas located off of Wallops Island, in Accomack County, Virginia. URS Group, Inc. (URS) conducted this work on behalf of Wallops Flight Facility (WFF) to assist the National Aeronautics and Space administration's (NASA) Wallops Flight Facility (WFF) with compliance with Section 106 of the National Historic Preservation Act of 1966, as amended; with the Abandoned Shipwreck Act of 1987; and with the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 et seq.) of 1970. NASA is the lead agency preparing an Environmental Impact Statement under NEPA for their Shoreline Restoration and Infrastructure Protection Program (SRIPP) at WFF; the U.S. Army Corps of Engineers (USACE) and the Minerals Management Service (MMS) are cooperating agencies on the EIS and other SRIPP-related compliance including Section 106 of the National Historic Preservation Act of 1966, as amended and the Abandoned Shipwreck Act of 1987. The EIS analyzes potential impacts to human health and the environment from the SRIPP proposed action of borrowing sand from either of two offshore sand shoals (Unnamed Shoal A and Unnamed Shoal B) in order to replenish the eroded beach faces of WFF. This investigation was undertaken in consultation with MMS, and in accordance with guidelines established in MMS Notice to Lessee (NTL) 2005-G07, entitled *Archaeological Resource Surveys and Reports*, and the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation* (Federal Register 48, No 190, 1983). MMS regulates activities on the portions of the Outer Continental Shelf (OCS) that contain these proposed sand borrow areas. WFF and URS consulted with MMS staff during 2008 and 2009 to ensure that the requirements set forth in NTL 2005-G07 would apply to the current project.

The primary objective of this study was to identify maritime related cultural resources, particularly submerged watercraft, and buried prehistoric sites within the survey areas. Archival research and a remote sensing survey were used to accomplish these tasks. Research indicated a moderate potential to encounter submerged historic resources, and a relatively low potential to encounter buried prehistoric resources within the project area. Review of the National Oceanic and Atmospheric Administrations Automated Wreck and Obstruction System (AWOIS) and other pertinent sources suggests a total of 12 shipwrecks within a 21 kilometer (13 mile) radius of Wallops Island.

This investigation took place between March and September of 2009. Christopher Polglase, RPA served as project manager for this project. Jean B. Pelletier, RPA served as principal investigator and as senior remote sensing specialist and analyst. Anthony Randolph served as remote sensing specialist and analyst. Bridget Johnson conducted archival research and produced graphics for the report.

Survey operations were conducted from the 14 meter (46 foot) research vessel, Venture III, chartered from Captains Paul and Ruth Hepler of Belmont, New Jersey. The survey array consisted of a Hemisphere Crescent R130 Digital Positioning System (DGPS), a Geometrics G882 marine cesium magnetometer, an ODEM Hydrotrac digital echo sounder, and a 600 kHz Marine Sonics side scan sonar system. Survey control and data quality control were achieved with Hypack's *Hypack 2009a* ® survey software.

This report is divided into seven sections, including this introduction. Section Two is a review of previous archaeological and architectural sites and contains surveys within 1.6 kilometers (1 mile) of the project area, followed by a discussion of known shipwrecks within 21 kilometers (13 miles) of the project area. Section Three contains the prehistoric and historic cultural contexts, which are used to evaluate the potential for encountering submerged prehistoric and historic cultural resources within the project area. Section Four contains the environmental setting of the region. Section Five presents the research methods and repositories used during background investigations, survey methods, and the expected results of the survey. Section Six contains the results of the remote sensing survey. Section Seven presents the summary and recommendations for targets identified in Section Six. Section Eight contains the List of References Cited. Report figures and plates are included as an addendum. Appendix A contains a table of side scan sonar images and Appendix B contains the Qualifications of Investigators.

2.0 PREVIOUS INVESTIGATIONS

2.1 ARCHAEOLOGICAL INVESTIGATIONS

A review of previously investigated sites provides a context used to assess the potential to encounter archaeological materials within the project area. A total of seven archaeological surveys were conducted within 1.6 kilometers (1 mile) of the beach area where sand is to be deposited (Table 2-1). These surveys identified a total of 10 archaeological sites within this radius (Table 2-2). Site 44AC558 was identified by the Eastern Shore Archaeological Society, but no formal report has been filed.

Table 2-1. Archaeological Surveys within 1.6 kilometers (1 mile) of the Beach Area

Sites Identified	Company Name	Report Date
None	Mark Wittkofski (Wittkofski 1980)	1980
None	Greenhorn & O'Mara, Inc (Dinnell and Collier 1990)	1990
None	Telemarc, Inc (Otter 1991)	1991
None	3D/Environmental Services Inc. (Miller 1991)	1991
None	Louis Berger Group, Inc (Ahlman and LaBudde 2001)	2001
44AC9, 44AC89	Darrin Lowery (Lowery 2000, 2003)	2000, 2003
44AC159, 44AC459	URS Corporation (Myers 2003)	2003

Mark Wittkofski conducted a Phase I reconnaissance for a proposed parking lot on Wallops Island for the US Navy in 1980. He determined that the area had a low potential to contain archaeological resources as it had been disturbed and graded with modern fill (Wittkofski 1980). Wittkofski conducted a comprehensive survey of Accomack and Northampton Counties throughout the 1980s. This survey identified 281 previously unrecorded archaeological sites, none of which are within the beach area.

Greenhorne & O’Mara, Inc. (Dinnell and Collier 1990) conducted a study of the southwestern portion of the Main Base for the Wallops Naval Facilities Engineering Command. They identified one site, but it was outside the 1.6 kilometer (1 mile) radius of the current beach area in which sand will be deposited.

Telmarc, Inc (Otter 1991) conducted a Phase I archaeological survey adjacent to the WFF in 1991. This study was conducted as part of a property acquisition west of a runway. No cultural resources were identified.

3D/Environmental Services, Inc. (Miller 1991) completed a cultural resources inventory which included an evaluation of archaeological and architectural resources of the WFF in 1991. The study was designed to produce a predictive model and sensitivity assessment for archaeological resources, as well as acting as a planning document for future evaluations at WFF.

Louis Berger Group, Inc. (Ahlman and LaBudde 2001) conducted an archaeological survey for the proposed Route 709 bridge replacement located northwest of the island. They identified three archaeological sites. These sites are all located beyond the 1.6 kilometers (1 mile) radius of the proposed sand deposit area.

Darrin Lowery (2000, 2003) conducted an archaeological survey of the Chesapeake and Atlantic shorelines associated with Accomack and Northampton Counties of Virginia. His findings were presented in two volumes designed to assess the impact of natural and human activities to archaeological sites along the shore. He documented numerous previously identified sites, both historic and prehistoric in nature, as well as documenting several new sites. His report identified seven sites (44AC9, 44AC77, 44AC78, 44AC79, 44AC80, 44AC81, 44AC89) within a 1.6 kilometer (1 mile) radius of the project area. Site 44AC9 represents an Archaic shell midden that is limited to the plowzone and includes a few prehistoric ceramics sherds. Sites 44AC78, 44AC79, 44AC80, and 44AC81 all represent shell middens from an undetermined prehistoric period. Site 44AC77 was a historic artifact scatter consisting primarily of ceramics which date to the second and third quarters of the 19th century. Site 44AC89 consists of a possible Revolutionary War earthwork located on Wallops Island.

URS conducted a cultural resources assessment of WFF in 2003 (Meyers 2003). The goal of this study was to further assess archaeological and architectural potential. Two archaeological sites, 44AC159 and 44AC459 were encountered within the 1.6 kilometer (1 mile) radius of the current project area. Site 44AC159 is located on Wallops Island and consists of a clam and oyster shell midden approximately 3 feet in height. Site 44AC459 was a late 19th to early 20th century structure associated with the US Coast Guard. A total of 291 artifacts were recovered from this site including nails, brick, glass, ceramic, and shell.

Table 2-2. Archaeological Sites within 1.6 kilometers (1 mile) of the Beach Area

Site Number	Site Type	Cultural Period
44AC9	Shell Midden	Archaic
44AC77	Historic Artifact Scatter	Late 19th century
44AC78	Shell Midden	Undetermined Prehistoric
44AC79	Shell Midden	Undetermined Prehistoric
44AC80	Shell Midden	Undetermined Prehistoric
44AC81	Shell Midden	Undetermined Prehistoric
44AC89	Military Earthworks	Revolutionary War
44AC159	Shell Midden	Unknown
44AC459	Historic Coast Guard Site	Late 19th-20th century
44AC558	Artifact Scatter	Undetermined Prehistoric

2.2 ARCHITECTURAL INVESTIGATIONS

Two previously identified historic properties are located within a 1.6 kilometer (1 mile) radius of the project area (Table 2-3). Within the Wallops Flight Facility itself are two historic properties that were found to be eligible for listing in the NRHP in the 2004 *Historic Resources Survey and Eligibility Report for Wallops Flight Facility, Accomack County, Virginia* (URS/EG&G 2004): the Wallops Exchange and Morale Association (WEMA) Recreational Facility/U.S. Coast Guard (USCG) Lifesaving Station (V-065, VDHR# 001-0027-0100), and the Observation Tower (V-070, VDHR#001-0027-0101). In a letter dated November 4, 2004, VDHR concurred with NASA's determination of eligibility for these two properties.

Table 2-3. Architectural Sites within a 1.6 kilometer (1 mile) of the Project Area

DHR ID #	Name	National Register Eligible
001-0027-0100	U.S. Coast Guard Lifesaving Station	Yes
001-0027-0101	Observation Tower	Yes

2.3 KNOWN SHIPWRECKS IN THE WALLOPS ISLAND AREA

Twelve shipwrecks have been recorded in the vicinity of Wallops Island, extending 20.9 kilometers (13 miles) off shore (Table 2-4). These wrecks were identified primarily using NOAA's Automated Wreck and Obstruction Information System (AWOIS), and Bruce Berman's *Encyclopedia of American Shipwrecks* (1972).

The proximity of Wallops Island to the Chincoteague Inlet, which serves as the entrance to Chincoteague Bay, resulted in extensive commercial and recreational vessel traffic along the Wallops Island coastline en route to Chincoteague and other barrier islands. Reported craft losses in the vicinity of Wallops Island are consistent with vessel classes commonly operated within the Chesapeake region. All craft were lost during the 20th century. A total of four wrecks were sailing schooners and three were barges. A single tug boat and fishing trawler were also lost, along with three unidentified vessels.

Table 2-4. Vessels Sunk within 20.9 kilometers (13 miles) of Wallops Island

Vessel Name	Vessel Type	Date of Loss	Date Built	Tonnage	Cause of Loss	Location
E.R. Smith	Unknown	1/25/1943	Unknown	Unknown	Sunk	Lat: 37.8167 Long: 75.3663
Florence and Lillian	Schooner	9/19/1921	1874	252	Foundered	SW of Chincoteague Lighthouse
Jennie N Huddell	Schooner	2/4/1910	1870	279	Stranded	Carter's Shoal, Chincoteague
Lizzie Godfrey	Schooner	7/12/1914	1890	77	Stranded	Chincoteague Inlet
Nancy Jane	Fishing Trawler	3/2/1968	Unknown	Unknown	Sunk, broken up	Lat: 37.8667 Long: 75.4163
P. J Hooper	Tug	3/26/1971	Unknown	Unknown	Unknown	Lat: 37.8367 Long: 75.3399
Ruhama Shaw	Barge	12/8/1917	1915	473	Foundered	Blackfish Bank, VA.
Ruth	Barge	12/9/1917	1908	435	Foundered	Blackfish Bank, VA.
Steel Barge No. 2	Barge	1/23/1935	1889	2217	Foundered	Blackfish Bank Buoy, VA.
Unknown	Sailing	Unknown	Unknown	Unknown	Unknown	Lat: 37.8646 Long: 75.4005
Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Lat: 37.8001 Long: 75.2463
Wm. Meekins	Schooner	12/22/1918	1874	79	Stranded	Chincoteague, VA.
Source: AWOIS, Berman 1972						

3.0 CULTURAL CONTEXT

The Virginia Department of Historic Resources (VDHR) has developed a chronological framework for the prehistory and history of the Commonwealth. This framework provides the basis for understanding prehistoric and historic cultural development in the area, as well as providing a context for predicting the types and kinds of archaeological sites expected in the project area. Included in this background section are Prehistoric Context and Historic Contexts.

3.1 PREHISTORIC CONTEXT

VDHR has defined three major periods of prehistory. These are the Paleoindian Period (10,000 – 8000 BC), the Archaic Period (8000 – 1000 BC), and the Woodland Period (1000 BC – AD 1600). Table 3-1 summarizes the chronology of these periods. The Archaic and Woodland Periods are further subdivided into Early, Middle, and Late Periods, which are characterized by changes in material culture (e.g., projectile point styles), environmental adaptation, subsistence strategies (e.g., hunting and gathering, fishing, and horticulture), settlement patterns, technology, and socio-political configurations. Each major time period is discussed below, along with relevant data concerning settlement and subsistence patterns established by excavations and study of archaeological sites in the Coastal Plain.

Table 3-1. Prehistoric Culture Chronology

Culture Period	Sub-Period	Date Ranges
Paleoindian	n/a	10,000 – 8000 BC
Archaic	Early	8000 – 6500 BC
	Middle	6500 – 3000 BC
	Late	3000 – 1000 BC
Woodland	Early	1000 BC – AD 300
	Middle	AD 300 – AD 1000
	Late	AD 1000 – AD 1600
Contact	n/a	ca. AD 1600

3.1.1 Paleoindian Period (10,000 – 8000 BC)

The region was first inhabited approximately 12,000 years ago with an influx of people who practiced a hunting and foraging lifestyle. Although there is evidence of human occupation in western North America and South America before 10,000 – 12,000 BC, there is no conclusive evidence in the Middle Atlantic region for human occupation before the Paleoindian Period. There is a great deal of debate over the issue of a “pre-Clovis” culture in the Americas that predates the traditional “Clovis” culture of the Paleoindian Period. Archaeological sites such as Cactus Hill in Virginia (e.g., McAvoy and McAvoy 1997), Meadowcroft Rockshelter in southwestern Pennsylvania (e.g., Adovasio et al. 1978), and the Topper Site in South Carolina (e.g., Parfit 2000; Rose 1999) have provided tantalizing but inconclusive evidence for human occupations predating the Paleoindian Period. There is currently no evidence for pre-Paleoindian occupations on the Delmarva Peninsula although shifts in survey strategies in recent decades (e.g. Lowery 2001, 2003) have resulted in new discoveries that may change the focus of research in this area. There are also extensive aeolian soils on the coastal plain that may cover more ancient fluvial sediments (Foss et al. 1978). Some of the depositional contexts may eventually reveal buried Paleoindian or pre-Paleo occupations. The discussion below focuses on the widely accepted definition of the Paleoindian culture in the Middle Atlantic region.

The end of the Pleistocene epoch (ca. 12,000 – 10,000 years ago) represents the terminus of the Ice Age or at least the beginning of a long interglacial episode. The environment during this time was quite different from modern conditions. Moisture locked in glacial ice sheets resulted in lower sea levels and greater exposure of coastal lands. Areas exposed during this time were subsequently inundated by the global sea level rise that began at the end of Pleistocene, when climatic amelioration resulted in melting continental ice sheets. During this period of post-glacial warming, the climate was probably three to eight degrees Celsius colder than at present, and the vegetation consisted of an open spruce parkland forest composed of spruce, pine, fir and alder (Brush 1986:149; Owens et al. 1974; Sirkin et al. 1977).

The Paleoindian toolkit included fluted projectile points, which were typically manufactured from high-quality lithic materials chosen for their predictable and consistent flaking properties. Projectile point types include Clovis, Cumberland/Barnes, Crowfield, Hardaway-Dalton, and Hardaway Side-Notched (Dent 1995; Lowery 2001, 2003). Other tools in the Paleoindian toolkit include endscrapers, sidescrapers, gravers, burins, denticulates, knives, *pieces esquillées*, wedges, perforators, and generalized unifaces and bifaces (Dent 1995).

Preferred lithic materials for these projectile points were high-quality cryptocrystalline rock such as jasper and chert (Brown 1979; McCary 1984), though tools made from locally available quartz and quartzite cobbles have been documented at sites in the Middle Atlantic region (e.g., Ebright 1992; McAvoy and McAvoy 1997). Archaeologists have postulated that Paleoindian hunter-gatherers traveled long distances to obtain raw materials for tool production (e.g., Custer 1984a; Gardner 1977). Recent research, however, has documented the availability of high-quality cherts and jasper cobbles in the Coastal Plain (e.g., Lowery 2001, 2003), suggesting that Paleoindians did not necessarily travel long distances to obtain lithic raw materials.

Paleoindian Period settlements consisted of seasonally-occupied camps, from which forays were made to obtain specialized resources, such as stone for tool manufacture (Custer 1984a; Dent 1995; Gardner 1977). Site types postulated for the Paleoindian Period include base camps, quarry sites, quarry reduction stations, quarry-related base camps, base camp maintenance stations, outlying hunting stations, and isolated projectile point finds (Custer 1989; Gardner 1989). These site types are considered part of the "seasonal round" of Paleoindian settlement patterning.

The isolated point find is the most common of these manifestations and the distribution of such finds on the Delmarva Peninsula shows a concentration on the Mid-peninsular drainage divide where bay-basin features represent Pleistocene surface water sources (Custer 1989:29). This is not to say that other areas were not frequented; perhaps it simply reflects the availability of more exposed acreage for occupation in the Middle of the peninsula. These sites are in headwater areas where streams flow to the bay and the ocean. Davidson (1981) also notes the use of interior drainages during this period; a trend that continues though the Middle Archaic. A single fluted point site is recorded in Virginia on the lower Delmarva Peninsula, (Custer 1989:93), but this find is not noted in McCary's (1984) fluted point survey.

Custer (1984a, 1989) classifies upper Delmarva Paleoindian sites within the Delaware Chalcedony Complex, which focuses on outcrops of high quality cryptocrystalline lithic raw materials, specifically Delaware chalcedony. Settlement patterns focused on these high quality lithic resources and on environmental resource gathering zones such as upland or interior swamps, headwater zones and similar early Holocene environmental settings.

Paleoindian subsistence patterns are difficult to discuss for the Middle Atlantic region due to the paucity of recovered faunal and floral remains. Paleoindians in the western United States are considered to be "big game" hunters of extinct Pleistocene megafauna such as the mammoth, caribou, musk ox, and giant beaver. There is no concrete evidence for a similar subsistence pattern in the Middle Atlantic region, though megafaunal remains have been recorded in the area (Custer 1989; Dent 1995; Edwards and Merrill 1977; Lowery 2001, 2003). Paleoindians in this area likely subsisted on mammals such as white-tailed deer, caribou and moose, along with smaller mammals. While Paleoindian subsistence probably focused on hunted game, there is evidence to suggest that plant foods and fish were also important food resources (Dent 1995; McNett l985). It should also be noted that a rich array of megafauna (e.g., mammoth, mastodon, walrus, and ground sloth) recovered from the continental shelf of the east coast may represent some of the key species that were hunted at the end of the Pleistocene (Edwards and Merrill 1977). One of the mammoth finds, for example, comes from the outer edge of the coastal plain in the lower Delmarva Peninsula area of Virginia (Edwards and Merrill 1977:11).

Paleoindian sites are not widely known in the Virginia Coastal Plain. Much of what archaeologists know about Paleoindians comes from isolated finds of fluted projectile points. Few intact Paleoindian sites have been identified in the region (Dent 1995; Lowery 2001, 2003), however, dozens of isolated fluted point finds have been documented on the Delmarva Peninsula (e.g., Custer 1989; Dent 1995). The Paw Paw Cove site, located in the northern Chesapeake Bay area in Maryland, is currently the only excavated Paleoindian site on the Delmarva Peninsula (Dent 1995; Lowery 2001, 2003). One theory explaining the lack of documented Paleoindian sites is that they are located on the Continental Shelf of the Atlantic Ocean in areas that would have been dry land during the Paleoindian Period (e.g., Dent 1995; Lowery 2001, 2003).

3.1.2 Archaic Period (8000 – 1000 BC)

The Archaic Period dates to ca. 10,000 to 3,000 years ago, and is conventionally sub-divided into the Early (8000 – 6500 BC), Middle (6500 – 3000 BC), and Late (3000 – 1000 BC) Sub-Periods. In the Middle Atlantic area, Archaic sites are much more numerous, larger, and richer in artifacts than earlier Paleoindian sites. They represent a series of adaptations that engendered an increasingly sedentary existence, and focused on resources available along large rivers and major tributaries. Other, often smaller sites of this period located away from the main streams probably represent seasonal or other specialized activities. Increasing territoriality and regional diversity are reflected in numerous artifact varieties, especially projectile points, throughout the Archaic Period. Evidence from Paleoindian and Early Archaic sites suggests that the transition from the Paleoindian way of life was a gradual transition (Custer 1990).

This transition was associated with a major climatic change that marks the end of the Pleistocene and beginning of the Holocene. The cool and moist climate of the late Ice Age shifted to a warmer and drier climate that approximates that of today. Rising sea levels inundated the lower Susquehanna River Valley and began forming the Chesapeake Bay estuary and its large salt and brackish water marshes, habitats that provided a rich and diverse subsistence base (Kraft 1976). As temperatures increased during the early Holocene, vegetation in the region shifted from coniferous forests of spruce to mixed deciduous/coniferous forests of hemlock, birch, hickory, and oak (Brush 1986:149; Custer 1990:10; Owens et al. 1974; Sirkin et al. 1977). The spread of deciduous woodlands into upland areas after 7000 BC opened up new habitats to be exploited by animals and humans (Custer 1990).

3.1.3 Early Archaic Period (8000 – 6500 BC)

Environmental conditions during the Early Archaic Period were not drastically different from the Paleoindian Period. Glacial recession continued and deciduous forests expanded, possibly leading to a proliferation of temperate fauna. The most distinctive cultural characteristic of the Early Archaic was the appearance of notched projectile points, most notably the Palmer and Kirk varieties. There was a continuation of the Paleoindian tradition of using high quality cryptocrystalline lithic materials until the end of the Early Archaic Period, when lower quality quartz and quartzite materials were more frequently used. Archaeological investigations in the Patuxent River drainage showed that the majority of Kirk points found were made of rhyolite. This indicates that by the Kirk phase, people traveled long distances in order to obtain preferred lithic raw materials, or that by this time long-range trade networks had been established (Steponaitis 1980:68). Although rhyolite is certainly exploited as a lithic raw material by this time, it still does not represent the intensive use evident during the Late Archaic.

There was significant innovation in stone tool kits during the Early Archaic Period. Stemmed and side-notched serrated projectile points replaced fluted projectile point varieties. The variety of projectile points associated with these periods indicates possible changes in subsistence strategies and exchange networks, and a possible regionalization of cultural traditions. Projectile point styles characteristic of the period include: corner-notched, serrated point styles such as Kirk, Palmer, Charleston, Lost Lake, Decatur, Amos, Kessel, and Fort Nottoway/Thebes; and stemmed points such as the Kirk stemmed and Pequea types (Custer 1984a, 1989, 1996; Dent 1995; Lowery 2001, 2003). Other tool types characteristic of Early Archaic Period assemblages include grinding slabs, milling stones, nutting stones, chipped stone adzes, wedges, perforators, knives, and scrapers, as well as unifacial and bifacial tools (Dent 1995; Lowery 2001, 2003).

Early Archaic Period inhabitants continued to show a preference for high-quality lithic materials, either transported into the area through trade or travel, or obtained from cobble sources in river and stream beds. Some researchers (e.g., Lowery 2001, 2003) have noted that Early Archaic people appear to have a preference for non-local cherts, chalcedonies, and jaspers, and have also noted the increased use of rhyolite for tools during this period (e.g., Custer 1984a; Dent 1995; Lowery 2001, 2003).

Both Gardner (1974) and Custer (1980) have hypothesized that Early Archaic Period peoples banded together into macro-base camps, or groups of families, in the spring and summer, and dispersed into smaller micro-base camps in the fall and winter months. Larger base camps were located in the valley floodplains while the smaller autumn and winter encampments were located in upland regions.

There is little faunal evidence from archaeological sites dating to the Early Archaic period, though "it is assumed that this environment supported bear, deer, elk, and a variety of small game adapted to a northern climate" (Kavanagh 1982:9). One exception is the Cactus Hill site (44SX202) which contains the remains of species that are still common in the region today (Whyte 1995). Floral evidence from sites such as the Crane Point site, in Talbot County, Maryland, includes hickory nut, butternut, acorn, amaranth, and chenopodium (Lowery 2001, 2003). Other sites in the Chesapeake Bay region have produced similar results (Dent 1995). The floral remains recovered from Early Archaic contexts indicate that a variety of plants were used for food. Stone artifacts such as grinding slabs, milling stones, and nutting stones are also indicative of increased reliance on plant foods, while adzes indicate increased manufacture of items from wood (e.g., shelter). The changes in tool types have been interpreted as a shift in subsistence strategies towards a broad-spectrum adaptation, utilizing a variety of species of animals and plants, rather than focusing primarily on large animals.

Numerous Early Archaic Period sites are located throughout the Delmarva Peninsula (Custer 1989; Dent 1995), mostly from surface finds in estuarine and shore locations. Early Archaic Period base camps on the Eastern Shore may have been located on floodplains or river terraces that have since become submerged by sea level rise. Smaller procurement or temporary camps may be located on the high terrace areas (elevations above 25 feet amsl), though none have been recorded in Accomack County. The same terraces that produced fluted points have also produced numerous finds of Early Archaic points, recovered by artifact collectors who search shoreline surfaces at low tide. These submerged manifestations represent significant clusters of Early Holocene sites. Nearby upland areas may also contain a variety of procurement sites and lithic scatters.

3.1.4 Middle Archaic Period (6500 – 3000 BC)

The beginning of the Middle Archaic Period coincides with the on-set of the Atlantic climatic episode, which was a warm, humid period with a gradual rise in sea level that led to the development of inland swamps. It was a period marked by an increase in summer drought, sea level rise, grassland expansion into the Eastern Woodlands, and the appearance of new plant species (Carbone 1976:106; Hantman 1990:138). Human settlements consisted of small base camps located in or near inland swamps that were convenient to access seasonally available subsistence resources as well as small, temporary upland hunting sites. This adaptation, along with the use of a greater variety of plant resources, allowed for an increase in general foraging (Kavanagh 1982:50).

The Middle Archaic Period is characterized by a variety of projectile point styles, including bifurcated styles (e.g., St. Albans, LeCroy, and Kanawha) that were introduced at the end of the Early Archaic Period (Dent 1995). Other projectile point styles used during the Middle Archaic Period include Stanly Stemmed, Neville, Morrow Mountain I and II, Halifax, and Guilford types (Dent 1995; Lowery 2001, 2003). Morrow Mountain and Neville points are more rarely found in Virginia. The former are found principally in the Southeast whereas Neville points are a typical Northeast type. Brewerton and Otter Creek styles were introduced during the latter part of the Middle Archaic Period, and persist into the early Late Archaic Period. Other artifact types characteristic of the Middle Archaic Period include groundstone tools (e.g., adzes and gouges), as well as scrapers, perforators, spokeshaves, and expediently-made flake tools for a variety of functions (Dent 1995; Lowery 2001, 2003). Rhyolite became more commonly used for making tools, though other local resources such as quartz and quartzite were utilized as well. The tendency towards greater reliance on local lithic sources led to a marked increase in numbers of informal flake tools for short-term use.

Middle Archaic Period sites have been documented on the Delmarva Peninsula, and include isolated point finds as well as sites with buried components (Dent 1995; Lowery 2001, 2003). Community pattern and settlement data are somewhat limited due to the scarcity of Middle Archaic Period sites with good, interpretable depositional contexts. Surface sites are, however, located in a variety of settings including uplands, river terraces, and wetland areas. Middle Archaic Period sites on the Delmarva Peninsula have been documented along Carolina Bay features, spring-fed interior wetlands, upland terraces, and confluences of freshwater streams (Lowery 2001, 2003). Subsistence patterns appear to be very similar to the preceding Early Archaic Period, based on the limited data that are available (Dent 1995; Lowery 2001, 2003). Middle Archaic points in nearby areas of Maryland have been found on sites (e.g., 18SO75 and 18SO105) along Kings Creek and the Manokin River. Like earlier Holocene manifestations, most of sites are known through isolated point finds on river terraces and along eroding shorelines.

3.1.5 Late Archaic Period (3,000 – 1000 BC)

Modern vegetation had become established in the region by approximately 3,000 BC, and the climate was punctuated by alternating periods of dry and moist conditions (Brush 1986:150). The Late Archaic Period is characterized by a warmer and drier climate than today, with the development of xeric forests (e.g., oak and hickory) and open grasslands (Carbone 1976; Custer 1984b). Sea level continued to rise, but was relatively stable by the end of the Late Archaic Period (Dent 1995; Lowery 2001, 2003). The warmer and drier climate appears to have stabilized stream valleys and estuaries in the region, making such localities more attractive for settlement. These settings developed into rich habitats with a great diversity of exploitable resources, particularly shellfish and anadromous fish (Davidson 1981; Hughes 1980). This is reflected in the changes manifested in Late Archaic tool kits as well as in the number of site types and site locations utilized. For example, settlement data from the lower Eastern Shore show increased use of riverine and estuarine settings, and there is a concomitant use of ephemeral settings as well, including headwaters, and low and high order stream areas (Davidson 1981, Hughes 1980).

The Late Archaic Period is characterized by a large variety of projectile point styles, including Otter Creek, Vosburg, and Brewerton, Lackawaxen, Bare Island, Halifax Side-Notched, Vernon, Clagett, Piscataway (a type that persists into the Woodland Period), and Holmes (Dent 1995). The initial sequence for the Late Archaic was developed by Stephenson and Ferguson (1963) and referred to Piscataway, Otter Creek, Vernon, and Brewerton projectile point styles. Otter Creek points have been recovered from Middle and Late Archaic contexts including an Otter Creek component identified at the Higgins site (Ebright 1989). Other Otter Creek sites in the Middle Atlantic region and the Northeast in general are described by Steponaitis (1980) and Funk (1965).

Projectile point styles characteristic of the end of the Late Archaic (sometimes referred to as the Terminal Archaic Period) include “broadspears” such as the Savannah River, Susquehanna Broadspear, Koens-Crispin, Lehigh, and Perkiomen types (Dent 1995). Other projectile point types found during the Terminal Archaic that persist into the Early Woodland Period include the

Orient Fishtail and Dry Brook types. The Fishtail phase marks the end of the Archaic period and the beginning of the Early Woodland.

Besides the established formal projectile point styles, there appears to have been an increase in the production of informal tools made out of flakes (Klein and Klatka 1991:98). Other artifacts characteristic of the period include steatite (soapstone) bowls, groundstone tools (axes, adzes, celts, gouges), perforators and drills fashioned from broken projectile points, and scrapers (Dent 1995). Rhyolite was established during this period as a preferred lithic raw material for tool manufacturing. It was during the Terminal Archaic as well as the succeeding Early Woodland Period that large amounts of rhyolite were transported from sources in the Blue Ridge to the Coastal Plain. The network that facilitated trade in rhyolite is not well understood (Kavanagh 1982:99).

Surface collections in the Delmarva region show greater use of locally available lithic raw materials (e.g., quartz and quartzite) during the Late Archaic. Broadspears recovered from eastern shore sites, especially the Susquehanna broadspears, are almost exclusively made from South Mountain (Blue Ridge) rhyolite. In the lower eastern shore of Maryland, these have been recovered, along with bannerstones and gorgets, from sites (e.g., site 18WO32) along the Pocomoke River.

The Late Archaic was characterized in the eastern United States by evidence of population growth, patterns of regional differentiation, and increased technological specialization. Trade networks appear to have been established for the exchange of raw materials and finished goods. The first large, semi-sedentary (i.e., occupied for several months or seasons) base camps were established along rivers and streams, and along estuaries on the Delmarva Peninsula. Surface site data show increases in site size, which may simply represent multiple, repeated occupations rather than single, large group manifestations. Site types postulated for the area include base camps, temporary camps, and resource procurement stations (Dent 1995).

Subsistence was still largely based upon gathering and hunting, although there was an increased reliance on riverine resources toward the end of the period (Steponaitis 1980). Seasonal hunting and foraging continued, but exploitation of riverine resources rapidly became an important part of the subsistence base. This continues the earlier trend toward a broad spectrum adaptation in which a variety of resources were exploited in many different environmental settings. The result has been the identification of Late Archaic sites in just about every habitable setting in the region. This broad spectrum adaptation is another way of characterizing what Caldwell (1958) originally called *primary forest efficiency* in the Archaic of the Eastern Woodlands.

A number of indicators point to an intensification of certain subsistence strategies ca. 2000 BC, which represents a major change in lifeways. This intensification has been explained as a consequence of gradual change (Caldwell 1958) and as episodic change relating to a shift in the composition of the environment (Carbone 1976). Structures such as fish weirs, used to exploit anadromous fish runs, were constructed during this period, and reflect the intensive riverine focus of the latter part of this period. While riverine resources were certainly important, interior and upland areas continued to be utilized by Late Archaic peoples. Late Archaic subsistence economies may be described as diffuse, considering the use of upland areas for a broad range of resource procurement activities gathering foods such as acorns, hickory nuts, and butternuts as well as large and small game (Cleland 1976). Subterranean storage pits and steatite containers appear in the archaeological record by 1500 BC. These technological developments led to food surpluses and the subsequent preservation of these surpluses over an extended period. The appearance of large numbers of implements, useful in processing seed and fiber products, is further evidence of this emerging economic pattern.

3.1.6 Woodland Period (1000 BC – AD 1600)

The Woodland Period dates from 1000 BC – AD 1600, and is conventionally divided into the Early (1000 BC – AD 300), Middle (AD 300 – 1000), and Late (AD 1000 – 1600) sub-periods based on changes in ceramic types, lithic technologies, subsistence patterns, and social development. The climate during the Woodland Period is characterized by a return to cool, moist conditions and establishment of vegetation that is characteristic of the region today. The Woodland Period is marked by the introduction of ceramics, significant population growth, and an increasingly sedentary way of life. Hunting and gathering of wild floral and faunal resources remained important, but incipient horticulture, based on maize cultivation, eventually formed an important part of the subsistence base.

3.1.6.1 Early Woodland Period (1,000 BC – AD 300)

It was previously thought that the transition between the Late Archaic and Early Woodland Period represented the introduction of horticulture (e.g., Fritz 1993; Smith 1992, 1995). Although Early Woodland groups in the South and Midwest used cultivated plants, there is presently no evidence that cultivated foods played a role in the diet of Early Woodland people in the Chesapeake Bay area. Efficient hunting and gathering systems stemming from several millennia of development (e.g., Caldwell 1958), including the exploitation of riverine and marine species, apparently slowed the acceptance of viable cultigens. Cultivated foods begin to assume an important role after 800 to 900 AD, when varieties of tropical cultigens arrived in the Middle Atlantic area (Smith 1995). These complemented cultigens of the eastern agricultural complex (e.g. sunflower, goosefoot, sumpweed, little barley) that had been developing for centuries.

The introduction of pottery around 1,000 BC marks the beginning of the Woodland Period. Potters' innovations, as reflected in ceramic types, have become a significant basis for dating Woodland Period archaeological site components. The earliest ceramic types from the Eastern Shore are the steatite-tempered Marcey Creek ware and the crushed rock-tempered Dames Quarter ware. Both of these wares were later replaced by the sand or crushed quartz-tempered Accokeek wares, Wolfe Neck wares, and the grog-tempered (crushed clay) Coulbourn wares (Custer 1983, 1989; Dent 1995; Egloff and Potter 1982; Mouer 1991; Stephenson et al. 1963).

Stone artifacts characteristic of the Early Woodland Period include Calvert, Rossville, Potts, and Piscataway types, some of which are also found in Late Archaic contexts (Dent 1995; Lowery 2001, 2003; Hranicky 1991, 1993, 1994; Hranicky and Painter 1989). Other artifact types include drills, perforators, flake tools, scrapers, bifaces, anvil stones, net sinkers, mortars, pestles, manos, metates, groundstone tools (axes, adzes, celts), ground slate, gorgets, and tools made from animal bone and teeth (Dent 1995).

The Early Woodland Period is marked by an intensification of burial ceremonialism. Influences from the Ohio River Valley include the Adena culture, which is represented on a few key sites in the Middle Atlantic region during the Early Woodland Period. Artifacts associated with the Adena culture include Cresap stemmed points, large bifaces, blocked-end tubular pipes, effigy pipes, copper beads and other copper artifacts, gorgets, pendants, bird stones, bar stones, ground slate objects, and red ochre (Dent 1995; Lowery 2001, 2003). Although these artifacts are most typically found associated with cremation burials, Adena artifacts have been recovered from habitation sites in the region (Dent 1995; Lowery 2001, 2003). Evidence for Adena influence in the region has also been documented as surface finds of trade items (e.g., Adena blocked-end tubular pipes) along major streams and occasional finds of Adena projectile points (e.g., site 18WO144). The Nassawango site near Salisbury (Wise 1974) contained more substantial evidence of an Adena presence on the Coastal Plain in Maryland. Mortuary data have also come from Adena sites in nearby Delaware, such as Killens Pond (7K-E-3), Saint Jones (7K-D-1), and the Frederica site (7K-F-2) (Custer 1984a:121-2). On the western shore of Chesapeake Bay, a cremation site (West River Site) from which Adena artifacts were recovered is one of the few buried features dating to this time period in the region (Ford 1976).

Early Woodland settlement patterns were still predominantly riverine, with sites most often identified at the junction of freshwater and brackish water streams. Early Woodland sites are generally larger than those of previous times, and there seems to have been an increasing reliance on riverine and estuarine resource areas. The smaller camps were established seasonally in areas where ripening resources or concentrations of game could be found. Gardner (1982:60) notes that the settlement-subsistence system of this period was focused primarily on a series of base camps where people gathered together to exploit seasonally available resources. These base camps were used to harvest anadromous fish in the spring and early summer, and to exploit estuarine resources in the fall and early winter. Barber (1991) contends that an increase in sedentism was in part a result of a stabilized sea level that facilitated the establishment of resource-rich environments. Other than a trend toward sedentism and more focused hunting and gathering, subsistence patterns were similar to the preceding Late Archaic period with increasing reliance on marine resources (e.g., shellfish) and cultivated plants (Dent 1995; Lowery 2001, 2003).

3.1.6.2 Middle Woodland Period (AD 300 – 1000)

The Middle Woodland Period (AD 300 – 1000) generally is not well-defined, and researchers disagree about the exact boundaries of the period. Dent (1995:235) has referred to this period of "technological homogenization" where "ceramic and projectile point variability becomes limited to fewer types." Despite the presence of fewer ceramic and projectile point styles, the Middle Woodland Period represents a continuation and further development of cultural complexity that culminates in the Late Woodland Period. The intensification in trade networks over a large region is one of the notable trends evident by the onset of the Middle Woodland Period. It is thought that warmer and drier conditions may have prevailed during this period (Kellogg and Custer 1994; Lowery 2001, 2003).

The major ceramic types for the period are Popes Creek and Mockley wares (Dent 1995). Popes Creek ceramics were first manufactured in the Early Woodland Period, and the style persisted through the early Middle Woodland Period in the region (Maryland Archaeological Conservation Laboratory 2002). Mockley shell-tempered ceramics are common in the latter half of the Middle Woodland Period.

Stone tool kits utilized by Middle Woodland peoples are basically the same as those used during the succeeding Late Woodland, but more exotic lithic materials are evident in Middle Woodland assemblages. The technology evident in many Middle Woodland sites seems to favor bifacial tool production rather than the prepared core and blade flake technology that typifies Ohio Valley cultures. Projectile points characteristic of the Middle Woodland Period include Selby

Bay/Fox Creek and the Jack's Reef types (Custer 1989; Dent 1995; Potter 1993; Stewart 1992). Other tool types found during the Middle Woodland Period are similar to those found during the Early Woodland Period, and include drills, perforators, flake tools, scrapers, bifaces, anvil stones, net sinkers, mortars, pestles, manos, metates, groundstone tools (e.g., axes, adzes, celts), ground slate, gorgets, and tools made from animal bone and teeth (Dent 1995). Dent (1995) notes that bone tools, such as awls and needles, appear to be more ubiquitous during the Middle Woodland than the Early Woodland Period. The presence of non-local rhyolite, argillite, and jasper at a few sites suggests that exchange networks may have been established between the Costal Plain and areas near western Maryland and the New Jersey Fall Line.

There are a few sites in the Chesapeake Bay region that evidence an elaboration of mortuary ceremonialism, with projectile points, ceramics, bone artifacts, shell beads, large pentagonal bifaces, platform pipes, bannerstones, and pendants (Lowery 2001, 2003). These sites appear later in Middle Woodland period, suggesting a reemergence of mortuary ceremonialism and continued selective influences from the Ohio River Valley/Great Lakes region (Lowery 2001, 2003).

Settlement patterns were largely similar to those of the Early Woodland Period, although base-camp settlements located at freshwater/brackish water junctions appear to have been abandoned in favor of broader floodplain sites where maximum resource exploitation of both non-tidal and tidal aquatic resources was possible. The large number of sites for this time period and the extensive size of some of the sites support the argument for possible seasonal aggregation and dispersal. There is some evidence for a significant shift toward settlement of coastal and estuarine areas (Davidson 1981) though Hughes (1980) notes that inland areas along swamps and small streams are still being utilized at that time. Hunting and gathering continued as the primary food sources, with increased reliance on riverine and domesticated plant resources. The presence of large, shell Midden sites during the Middle Woodland Period indicates the increased reliance on shellfish. There is also an intensification of horticultural practices, although hunting, fishing, and plant collecting are still important subsistence pursuits. The subsistence economy is also marked by the initiation of maize horticulture.

3.1.7 Late Woodland Period (AD 1000 – 1600)

Cultivated crops came to play an important role in subsistence for much of the region during the Late Woodland Period (AD 1000 – 1600 (Dent 1995). Some researchers (e.g., Lowery 2001, 2003) suggest, however, that agriculture did not play a big role on the Delmarva Peninsula, and that hunting, gathering, and fishing were the basis of the subsistence economy. The climate had stabilized by this period, and "environmental conditions were essentially modern in character" (Lowery 2001:87).

Chesapeake Bay region artifacts characteristic of the Late Woodland Period include a variety of ceramic types, including Cashie Currioman, Gaston, Killens, Minguannan, Moyaone, Potomac Creek, Rappahannock, Roanoke, Sullivan Cove, Townsend, and Yeocomico wares (Dent 1995; Maryland Archaeological Conservation Laboratory 2002). Only the Killens, Minguannan, Rappahannock, and Townsend wares appear on Delmarva Peninsula archaeological sites (Custer 1989; Dent 1995).

Projectile points characteristic of the Late Woodland Period include small triangular styles, such as the Madison and Levanna types and their variants (Custer 1989; Dent 1995; Lowery 2001, 2003). There is an apparent preference for locally available stone material for making points.

Other stone artifacts recovered from Late Woodland Period sites include scrapers, perforators, bifaces, hoes, choppers, net sinkers, groundstone axes, celts, adzes, mauls, grinding slabs, metates, manos, mortars, pestles, pendants, boatstones, bannerstones, and abraders (Dent 1995; Stephenson et al. 1963). Artifacts made from shell and bone are recovered from Late Woodland Period sites, including fish hooks, scraping implements, pendants, beads, awls, bodkins, beamers, needles, pins, and beads (Dent 1995). Clay tobacco pipes were manufactured during this period. Copper beads and pendants are also, but rarely, found (Dent 1995).

Unlike the rich mortuary traditions of the Early and Middle Woodland Periods, Late Woodland mortuary sites consist of large ossuaries containing human remains and few grave goods. Exotic items found in Early and Middle Woodland Period mortuary contexts are absent from Late Woodland ossuaries (Dent 1995; Lowery 2001, 2003). Smaller, single interments are found throughout the Chesapeake region. Late Woodland Period dog burials have also been recorded in Virginia (Dent 1995).

The establishment of stable agriculture during the Late Woodland Period led to the development of sedentary floodplain village communities. Villages were often located within palisades near agricultural fields. The reliance on agriculture, and the presence of village palisades, hearths, storage pits, Middens, and burials, is indicative of the greatest degree of sedentism seen until this time. Settlements were generally located on broad floodplains, often near the junction of a tributary stream and river. Small transient camps have been found in upland settings (Gardner et al. 1984:18-20). Hunting and gathering was conducted from larger estuarine camps surrounded by micro-band camps. Other trends include shifts in lithic raw material preferences, perhaps related to the development of more sedentary lifestyles. Smaller foraging and hunting ranges would have resulted in more limited exploration for lithic raw materials and greater dependence on resources found near the camps, as well as those regularly obtained through exchange with other groups.

Increased population density and competition for choice land and resources led to the rise of chiefdoms and a hierarchical type of political organization. Hunting, gathering, and fishing were still practiced, but to a lesser extent than earlier. Agriculture does not appear to have played a major role in the Late Woodland Period subsistence economy on the Delmarva Peninsula, though populations do seem to have adopted a more sedentary lifestyle. There was an increase in social and political interaction among native tribes in the region after AD 1500, and Potter (1993:151) has suggested that an alliance of coastal plain Algonquian groups was formed prior to European contact.

3.1.8 Potential to Encounter Prehistoric Sites within the Project Area

The most likely sites to be encountered in the project area are Paleoindian in nature, because the offshore landforms being evaluated may have been exposed during the Late Pleistocene. Paleoindian sites are rare on the Delmarva Peninsula, and usually consist of isolated projectile point finds. Large habitation sites that may be detectable with remote sensing technologies are not associated with early prehistory.

A sub bottom profiler array can, in theory, detect buried relict channels that may have been exposed during the Late Pleistocene. The margins and confluences of these buried channels represent locations where Paleoindian Period peoples may have frequented. The preservation potential within the survey areas, which will be discussed in the next section, is very low, and it is highly unlikely that any buried relict channels have survived intact to the present time. By extension, there is a very low possibility to find an intact prehistoric site where there are no intact buried relict channels.

3.2 MARITIME HISTORIC CONTEXT

Wallops Island is a barrier land mass located on the eastern shore of the Delmarva Peninsula in Accomack County, Virginia. The maritime history of this sparsely inhabited island is intimately related to the political, economic, and cultural background of Virginia's Eastern Shore, particularly Accomack County. This maritime context will focus on the history of this portion of Virginia for this reason. Details regarding the history of Wallops Island are included throughout.

3.2.9 Contact Period (1524-1606)

The Contact Period begins as European explorer's first venture into North America in search of a northwestern passage to Asia and Cathay. Early voyages to the Eastern Shore of Virginia began in the early 16^{th}. The first documented landing took place in 1524, when French adventurer Giovanni da Verrazano landed approximately 16.1 kilometers (10 miles) north of Cape Charles. Contracted to explore the new world by Francis I of France, Verrazano hastily mapped the eastern shore of the Chesapeake Bay and daringly penetrated the headwaters of the Pokomoke River in his carrick, *La Dauphine*. He also documented lifeways of the indigenous Accomac peoples, including the construction and use of seaworthy dugout canoes. Verrazano dubbed the region Arcadia in a subsequent report to the French crown (Wise 1911, Lowery 2000). A second landing took place in 1525. Explorer Lucas Vasquez d' Ayllon cruised the interior of the Eastern Shore of Virginia in an effort to identify a northern passage out of the Chesapeake Bay. He surveyed numerous waterways during this venture and landed several times to provision his vessel (Wise 1911).

Other explorers who sailed Virginia's Eastern Shore between 1571 and 1606 were Englishman Bartholomew Gilbert and Dutch captain Richard Hakluyt (Wise 1911, Lowery 2000). Bartholomew Gilbert explored the southern coasts of Virginia, beginning in 1602, in search of the lost residents of Roanoke Island. Sailing a fifty ton bark with a small crew, Gilbert was caught in a storm off the Capes of Virginia during the summer of 1603. To escape the storm he sailed into the Chesapeake and anchored one mi (1.6 km) off the eastern shore. In need of provisions and water, Gilbert and a small well armed party went ashore. After travelling only a short distance on the beach they were attacked by the local Accawmack tribe, and Gilbert and a crew member were killed (Wise 1911).

Vessels employed by European explorers between 1525 and 1600 shared similar characteristics. The 16^{th} century was the first period during which ship design was based on predetermined mathematical projections. Vessels developed from these projections maintained rounded hulls with a length to breadth ratio between 2.8 and 3.1 to 1. These characteristics resulted in slow, seaworthy ships with a massive tonnage or carrying capacity. Waterline length varied between 20 and 45 meters (65.6 and 147.6 feet) (Steffy 1994). Ships of this time were called carrick, galleon, nao, caravel, pinnace, bergaitin, and fluit (Unger 1994).

3.2.9.1 Settlement to Society (1607-1750)

Much like the rest of the Chesapeake Bay region, Virginia's eastern shore was primarily settled by English immigrant farmers. Explorer John Smith attracted his countrymen to the area in 1607 when he exclaimed that the area was a fertile, wooded land with many creeks, bays and inlets that permitted navigation into the interior. The first settlement in the area was a satellite community hailing from Jamestown. Governor Thomas Dale sent Lieutenant William Craddock and a score of men to Smith Island in 1614 to provide salt and fish for the struggling Virginia colony (Wise 1911, Ames 1940). The success of this small town, called Dale's Gift, generated interest among colonists, thus initiating the permanent settlement of the region. Salt production became the first industry of Virginia's Eastern Shore, and it remained a profitable one until the early 18th century (Ames 1940).

The southern portion of the Delmarva Peninsula was formally recognized by the English crown in 1634 when the House of Burgesses established Accomac Shire under the direction of England and King Charles I. It stood as one of the original eight shires of Virginia and was named for the local Accawmack tribe. This shire was divided into Accomack and Northampton Counties in 1671 (Wise 1911). The earliest permanent settlement on Virginia's eastern shore was located on the southwestern side of the peninsula along the Chesapeake Bay where it was more protected from the elements. This settlement, known as Accomack Plantation, was composed of three distinct settlements along Kings Creek, Old Plantation Creek, and Magothy Bay at Cape Charles (Turman 1964). The town of Accomac became the location of a county courthouse on the seaward side of the peninsula.

English and Dutch settlement on the eastern shore gradually increased throughout the 17th century, and land grants were routinely issued throughout Accomack County for parcels ranging from 200 to 2,000 acres. The grant for Wallops Island was awarded during this land rush. Englishman John Wallop was given 1,450 acres on then Kickotank Island in 1672 to reward his effort to seed Accomack with British colonists. This grant was later revised to 1,800 acres in 1682 and then 1,500 acres in 1692. The island, which was later dubbed Wallops Island, is shown on the 1693 map of the region done by Daniel of St. Thomas Jenifer (Figure 3-1) It was intended that all lands granted by the English crown be farmed speculatively by the owner for the benefit of mother England and the still isolated peninsula (Whitelaw 1968). After being granted to Wallop, the island became known as Wallops Island and was passed down to his children and grandchildren.

The colonial economy of the Delmarva Peninsula was more diverse than that of the tobacco dominated western shore. Salt making began on Smith Island in 1619, and became a luxury commodity throughout the colonies until the first quarter of the 18th century. Fertile fields throughout Accomack and Northampton Counties yielded excellent grain, corn, and tobacco. Industries associated with these crops, such as grain mills and tobacco cask manufacturing houses, dotted the landscape as additional plantations were established. Hemp and flax were also grown for the manufacture of cloth, and bricks were made for the construction of permanent structures on plantations and at Accomac Town. Fishing and boat manufacture were also growing industries at coastal settlements (Ames 1940). Vessel production was so vital to the success of the region that the Accomack assembly offered an incentive in 1661 of 50 pounds of tobacco for every vessel ton produced (Wise 1911). The diverse eastern shore economy established in the early 17th century continued with little change over the next 300 years.

Prospective buyers in Amsterdam, Boston, Baltimore, London, and the Greater Antilles clamored for eastern shore products, and maritime trade became key to the prosperity of this isolated community between 1630 and 1750. Dutch and English trading houses located throughout Accomack County owned seaworthy vessels that traveled between Boston, England, Baltimore, and the Greater Antilles with cargoes of grain, tobacco, flax, and salt. These moderately sized 20 to 40 ton ships returned laden with molasses, sugar, rum, and refined goods slated for re-distribution among prospering colonists (Ames 1940). These trading craft, called *Africa*, *Blessing of Virginia*, *Deliverance*, *Anne Clear, May Flower*, and *Artillery*, became the face of eastern shore commerce for 120 years, and generated fortunes for merchants such as Richard Scarburgh and William Claybourne (Wise 1911).

The success of merchant fleets throughout colonial America did not go unrecognized by the English Crown, and Parliament passed a series of acts that restricted the local trade of competing nations. The first of these navigation acts was passed in 1651, and it stated that goods shipped to England had to be carried by English vessels. This declaration infuriated foreign merchants, particularly the large Dutch population on the eastern shore. The resultant regional conflict between Dutch and English traders became known as the Dutch War, which raged between 1651 and 1653. The war was contested politically on land and between Dutch and English privateers at sea, and many merchant vessels were sunk or taken as prizes as a result (Wise 1911, Ames 1940). Dutch interests suffered terribly during the conflict, and they ceased to be a major economic factor in the region after the war.

Maritime prosperity on the eastern shore also enticed those motivated by quick profit, and piracy was a looming threat along the eastern seaboard throughout the seventeenth and early eighteenth centuries. The isolated barrier islands of the southern Delmarva Peninsula served as excellent havens for captured prizes and pirate vessels alike (Shomette 1985). John James of *Providence Frigate*, William Kidd of *Adventure Galley*, Edward Davis, and John Cook all harried merchant shipping in the region (Middleton 1953). Fear of piracy along the eastern shore prompted local officials to establish lookouts along the coast; Captain Gilbert Moore was commissioned to patrol the coast in search of possible culprits. Accomack assembly member John Custis also petitioned the Virginia governor for a royal frigate to discourage further predation. Captain Edward Teach, commonly known as Blackbeard of *Queen Anne's Revenge*, was born and raised in Accomack County (Wise 1911, Shomette 1985).

As the Eastern Shore is relatively isolated from the mainland of Virginia, the most expedient way to travel between the two locations was by boat. In order to facilitate travel, a ferry system was established. A ferry had been making two round trips per week from the port of Northampton to York and Hampton since 1705. John Masters was given rights to operate a ferry from the Eastern Shore to the ports of York and Hampton in 1724. During his operation of the ferry the main port was soon moved to Mattawoman Creek, the main branch of Hungars. He provided one transport for the passage of foot passengers and one for men and horses (Turman 1964).

The importance of shipping on Virginia's Eastern Shore in this period became evident in the increased restrictions placed on shipping. Towns that could become ports and attract shipping grew exponentially both in population and wealth. Virginia passed "An Act for Cohabitation and Encouragement of Trade and Manufacture" in 1680 (Henning 1819b). This act was designed to establish towns for storehouses in order to better control the moment of tobacco and other exports. All produce was to be carried to the designated towns before export and all goods brought into the colony including "servants, Negros, and other slaves" were to be landed only in these towns (Henning 1819b: 477). Only one such town was established for Accomack County, called Onancock, on the bay side of the peninsula. This town was the site of brisk trade with the western shore of Virginia and was one of the major ports of the colony. In an attempt to limit the number of ports to concentrate prosperity, customs began being collected. Each port from which boats entered and departed had a customs collector, and each ship captain was responsible for ensuring that goods loaded aboard his ship had been properly inspected and a certificate from the customs collector (Turman 1964).

In 1691, Virginia passed an act concerning the establishment, location, and operation of ports throughout Virginia (Henning 1819a). This designated where vessels could load and unload goods and where goods could be sold (Henning 1819a). It also decried the home of the Naval Officer who kept track of the vessels coming and going for each district. This port was located in Accomack County at Onancock, where by 1691 "the court house, several dwelling houses and warehouses are already built" (Henning 1819a). The court remained at Onancock until 1786 when it was moved to the sea ward side of Accomack, as this location was considered more convenient for the local population (Wise 1967:233). Ports at Accomack in Folly Creek (seaside) and Onancock (bayside) were designated official ports in the same year (Henning 1819c:321). The two towns are only 4.5 mi apart by land.

As ports became larger and supported greater volume of incoming and outgoing traffic, it became necessary to protect the channels leading to these ports. Sailing vessels brought in significant amounts of sand, gravel and ballast stone, which were often dumped in the channels and wharves surrounding these ports. The General Assembly passed a law requiring every county adjacent to a navigable stream to provide a place to deposit ballast on shore where it would not wash back into the waterway and obstruct navigation (Turman 1964). They were also required to provide an overseer to regulate this process. Ship captains were required to pay the overseer a fee for unloading ballast on shore, which prompted many vessel operators to load their vessels with paying ballast such as limestone, chalk, bricks, and stones to avoid paying the ballast fee while earning freight charges.

Virginia, as a colony of Great Britain, was discouraged from manufacturing finished goods, and the crown mandated importation of nearly all housekeeping materials. Colonial officials reported to the Lords of Trade in 1741 that "The colonial Virginias has all the necessities they wished for the adornment of their persons or for the furnishing of the homes just as if they lived in Great Britain" (Coulter 1945:296). The majority of manufactured goods came from Great Britain, but other goods arrived from all over the known world. Five British ports dominated trade with Virginia during the 18th century; these were (in order of importance) London, Bristol, Glasgow, Liverpool and Whitehaven. England's center of shipping was London, and "Drawing into its markets the manufactures of Britain, continental Europe, and Asia, and having its own special products, 18th century London was the world emporium of trade" (Coulter 1945:297). Vessels destined for Virginia may have originated in Britain, but the cargo came from all over the world.

There was considerable trade between Virginia and the British West Indies during the colonial period. The islands of Barbados, Antigua, St. Kitts and Jamaica were producers of sugar and rum, and imported food and wood from the colonies in return. Vessels traveling to Virginia from the West Indies usually carried a cargo of sugar and a few slaves. The vessels were smaller sloops, not the larger African ships devoted to slaving (Kline 1975). Moreover, slaves that had spent time in the West Indies were considered "seasoned" or acclimated to the climate and culture of colonial America. These were preferred to slaves that came directly from Africa for reasons associated with disease, language, and conduct (Coulter 1945).

Accomack County and its district port of Accomack were a common destination for the smaller coastal vessels from northern American colonies and the West Indies (Kline 1975). Larger vessels, such as the slavers coming directly from Africa, would call on the larger ports of the South Potomac, Rappahannock, and York River districts (Klien 1975). Accomack, being small and removed from the rest of the colony, was not a favored destination of slave traders. Only 125 slaves were brought to the county (via the port at Accomack) during the 42 year period of 1727 to 1769. None of the voyages to Accomack came directly from Africa, but from the West Indies and other colonies. In contrast, the district of York River received 15,607 slaves during the same period, with 60 percent of the voyages coming directly from Africa (Kline 1975). There was a direct correlation between the size of the vessels and the size of the port it was able to enter.

Craft common to the southern eastern shore between 1607 and 1750 were varied. During both the 17th and 18th century, vessels operating in the Wallops Island area would have been small craft used to move small amounts of goods and produce up and down the seaside of the peninsula. Their capacity would have been that of livery, or transport, to the larger transatlantic vessels that would carry hundreds of large hogsheads of tobacco to London and beyond. One colonist described the Chesapeake Bay and the surrounding waterways in 1724 as "navigable for sloops, shallops, long-boats, flats, canoes and *Periaguas*" (Brewington 1953). Vessels used in the American colonies were very similar to their European counterparts, as locally constructed vessels were not typically built for a specific purpose, but could be used for anything befitting their size (Chapelle 1951). There were few distinctly colonial vessel types recorded during this period. Modifications of previously used vessels were made, but there are seldom detailed descriptions or terms for these regionally modified vessels. The major vessel types used during this period include the dugout/log canoe, the punt or flat boat, bateau, the sloop, and the shallop.

The dugout represents the earliest vessel type employed in the Chesapeake region. It originated from the local Native American population that inhabited Virginia's Eastern Shore. These vessels were typically carved from a single log to form a trough-like vessel (Brewington 1963). This vessel type, which was embraced and modified by the colonists, ultimately resulted in a craft ranging from 12 to 40 feet in length that could be constructed of several logs shaped and mortised together. Adaptations of this general form included the addition of multiple logs, which allowed the vessels to be larger, more stable, and have a deeper draft. They were typically undecked, and sometimes had framed and planked topsides with sharp ends. These canoes were likely originally rowed and punted, but were adapted to be rigged with one or two spritsails and could have a jib set on raking, unstayed pole masts (Brewington 1966). Large dugout canoes fitted with sails were often referred to as *periaguas* (Chapelle 1951).

The punt and flat represent very similar vessel types; the distinction between the two was the presence or absence of sails. The flat was frequently employed as a ferryboat, and possessed curved ends with platforms at the bow and stern with the rest of the hull left open (Chapelle 1951). This vessel was typically flat bottomed, and double ended. The flat was commonly rowed or punted, and generally did not have a sail. The punt was constructed very similarly to the flat but it possessed a single forward mast and a boomless spritsail (Chapelle 1951). Both the flat and the punt were simple to construct and very efficient in the shallow, shoal waters of the Chesapeake. They were used as ferry boats and for transporting goods.

The *bateau*, which translates to boat in French, became a specialized vessel type in the Chesapeake during the 18th century. Regionally, the term bateau was applied to a chine built hull that averaged 40 to 45 feet long (Chapelle 1951). These vessels could be rowed or poled. They were occasionally fitted with sails and external keels to facilitate sailing close-hauled.

The sloop was the most popular vessel type used in the British colonial period. Sloops varied in capacity from 25 to 70 tons during the 18th century, and were typically rigged fore and aft (Chapelle 1951). These vessels would have a single mast with a gaff mainsail, two to three headsails, a square topsail and a square lower sail (Chapelle 1935). Sloops were designed with an external rudder, a flat transom, a slightly curved bow, and a single mast with no bowsprit (Chapelle 1935). They tended to be at least partially decked. Sloops were small in the beginning of this period, but were constructed larger as the 18th century progressed.

The shallop represents one of the many vessel types used during the colonial period for which the name can represent many vessel configurations. The authors of the 17th and 18th century were not overly familiar with nautical terminology, and used various terms to describe them. The shallop was often referred to as a ship's boat, longboat, or launch. These vessels were initially used to lighter crew from ship to shore, and were very popular in the Chesapeake due to a shallow draft and ease of handling. It was a versatile vessel that was easy and inexpensive to construct. Shallops could be used for fishing and transportation of goods and people in a region that favored water transport over road travel (Baker 1966). The shallop often acted as a farm and household boat to be used for everyday purposes. These vessels were typically two masted, open boats without a boom on the main mast which could range from 18 to 28 feet along the keel (Chapelle 1951). A less common variation included decking with a boomed mainsail.

3.2.10 Colony to Nation (1750-1789)

The second half of the 18th century along Virginia's Eastern Shore was fraught with conflict. The Seven Year's War, which began in 1755 and lasted nine years in Virginia, was a dispute between England and France. It had a notable influence upon Virginia. Fighting occurred throughout North America, including the Eastern Shore. The Virginia General Assembly met in 1755 to establish a quota of men to be recruited from each county (Turman 1964). The conflict was to establish British supremacy on the North American continent, but Eastern Shore residents were more concerned with preventing British occupation of their homes. Many local men were placed on guard duty or sent to occupy the frontier to such an extent that tobacco production diminished and overall trade declined. Militiamen were placed on guard in all navigable creeks and rivers. Several forts were also established (Turman 1964).

The war had a detrimental effect on tobacco production and trade on the Eastern Shore, but it also began to make the local population more self sufficient. With a limited ability to receive goods from British ships, Eastern Shore residents began making many of their own goods. Travelling weavers, tailors, and shoemakers also went from town to town making necessary items. Virginia-made linen sheets and pillow cases became more prevalent, and weaving equipment became a necessity on every plantation (Turman 1964).

King George III succeeded his grandfather as ruler of England after the Seven Year's War, and began exerting his authority over the colonies in ways that had never before been experienced. Parliament passed the Townshend duties in 1767, which taxed lead, paint, paper, tea, and glass (Turman 1964). This act had a dramatic impact on residents of the Eastern Shore, as the paper tax affected all legal documents as well as newspapers and almanacs. The paint tax represented a hardship to ship builders who were now unable to paint ship bottoms. It also challenged the residents who painted their homes in order to preserve the wood in the damp seaside climate. This act was repealed in 1770 following intense protest and the boycott of goods, with the exception of the tax on tea.

The boycotts of British made goods, as well as the difficulty in receiving imported goods during the Seven Years War, made Virginia's Eastern Shore largely self sufficient. They were capable of producing many necessities themselves, saving money typically used for imported products from England and other European nations. Tobacco remained the principal cash crop, but pork, beef, hides, shoes, corn, wheat, salt and sea food also became major exports. Records show that castor oil, which could be used for medicine, soap, axle grease, and paint, was also produced in quantities large enough for export (Turman 1964). Flax was also produced for domestic use and export. It could be used to produce linen, and its seeds were used in the production of house and boat paint.

When the war for independence broke out with England, the general sentiment on the Eastern Shore was in favor of colonial independence. The two Eastern Shore counties supplied seven companies of soldiers, one captain, two lieutenants, one ensign, four sergeants and a drummer to the Ninth Virginia Regiment (Turman 1964).

War soon touched the lives of residents of Accomack and Northampton Counties, as British warships took control of the mouth of the Chesapeake Bay. The ports of these two counties soon became a major part of the Colonial supply line. The 1751 Fry and Jefferson map illustrates many of the important creeks and islands which became vital cogs in supplying the Continental Army (Figure 3-2). Ports along the ocean side of the peninsula, including Metompkin and Chincoteague Creeks, were able to receive supplies from France and other neutral countries and transport them to the interior. Medicine, munitions, and other necessary supplies were received along the seaside, transported over land, and reloaded onto small vessels in the creeks and rivers of the Chesapeake, where they were transported to the head of the Bay and down the western side of Virginia and Maryland (Turman 1964). This round-about route was necessary to avoid blockading British vessels and raiding barges operating throughout the Chesapeake region.

A fort was established on Parramores Beach in order to prevent British raiding barges from entering the vital port of Metompkin Creek, and to protect incoming ships (Turman 1964). The fort and other defensive measures along the Eastern Shore peninsula did not prevent the British from seizing a portion of the shore in 1779. This action, and the establishment of a base on Hog Island under the command of Captain John Kidd, infuriated Virginians. This base allowed the British to send out small ships, tenders, and barges to raid surrounding farms and plantations to supply nearby warships. Raids typically took place at night when livestock were corralled and poultry were in their roosts. It was not uncommon for British raiding parties to burn the property of, and steal silver and valuables from, resistors (Turman 1964).

Ferry service between the Eastern Shore and the mainland was discontinued during the British occupation. Vessels that had been involved in the ferry service were leased to the fledgling American government and used to transport troops and goods along the Bay (Turman 1964). These ferries and similar privately owned transport vessels were used to transport Washington and his troops from the Head of the Chesapeake to just north of Yorktown in 1781 where the decisive battle of the war was fought.

Yorktown, which is commonly touted as the last battle of the American Revolution, was fought in 1781, but the last naval engagement of the war involving the Eastern Shore took place in November 1782. The Battle of the Barges occurred when Commodore Whaley of Maryland, who was charged with barges ordered to protect Maryland from British Commodore Kidd's marauding vessels, traveled into Onancock Creek to select volunteers for a skirmish with six enemy barges (Turman 1964). Buoyed by 25 new volunteers and a vessel to be commanded by Colonel John Dropper, Whaley and his fleet successfully discerned the size of the British fleet and their location at Cadger's Strait (Shomette 1985). After a quick, forceful attack by Whaley, the British vessels nearly fled. The battle would have been a victory for the Americans, but the powder magazine exploded on one of the colonial vessels, causing death, destruction, and general pandemonium. The ensuing chaos allowed the British to board and capture Whaley's fleet, rending the conflict an embarrassing loss (Shomette 1985).

A significant trade conflict arose on the Eastern Shore between the adoption of the Virginia Constitution in 1776 and the adoption of the United States Constitution. Virginia's right to charge a toll on ships travelling between the Virginia Capes and Maryland was disputed along with the right to build piers and fish on the south bank of the Potomac. The agreement that was reached allowed Maryland ships to travel through the entrance to the Chesapeake without being charged in exchange for use of the Potomac River by Virginia citizens for commerce and fishing (Turman 1964). This agreement remains in effect to the present and illustrates the importance of maritime commerce and navigation to the residents of Virginia and Maryland.

Vessels used during this era were the same as those of the previous period with few additions. General craft continue to be small to accommodate travel in the often shallow, shoal prone waters of the Chesapeake and the barrier islands. This period and the one prior continue to exhibit ambiguity in vessel and rig types. A vessel could be described by its hull form or its rigging. The major addition of this period was the schooner.

The schooner is mentioned at various times during the first quarter of the 18th century in reference to a rigging style that was largely un-standardized (Chapelle 1935). The term "schooner" supposedly arose in 1713 when upon the launch of a new vessel, a spectator commented "Oh, how she scoons!" The owner of the vessel was enamored with this comment, and declared that it should be called a schooner (MacGregor 1997). While this may or may not be the origin of the term, these vessels became standardized by the second half of the 18th century (Chapelle 1935). Howard Chapelle (1935) suggests that the schooner is one of the first distinctive American vessels. These vessels were the most common type found in colonial waters by the time of the American Revolution because they were fast and relatively simple to construct and sail. The schooner was quickly adopted for legal and illegal trade throughout the colonies.

Most schooners were sloop hulls with two fore and aft rigged masts, with the occasional topsail added (Chapelle 1935 and Brewington 1966). They were designed to be very sharp and fast with a large sail plan. Schooners tended to be relatively small, ocean going vessels that were often used by the Royal Navy as transports (Chapelle 1935). The schooner that became the workhorse of the Chesapeake Bay had a shorter sail plan, more upright spars, and a topmast on the main mast only. This adaptation contrasted with the schooners involved in the ocean trade (Brewington 1966). Schooners would increase in length over time and ultimately transformed into clipper ships.

3.2.11 Early National and Antebellum (1789-1860)

The end of the American Revolution and the establishment of the fledgling United States ushered in a period of peace and growth on the Eastern Shore. The Eastern Shore accounted for three percent of the Virginia population with a total of 20,848 people during the first United States census in 1790 (Turman 1964). The population of the two Virginia Eastern Shore counties had increased slightly by 1800 to 22,456 with 8,479 in Accomack County (Turman 1964). Wallops Island had 30 residents, 14 of them above the age of 16.

Industry on the Eastern Shore continued unchanged. Tobacco was still a major cash crop, with warehouses constructed near ferry landings to store the crop before transportation to market. Tobacco was placed in a “rolling house” before being transported via a “rolling road” constructed from the bayside to a warehouse along the seaside. The large hogsheads of tobacco could be attached to a frame which allowed it to roll and be pulled by a horse or ox (Turman 1964). Madison’s 1807 map of Virginia illustrates the major islands and creeks of the Eastern Shore that were vital for the tobacco trade (Figure 3-3).

The production of flax was also important, and was used in the production of linen cloth, boat sails, thread, fishing lines, nets, and rope. Flax seed was also a lucrative byproduct of flax production, for the seeds could be used for making medicine and linseed oil for paints. Wool had also become an important home industry on the Eastern Shore (Turman 1964).

Ferry service between the Eastern and Western shores resumed, with two trips per week made from the port of Hungars. The major change to the ferry service was the addition of a mail contract. The operators of the Hungars ferry were to pick up the mail from the Western Shore on each trip across the Bay to deliver it to the post office on the Eastern Shore (Turman 1964).

War was again declared between the United States and Great Britain in June 1812, and the Eastern Shore was vulnerable to attack and possible occupation. The militia continued to drill regularly, and men from both Accomack and Northampton counties were called to defend their homes. The militia rotated watches along the mouths of bayside creeks. The British did not bother landing on the seaward side of the peninsula, but instead concentrated on taking control of the Chesapeake Bay. The appearance of enemy ships at the mouth of the Chesapeake once again brought an end to ferry service between the Eastern and Western shores (Turman 1964).

The British soon turned their attention to preparing to attack the American capital, Washington, D.C. The British navy selected Accomack County as its base of operation. The attack was to be a naval campaign and the Navy needed a base out of reach of the Eastern Shore militia. They selected Tangier Island located on the Chesapeake Bay to this end. Tangier Island was occupied on April 5, 1814, under command of British Rear Admiral George Cockburn. They constructed a fort there and used it until the end of the war.

The first record of attack on Virginia from this base occurred near Pungoteague on May 30, 1814. Known as the Battle of Pungoteague, British barges and tenders fired cannon at the mouth of Onancock Creek in order to draw the American militia there. The British soon crossed the bar of Pungoteague Creek in 11 tenders and barges before landing on the north side of the creek and advancing more than one mile (1.6 km). The militia engaged them briefly with no notable results. The British soon retreated back to Tangier Island. This battle, however, marked the only battle on the Eastern Shore against a European nation (Turman 1964).

Trade during the war was impaired but not paralyzed. Eastern Shore residents found themselves experiencing great difficulty transporting and receiving goods from northern cities, but local industry had developed to such an extent that they were largely self sufficient. This self sufficiency produced most of the necessities and allowed them to purchase goods from New England, France, and other friendly European countries as vessels were able to evade the British and land at seaward ports.

The war ended with little damage to the Eastern Shore, and ferry service resumed in 1815 at Hungars Ferry. This ferry, which had operated since 1724, soon faced competition from the Port of Pungoteague. The new ferry also ran two trips per week from one shore to the other (Turman 1964). A steamboat ferry service was established by the early 1840s, and it ran between the Eastern Shore and Norfolk, Hampton, and Yorktown on the Western Shore. A steamboat company was able to obtain a franchise to operate in both Northampton and Accomack Counties, and the terminal was moved to Cherrystone Creek where two trips per week were made to the mainland (Turman 1964). Once per week a steamer was sent to Pungoteague. The vessels used on this route included steamboats *Star* and *Joseph E. Coffee.*

The end of the war ushered another period of growth on the Eastern Shore. The principal crops were wheat, rye, oats, beans, peas, Indian corn, cotton, and potatoes. Castor beans were also frequently produced to manufacture castor oil. Tobacco, while still produced, was slowly being replaced by other crops. The first agricultural figures were officially recorded in the 1840 census, and the transition from staple crops to production of commercial vegetables had begun (Turman 1964). The census reports that 10,254 pounds of cotton, 107 tons of flax, and 112 pounds of tobacco were produced along with 173 pounds of beeswax, 4,598 bushels of salt, and 3,372 cords of firewood (Turman 1964). Farm products produced here were in demand in Washington, D.C., Baltimore, Philadelphia, and New York. Completion of the Chesapeake and Delaware Canal across the 14 mi neck of the Delmarva Peninsula in 1829 aided the transport of goods to the northern markets. The eventual development of steam also allowed Eastern Shore produce to be transported to market with greater speed than sailing vessels.

The increase in commercial agricultural production, especially wheat and corn, prompted the construction of mills for grinding these crops. There were a total of 75 mills between both counties by 1840. There were also five lumber mills and one brick making plant (Turman 1964). The seafood industry was also becoming increasingly important. It had become such a booming industry that the legislature was required to prohibit the sale of oysters between the first of May and the first of September in order to conserve the supply.

The location of Virginia's Eastern Shore on a peninsula with numerous small creeks, shoals, and tributaries made vessel travel necessary and hazardous. The need for lighthouses had been clear since colonial times, but the first lighthouse was not started until the late 1820s. The Cape Charles Light on Smith Island was completed in 1832 at a cost of $7,398.82. Lighthouses were completed on Assateague Island and Watts Island in 1833. A study was conducted at this time regarding the placement of a lighthouse on Hog Island, but it was not until 1852 that Congress appropriated money for its construction. Dwellings for the light keeper and assistant keeper were also constructed. Smaller lighthouses also marked the entrances to Occohannock and Pungoteague Creeks. The lights were fueled by oil with reflectors, which required regular cleaning and daily care by the lighthouse keeper. The lighthouse keeper was a vital part of Eastern Shore life until the lights were electrified nearly a century later.

19^{th} century vessel types were designed to meet demand. The main economic stimulus in the Chesapeake was the oyster harvest, and this encouraged vessel development. Vessels became larger but retained the sails, shallow drafts, and flat bottoms necessary for navigation in the marshes, cuts, and islands of both the seaward side and bay of the Eastern Shore. Centerboard, or drop keel vessels became popular in the Eastern Shore region after 1850 (Chapelle 1951). Vessel names varied by region, but were largely dependent on the type of rigging employed.

Craft used during this period included the earlier forms like the sloop and schooner, but also boasted the clipper, various regionalized watercraft, and steam powered vessels.

The heyday of the fast clipper ships, regionally known as Baltimore Clippers, was 1845 to 1860 (Crothers 1997). This vessel type is a result of the rising demand for fast ships. Their construction design often sacrificed cargo space and low operating costs in favor of speed (Chapelle 1935). It was this disregard for practical aspects of sailing and ship construction that led to a relatively short period of use. The clippers which have been greatly popularized and romanticized are not constructed with a single characteristic hull form but rather used three basic models. These consisted of the Baltimore Clipper, which was characterized by a very sharp deadrise and fine ends, the sharp ended clipper with a very full midrise and very small deadrise, and a compromise between the two extremes, which was characterized by a noticeable, but not extreme amount of deadrise (Chapelle 1967). None of these models became dominant, as all had advantages and disadvantages and were used for different purposes. The common clipper varied in length along the waterline from 105 feet to 228 feet (Crothers 1997). The bow and stern were extremely V-shaped and very sharp at the waterline. They were typically wide at midship to accommodate cargo. Most clipper ships were three masted, but four masted vessels were also common. Four masted variants were rigged with a spanker gaff and boom on a smaller mast set near the stern (Crothers 1997). Typical rigging plans had as many as 15 yards to support sails (Crothers 1997).

A number of more regional watercraft were also being used during this period. These include the scow and the pungy. The scow first appeared in the 1750s, but was most popular in the early 19th century. It was characterized by square raked ends, hard chines, and a flat bottomed hull (Brewington 1966). They were typically rigged as a sloop or a schooner, and were fitted with a leeboard rather than a keel or centerboard. Ranging from 30 to 50 feet in length, these watercraft were considered workhorses used to haul goods and crops (Brewington 1966).

The pungy was another regional craft operating along the Eastern Shore, and has been considered the best of all native Chesapeake watercraft. While very similar in configuration to the schooner, this vessel type was characterized by a much deeper stern than bow, with a greater deadrise. The beam was greatest further forward, the ends were more raking, and a log rail was employed rather than the bulwarks of the schooner (Brewington 1966). The transom was also hewn from a solid timber rather than built plank over frame. It employed a very similar sail plan to that of the schooner but tended to be taller with lighter spars and more sharply raked rigging (Brewington 1966). While lamenting its demise, one waterman noted "no pungy was ever lost except by bad management. A pungy is all keel and no hold. She can't carry much more than a common freight car" (*Peninsula Enterprise*, July 20, 1907). A few variations on the pungy existed, including one fitted with a centerboard for navigating shoal waters. That same waterman also commented on the speed and maneuverability of the pungy saying "a deep model, what I call long-legged, with only one topsail, no jibboom and nothin' but a standin' jib is surely goin' to be a little lazy in a calm. But the more it blows the faster a pungy is. In oyster weather, fall and winter, she's a goer. She's got the stern to be fast" (*Peninsula Enterprise*, July 20, 1907). One of the most obvious traits of the pungy was its distinctive paint scheme. They would be painted with "the bottom, copper; the boot-top, "flesh" pink the bends, bottle green; and the bead, scarlet" (Brewington 1966).

Schooner hulls were converted into steam vessels in the Chesapeake region by making room below decks for engines and equipment and installing exhaust piping on deck. When purpose built steam vessels were constructed, they had long, narrow hulls with a vertical single cylinder engine and side paddle wheels (Labaree et al. 1998). The boilers, like those on locomotives, were first wood burning, then coal and later diesel. Bay and river vessels employed a superstructure to prevent hogging and to stiffen the vessel (Labaree et al. 1998). They typically had two decks with the greater part of the vessel above the waterline. These vessels were ideal for carrying bulk cargo.

Steamboats in the Chesapeake region retained a shallow draft and stern paddle wheels that suited the calmer waters of the region. Ocean going steam vessels employed propellers and were constructed with a sharper hull (Labaree et al. 1998). There was great variation in hull form in steam powered vessels, but a majority of builders eventually moved both storage and cabins from below to above deck. One example of an early steamboat is the *Alabama*. This wooden hull, side wheeler was built in 1838 and was “210 feet in length, by 24.6 beam and 13.5 depth of hold” (Brown 1938:392). This vessel was owned by the Maryland and Virginia Steamboat Company and did the Baltimore to Norfolk run (Brown 1938). Vessels of this period boasted speeds of up to 10 to 14 miles-per-hour (Brown 1938).

The Chesapeake Bay was home to some of the earliest steam powered vessels, and by 1813 steam service began between Baltimore, Frenchtown and Philadelphia (Labaree et al. 1998:256). The first steamboat operating on the Eastern Shore was owned by the Floyd family and ran from Townfields to the Hampton Roads area (Whitelaw 1968). Steam vessels were employed as transport ships that offered regular service from cities such as New York and Baltimore to Norfolk and New Orleans; “In the year 1838 Maryland had nineteen registered steamboats and Virginia, sixteen” (Brown 1938:391). The railroads and steamships worked in tandem to move produce, goods and people up and down the bay by the 1850s.

Different types of work vessels evolved with the advent of steam. The steam tug boat was used to move sailing vessels through canals and rivers out to sea (Labaree et al. 1998). These hulls were both wood and metal. They set low in the water and were designed with a low, rounded stern to accommodate lines off the aft deck.

3.2.12 Civil War (1861-1865)

Virginia’s Eastern Shore had become a vital farming and maritime region on the eve of the Civil War. Water transportation was far more expedient than road travel during this period. Steamboats were making scheduled stops on both the bayside and seaside ports to take on cargoes of produce, seafood, and other goods. While steam had gained a significant foothold in shipping commercial goods, the local people still relied upon sail transport (Turman 1964). Sailing vessels and rigging had improved to the point that more speed could be gained with smaller crews. Sail propelled vessels could also be locally produced while steam was more costly and complicated. Fleets of sailing vessels under the ownership and direction of local people were trading as far as Cuba and northern cities.

Delegates from Accomack and Northampton Counties traveled to Richmond in February of 1861 for a convention considering a referendum that allowed people to determine whether to join the Confederacy or remain in the Union. The convention chose to allow the referendum and it was scheduled for May 23, 1861 (Turman 1964). Union ships blockaded the lower Chesapeake before the referendum could take place. Lighthouses were darkened by Confederate forces and ferry service was once again halted between the Shore and the mainland. The only lighthouse that continued operation was the Assateague Light. Both counties, with the exception of the Chincoteague precinct, voted to join the Confederacy when the referendum took place.

The courts of both Accomack and Northampton Counties authorized funds for recruiting, arms, and ammunition after deciding to join the Confederate cause. This resulted in 800 men being organized into eight companies of infantry, two cavalry, and one light artillery. These men were later divided into three regiments, two from Accomack County and one from Northampton. This arrangement was a holdover from the War of 1812 (Turman 1964). Every capable man on the peninsula was already in the militia and was required to drill three times per year.

The Eastern Shore of Virginia was a prime location for smugglers due to the many miles of coastline and small inlets that made hiding a vessel from Union patrols a relatively simple task. Fake licenses to operate were being issued to Virginia boat owners that identified them as Maryland residents. These documents allowed them to fill up their small schooners and rowboats and take them down to the Eastern Shore to supply the Confederacy (Mills 1996). Supplies could also be smuggled from the North to Chincoteague on the ocean side, and then transported overland to waiting boats along the Bay (Mills 1996). The prevalence of smuggling led to a boat burning expedition led by the Union army. They ran from Fort Monroe up Back Creek and successfully captured or destroyed several vessels engaged in smuggling (Mills 1996).

Major General John Dix was put in command of the defense of Maryland to prevent goods and men from flowing through Maryland to the Confederacy and to intimidate rebel troops (Mills 1996). His major responsibilities including ensuring supplies did not flow into Accomack and Northampton Counties. To achieve this end he devised a plan to occupy the two Eastern Shore Counties.

Brigadier General Henry H. Lockwood was to head the occupying army. He received a report on Confederate activities in the region and requested an army large enough to convince them that resistance was unwise (Turman 1964). Dix sent a letter to the people of Virginia's Eastern Shore offering protection of private property if the people would not resist occupation. He also promised to restore trade with those counties and to restore the lights in the lighthouses (Mills 1996).

Confederate General Smith ordered his men and the militia to the northern part of Accomack County to mount a defense, but he had no choice but to retreat when he received the proclamation from Dix (Turman 1964). A total of 44 officers and 64 enlisted men were able to escape to the Western Shore by boat before the Union army completely occupied the Shore. Young men who were away in college also enlisted, and others ran the blockade to join the Confederate army (Turman 1964). A total of 197 men from Accomack County and 255 from Northampton County served in the Confederacy.

Several attempts were made to run the blockade during the Union occupation, so guards were placed at the mounts of 16 streams and landings including Cape Charles, Cherrystone Inlet, Hungars Creek, and Pungoteague Inlet. Strict orders were issued that no trade was to be permitted between locals and soldiers except under very strict regulations (Turman 1964). Penalty for violation of these orders was one month hard labor or one month's imprisonment with bread and water. Once occupied, the Eastern Shore was cut off both geographically and politically from the rest of Virginia. Smuggling and blockade running continued throughout the war, but it was not as flagrant or frequent as it was originally (Mills 1996).

Despite the fact that Virginia had seceded from the Union, there were those who lived on the Eastern Shore with no interest in the war. They were simply interested in selling their daily catch of oysters. Many on Chincoteague Island remained loyal to the Union and signed an oath of allegiance on October 15, 1862, which gained them Union protection and permission to sell their oysters as far north as New York and Philadelphia (Mills 1996).

The Eastern Shore had become an important link in communication between Washington D.C. and Fort Monroe in the Hampton Roads area. A telegraph line was quickly constructed through the Eastern Shore to Cherrystone Inlet and a cable was laid to Old Point. Troops could also be moved down the shore to reinforce Fort Monroe. Steamboat service was established by the army to more easily transport goods and soldiers (Turman 1964).

There were no new vessel types introduced on the Chesapeake during the Civil War, but local craft continued to be used, as well as steam powered vessels. Vessels employed during the period leading up to the Civil War continued in use. It was not uncommon for residents of the Eastern Shore to construct work vessels for their own use in blockade running or for everyday work. The oyster industry was disrupted during the war to such an extent that watermen found the freight and ferry business to be far more profitable than oystering (Wennersten 1978)

3.2.13 Reconstruction and Growth (1865-1914)

Virginia was designated a territory following the surrender at Appomattox in 1865, and was part of Military District Number 1 (Turman 1964). This included Accomack and Northampton Counties. A constitutional convention was held in 1867, and produced a constitution that was ratified by voters in 1869. Virginia was readmitted to the Union in 1870 (Turman 1964). After being under military rule for more than eight years, residents of the Eastern Shore were excited to have self government restored.

The Federal Government realized the need to establish lifesaving stations along the Shore in 1874. Congress created the Life Saving Service in 1871 but it took three years for stations to be authorized and funds appropriated for construction in Accomack and Northampton Counties (Turman 1964). Stations authorized in 1874 included Assateague Beach Station, Wachapreague Beach Station, Hog Island Station, Cobbs Island Station, and Smith Island Station. Four more stations were authorized in 1878 and 1882, including one on Wallops Island, which is visible in the 1892 Coast and Geodetic Survey Map (Figure 3-4, Turman 1964).

Prior to the authorization of life saving stations, volunteers stepped in whenever they found a ship in distress. The addition of formal life saving stations meant that trained men with the proper equipment were always on duty and ready to assist a vessel or sailor in distress. The stations were composed of two story frame houses constructed with rooms for lifeboats which were always ready for deployment, as well as living quarters for the men. Those serving at a station were on duty for one week with at least that much time off before the next shift (Turman 1964). The keeper of the station had the same status as a commissioned officer and was tasked with training and drilling the men and directing a rescue. The coastline from Delaware Bay to the Mouth of the Chesapeake Bay made up Life Saving District 6 (Turman 1964). This district was under command of Captain Benjamin Rich from 1875 until his death in 1901. While under his command more than 800 disasters involving 6300 people were addressed as well as $12 million in property of which more than $8 million was saved. During this 26 year period, only 45 lives were lost (Turman 1964).

The Eastern Shore and much of Virginia was forced to shift from a tobacco and slave based economy to one more diversified. This eastern coastal region of Virginia began to export produce, peanuts, fish, and oysters to the western part of the state and beyond (Surface 1907). Chincoteague Island and the Bay islands of the Chesapeake became known for oyster harvesting, tonging, dredging, and dragging. Chesapeake oysters were exported all over the world. Oysters were harvested in vessels including sloops, schooners, bugeyes and skipjacks, first via wind power, then steam.

In the late 19th century, truck farming—the cultivation of a few crops for shipment to localities in which such crops cannot be grown, became very important to the Eastern Shore of Virginia and Maryland (Gemmill 1926). Large farms producing a few main crops for sale to the open market, often at some distance from the farm, became the norm on the peninsula. This required seasonal labor and reliable transportation. The need for transportation was met by wagon, boat, and rail. Farmers brought their produce to local wholesale markets by wagon and boat, where it was then transported by rail to Baltimore, Philadelphia, and New York. Skipjacks and buyboats brought the produce from remote areas. Steam vessels would transport large loads of produce from areas without ready access to the railway. Remote areas were able to receive a wider range of goods due to new transportation routes.

A railroad line was initially proposed for the Eastern Shore of Virginia and Maryland as early as 1835 (US Senate 1937). It was considered again in 1855 when plans and maps were drawn but the project abandoned (Turman 1964). The oyster trade prompted the establishment of the first rail line on the Eastern Shore. "The railroad first touched the Eastern Shore seaside in 1876 when a line… laid southwestward of Snow Hill, Maryland reached its terminus just below the Maryland-Virginia boundary and next to the Chincoteague Bay oyster grounds at what became Franklin City" (Thomas, Barnes, and Szuba 2007). This area was not only famous for oysters but also for the outdoor sports of duck hunting and fishing. Advertisements highlighted the easy transportation to the Virginia Eastern Shore: "The upper portion of the peninsula can be reached daily by rail from Philadelphia, the terminus being Greenbackville, on the sea side opposite to Chincoteague Island, and distant from it about five miles. A steam ferryboat conveys passengers from the depot to the island" (Hallock 1877).

Ready access to the railroad, and the advent of refrigerated boxcars encouraged the growth of the seafood industry. It opened many new markets and increased the demand for Chesapeake Bay seafood. A rail line was established in 1884, serving the length of the peninsula (Turman 1964). The New York, Philadelphia and Norfolk Railroad, which also owned steamships, undertook the construction of the line, running north to connect with the existing rail line near the state boarder (General Assembly of Virginia 1884). This coincided with the construction of a harbor and wharf at Cape Charles that was deep and large enough to accommodate steamships (Turman 1964). "By 1889 more than one hundred vessels from 5 to 65 tons and about two hundred decked vessels of under five tons participated in the upper seaside oyster trade" (Thomas, Barnes, and Szuba 2007). These transportation advancements promoted both truck farming and the oyster trade as tomatoes, potatoes and oysters could be put on the train in the morning and served in a restaurant in Baltimore or New York that same evening.

There was a pleasure club on Wallops Island by 1891, complete with a steam powered pleasure boat for excursions (*Peninsula Enterprise*, May 16, 1891). Other sporting clubs soon opened as the news of the fine hunting and fishing spread; "There are three clubs located on the ocean side of Accomack, one on Wallops Beach, composed principally of Pennsylvanians; one on Revels

Island and one of Wachapreague" (Johnson 1899). This was all made possible by trains and motor powered boats operating in the region.

Many of the vessels used during this period were similar to those of the previous period, with developments and innovations most often focused on the oyster business. The Chesapeake Bay was known for producing regionalized vessels designed for the oyster harvest and to meet local needs. Many of these vessel types and the miniscule distinctions between them have been lost with the shipwrights who constructed them. The vessels which became prominent during this period included the flattie, the skipjack, the bugeye, and the buyboat.

The flattie was originally used to transport produce on the Virginia and Maryland tidewater streams, as well as for use in oystering, crabbing, and duck hunting (Chapelle 1951). These vessels likely first appeared prior to the Civil War, but were most prominent during the last portion of the 19^{th} century and represent the smaller predecessor to the skipjack. They are characterized by a V-bottom with some deadrise aft. They ranged from 16 to 30 feet in length, and tended to be partially decked (Chapelle 1951). This vessel type was supposedly out of use by the 1890s, but Chapelle notes seeing a number on the Eastern Shore in 1940 (Chapelle 1951). This vessel is said to have been created to "produce a wide sharpie that would sail well" (Chapelle 1951:312). They were said to sail very well when properly canvassed and were commonly constructed by Eastern Shore mariners for their own use. Accomack County is said to have produced the greatest number of these vessels (Chapelle 1951).

The skipjack, which was a dead-rise skiff with a V-bottom, first appeared after 1860 but did not become popular until the 1880s (Chapelle 1951). The term skipjack is frequently associated with the rigging of the Chesapeake oyster boats rather than a specific hull form. The name is said to be after the bluefish that is known to "skip" across the surface of the Bay (Wennersten 1978). The characteristic rigging is a sprit sail and a jib, without the topsail which was characteristic of older, similar vessels (Chapelle 1951). Construction was done in a very plain, craftsman-like fashion. Skipjacks usually had one raking pole mast on the foredeck and an external rudder on a square transom. One author in 1880 comments that skipjacks are "very wide, with sharp rise of floor the full length of the bottom, jib-and-mainsail rigged, heavily canvassed, and with a reputation for being very fast and Weatherly (Chapelle 1951:306)." A very specialized type originated at Chincoteague Island with masts located fore and aft that could be operated single-handedly (Chapelle 1951:330).

The bugeye originated in the Chesapeake region in the second half of the 19^{th} century when the demand for simple, inexpensive to construct oyster dredging vessels peaked. The bugeye persisted as a popular type until nearly 1920, and is noted as the preferred vessel for oyster dredging due to its simple operation and the ability to be operated by one man (Wennersten 1978). The bugeye was originally little more than an enlarged, decked log canoe with a fixed rig, but it gradually grew and was refined. Employed primarily in oyster dredging, this vessel has been described as a "flat-bottomed centerboard schooner of small size (3 to 15 tons) decked over and with a cabin aft" (Brewington 1964:35). These watercraft typically have two masts, one situated on the foredeck and one located aft of amidships with a leg-of-mutton foresail, a mainsail and jib with a single halyard and sheet (Brewington 1964:59). They tend to have a sharp bow with a stubby bowsprit. This vessel type ranged in size between three to fifteen tons, 30 to 80 feet in length, 10 to 23 feet in beam and 2.5 to 5.5 in draft. The average vessel measured 50 feet in length, 15 feet in beam with a 4 foot draft (Brewington 1966). Hull variations began appearing in the 1880s as a means of gaining deck space. These variations included round and square sterned vessels as well as the "patent stern" which developed in 1908 as an outboard projection of the deck. They are characterized by flat bottoms and hard bilges (Chapelle 1935).

One of the more notable vessels used in oystering, specifically tonging, was a round bottomed boat that was formed from three dug out logs that were joined together. This vessel type was used through the end of the 19^{th} century and was rigged with a jib and one or two sails, and had no deck. They tended to be approximately eight to 25 feet in length and are noted to be especially seaworthy (Wennersten 1978).

The buyboat is synonymous in the modern Chesapeake Bay. The term "buy-boat" originated from their utility. These vessels met oyster boats, purchased their catch and transferred it on the water from boat to boat. The buyboat, though engine powered, continued to possess a main mast and limited rigging needed for a boom crane. It was developed at the dawn of the 20^{th} century with the advent of the gas motor (Chowning 2003). It represents the end of sail power and the beginning of motor vessel ascendancy. Even though steam powered vessels were in use before gas or diesel engines, early bay vessels were too small for the boiler assembly (Chowning 2003).

The traditional schooner, skipjack or bugeye hulls would be fitted with an engine during the early years of motor adaptation, but appearance of the vessel was largely unchanged (Chowning 2003:34). Some early buyboats were bugeyes or skipjacks with cut masts, the bow sprit removed, and a small cabin on deck for shelter. The buyboat hull was designed and built to utilize both sail and motor propulsion. Buyboats were versatile and purpose designed for watermen as they could use sail power to harvest oysters (in Maryland waters power harvesting was restricted for preservation purposes) and could be used under power for hauling and other types of fishing (Chowning 2003). They ranged in length from 40 to 100 feet, with a stub mast and boom forward of the hold, a pilothouse aft, and a decked hull (Chowning 2003:3). They have three main hull configurations: frame-built, log built, and deadrise or box-built (Chowning 2003:3). The buyboat was used to haul grain, coal, log wood, produce, people, and sometimes vehicles in a time before bridges and extensive roadways (Chowning 2003). They continue to be used to the present.

Two shipwrecks from this time period are known to have been lost within 13 mi (21 km) of the Wallops Island area. Both vessels were schooners. The first, the *Jennie N. Huddel*, was a 279 ton vessel built in 1870 that was stranded at Carters Shoal in Chincoteague in 1910. The second vessel was the *Lizzie Godfrey*, a 77 ton schooner stranded at Chincoteague Inlet in 1914. These two vessels represent the first craft identified to have been lost in the vicinity. While there were likely many vessels lost here in the preceding periods, these are the first for which documentation exists.

3.2.14 World War I to the Present (1915-Present)

World War I was officially declared in 1917, and the US Coast Guard was the only armed protection available on the Eastern Shore (Turman 1964). Beaches were closely patrolled to prevent landing of enemy spies and submarines. Watch was also kept at the Cape Charles Station for enemy ships and submarine periscopes. The Life Saving Service had been combined with the Revenue Cutter Service to form the US Coast Guard in 1915. It remained under the Treasury Department, but the men serving in the Coast Guard became naval reserve units for use in time of war. The Eastern Shore became part of the Fifth Coast Guard District. Stations were linked by telephone so that in the event of a large disaster men and resources could be drawn upon from multiple stations (Turman 1964).

World War I did not have a dramatic influence upon life on the Eastern Shore of Virginia, but the end of the war and the return of troops brought remarkable changes and prosperity. Automobile use had grown so much that it had to be regulated, jobs were plentiful, and a college education was attainable (Turman 1964). Every steamboat returning to the Eastern Shore brought new cars from Baltimore. Trains also brought them on flat cars (Turman 1964). Filling stations and garages had to be erected to accommodate the flood of new automobiles. Land prices were also spiraling upward as people invested in stocks, bonds, or loans to others to grow more Irish potatoes, a major cash crop. Approximately 53,267 acres of Irish potatoes were grown in 1920 with amounts increasing yearly.

Prompted by rapid growth, the Chincoteague Toll Road and Bridge Company was organized in 1919 (Turman 1964). The road and bridge was a lifelong dream of John B. Whealton. He surveyed the land from the south of Chincoteague Island to Wallops Neck before convincing Company directors that the bridge should run into the business section of town (Turman 1964). The land was resurveyed and permission was granted by the Federal Government for a drawbridge spanning the Chincoteague Channel. The Virginia General Assembly then granted permission to build

> "A road from A.F. Jester's dock, next to the Atlantic Hotel Dock, leading across Chincoteague Channel to the marsh and then across Black Narrows Channel and marsh, then in a southwestern direction across Wide Narrows to Queen Sound at the mouth of Shell Bay, then in a westerly direction to W.H. Hickman's Farm in Wallops Neck" (Turman 1964:226).

The road was opened on November 15, 1922 with nearly 4,000 visitors arriving on the island to witness the ribbon cutting and hear the Governor speak. The newly constructed earthen causeway was eroded by rain during the speech, and many travelers became stranded on the causeway to be rescued by small boats (Turman 1964). The following day the stranded cars were rescued by ferry and renovations of the road began. The causeway reopened by Christmas of the same year.

The 1920s continued to bring changes to Accomack and Northampton Counties, including new buildings, changes to the school system, troopers appointed for highway safety, and increased public involvement by women who had been granted the right to vote. Farmers, watermen, and professionals associated with these two industries also experienced renewed success during this period (Turman 1964).

The prosperity of the 1920s was evident in the local recreational facilities. Hotels were built and visited by sportsmen during both hunting and fishing seasons. Local people also enjoyed these facilities which included three country clubs, each with a nine hole golf course (Turman 1964). Many residents also owned pleasure boats that were often raced.

The railroad was also prospering, and the railroad companies invested in several new ferries, including *Virginia Lee*, which was touted as the finest steamboat running between Norfolk, Old Point, and Cape Charles (Turman 1964). This steamer was 300 feet long with an auto deck capacity of 80 cars. *Virginia Lee* and *Maryland* made three round trips per day between Cape Charles, Norfolk, and Old Point. While *Maryland* was capable of ferrying cars on an improvised automobile deck, fares were high enough on all steamers to encourage travel by train rather than private automobile (Turman 1964).

A ferry franchise was granted to the Peninsula Ferry Company in 1930. They began operating between the north side of Cape Charles and Pine Beach (Turman 1964). They ran a large open steamer with a 100 car capacity. The Peninsula Ferry Company was able to charge fares lower than the Pennsylvania Railroad Steamers, which contributed to their success. The Virginia Ferry Company, partially owned by the Pennsylvania Railroad, superseded the Peninsula Ferry Company in 1933 with *Delmarva*, a streamlined steamer designed to carry cars and trucks (Turman 1964). The ferry terminal was moved that same year to the Pennsylvania Railroad Terminal, while the southern terminal was at Little Creek, where the railroad had built tracks for box car barges (Turman 1964).

The stock market crashed in October 1929, but the real impact of the Depression did not peak until 1934 (Turman 1964). The price of Irish potatoes fell dramatically, which brought hardship to farmers, merchants, and professionals due to the prevalence of the potato as a cash crop. When the price of potatoes fell below the cost to produce them, Virginia's Eastern Shore felt the effects of the Great Depression in earnest.

Canning and gardening began to increase in an attempt to recover from the effects of the potato failure, and thrift and industry again returned. The WPA stepped in to assist in the recovery by developing roads, mosquito control, and water systems, and opening sewing rooms for women to produce linen curtains (Turman 1964). Flax was once again produced for linen.

Farmers were harvesting crops that did not include potatoes when World War II broke out in 1939. Soybeans and vegetables that could be canned were being grown, and many of them were shipped by truck to canneries and a newly opened quick-frozen food plant (Turman 1964). Farmers were growing tomatoes, potatoes, sweet potatoes, corn, peas, string beans, lima beans, turnip greens, broccoli, spinach, and strawberries both for personal use and for sale to the military (Turman 1964). The war also expanded the poultry industry that had begun in the 1930s, and 5,745,420 chickens were fattened in Accomack County in 1945 (Turman 1964). Many other veterans were seeking employment in shipyards and war material plants by 1940.

The war brought recovery to the region, but it also brought uncertainty. The return of the draft and quotas made the war more of a reality. The Federal Government acquired land at the mouth of the Chesapeake Bay in 1940 to construct Fort John Custis (Turman 1964). This represented the first visible sign of war on the Eastern Shore.

Coastlines were being very closely monitored by 1942, especially the Atlantic side of the peninsula. Small army posts had been established at the towns of Chincoteague and Accomack, and were responsible for patrolling the shores with trained dogs from dusk to dawn (Turman 1964). These patrols were designed to locate submarines and to prevent enemy landings. While the number of submarines sunk in the Atlantic by the Civil Air Patrol operating out of Accomack and Northampton counties is unknown, there were at least 10 American ships recorded as torpedoed by enemy submarines (Turman 1964). It was not unusual for those living near the coast to hear explosions or feel their homes shake when the Civil Air Patrol was working (Turman 1964).

The government purchased land on Wallops Neck for a naval air station in 1942 and subsequently constructed a landing strip and buildings for officers and members of the unit. The

Chincoteague Naval Air Station was commissioned in March of 1943 (Turman 1964). This was soon followed by the opening of a base on Wallops Island under the command of Langley Field Research Center of the National Advisory Committee for Aeronautics. They surveyed the island in 1945, which was then owned by a group of sportsmen using it for fishing and hunting, and a portion was owned by the U.S. Lifesaving Service (Figure 3-5, Turman 1964). A total of 80 acres at the south end of the island were purchased and 1000 acres leased. Construction of facilities for firing rockets started in May 1945 and the first test rocket was fired in June. The remaining portions of Wallops Island were purchased by the Federal Government in 1949 (Turman 1964).

The end of World War II brought another period of growth to Accomack and Northampton Counties. Crops were bringing in good prices and canneries were operating to full capacity (Turman 1964). Televisions, refrigerators, and new cars were popular post-war purchases.

The Virginia Ferry Company was taken over by the Chesapeake Bay Ferry Commission in 1954 by authorization of the General Assembly (Turman 1964). The fleet boasted five vessels, three of which would be enlarged, with two more joining the fleet. They began exploring the possibility of constructing a combination bridge and tunnel across the Bay not long after the Commission was formed. This would be completed in the 1960s.

The Chincoteague Naval Air Station closed in June 1959 and preliminary negotiations were underway to allow NASA to acquire the 1,000 acres of land west of Wallops Island (Turman 1964). It was ultimately decided that the NASA expansion would take place on the former Naval Air Station site. The administrative and technical support facilities on Wallops Island were moved to the mainland on July 1, 1959, which allowed NASA to occupy the location formerly used by the Langley Field Research Center (Turman 1964). NASA was now in control of Wallops Island, which was connected to the mainland by bridge in 1960.

The close of the 20th century and the beginning of the 21st century was marked by a period of declining numbers of farms, but the rise of large farms made it possible for fewer permanent workers (Turman 1964). The major crops included potatoes, both Irish and sweet, tomatoes, snap beans, strawberries, soybeans, and other assorted vegetables. The food packing and processing industry as well as the frozen food industry also became very profitable. The seafood industry remained important but was in decline. Clams, oysters, and crabs continued to be sold in large quantities, and a number of deep sea fishing fleets operate from Virginia's Eastern Shore (Turman 1964).

Lifeboat stations operate on the ocean islands including Smith, Cobb, Hog, Little Machipongo, Parramore, Metompkin, Assateague, and Popes Islands to provide protection for mariners. These stations are under the purview of the Fifth Coast Guard District. Each station continues to provide living quarters for men on duty as well as rescue equipment and boats. While employees live on the mainland and work in shifts, all personnel will be subject to duty around the clock in the event of a disaster (Turman 1964).

The 20th century is not characterized by any distinctive regional vessel types. The primary forms operating in the region were ferries, barges, fishing vessels, tugs, and pleasure craft. These vessel types were all associated with the various maritime activities of the region.

Numerous barges and ferries were operating in the Wallops Island region during the early 20th century. Barges were used as a means of transporting large objects along the coast. There are several reports of tug towed barges transporting cars or boxcars being lost in storms (Turman 1964). One 1906 newspaper remarked that, "there are some 100 barges, with 15 tugs to attend exclusively to bay towing" (Turman 1964: 237). Fishing boats were extremely prominent in this area and remain so to the present. The Chesapeake Bay produced nearly nine times more tons of fish per square mile (2.6 square km) than did the fishing grounds of New England in the late 1920s (Labaree et al. 1998).

A 1912 report from the United States Army to Congress to assess the necessity of dredging the Chincoteague Inlet produced the following list of vessels registered in the area during this period (United States Secretary of War 1912).

600 small boats, not registered, value each $250	$150,000
300 gasoline boats, value each $700	$210,000
100 boats between 5 and 20 tons, value each $800	$80,000
18 vessels over 20 tons, value each $2,000	$36,000
500 barges, scows, etc., value each $40	$20,000
1 steamer (ferryboat)	$10,000
1 steamer (tugboat)	$3,000

These vessels provide a snapshot of the types and importance of the vessels operating in the Wallops Island vicinity during the early 20th century. The emphasis is on practical, working vessels.

The majority of the documented wrecks in within 21 kilometers (13 miles) of the Wallops Island area occurred during this period. The eight vessels lost include two schooners, one fishing trawler, one tug, three barges, and one of unknown type. This likely does not represent the full range of vessels lost in the vicinity, but does provide a cross section of the types of vessels operating in the area during the post World War I era.

3.2.15 Shipwreck Potential within the Project Area

There was a moderate potential to encounter shipwrecks in the project area. This determination was based upon evaluation of known shipwrecks in the area and upon archival research. The likelihood of encountering vessels from the Contact Period through the late 18th century is slight because relatively few vessels traversed the Wallops Island coastline during this time period. Vessels common to this period, which include sloops, bateau, punts, flats, and shallops, were also small coastal vessels that rarely ranged that far from shore. They were also lightly constructed and less likely to have survived to the present.

Potential for encountering vessels from the 1840s to the present increases over the previous periods because the relative prosperity of Virginia's Eastern Shore generated a sharp rise in seagoing merchant vessel traffic and a general increase in seaworthy vessel forms. The most common seagoing craft operating near the project area were schooners, steamboats, barges, and assorted regional watercraft such as larger skipjacks and bugeyes.

A total of 12 known ships were reported wrecked in the project area vicinity (Table 2-4), and all were lost during the 20th century. The loss of four schooners constructed during the last quarter of the 19th century, along with three turn of the century barges, are illustrative of the vessel classes expected offshore of Wallops Island. The preponderance of these two forms on the list suggests that schooner type vessels and barges were common sights along the Wallops coastline, and that they were susceptible to loss in sea conditions endemic to that stretch of the sea. The overall potential to encounter shipwrecks in the project area is moderate, and those that may have been encountered would most likely date from 1840 to the present, and would represent schooners, barges, or other working vessels.

4.0 ENVIRONMENTAL CONTEXT

4.1 INTRODUCTION

This chapter focuses on the natural settings of the coastal and nearshore marine environment of Wallops Island, Virginia. The primary objective is to present the overall setting of the study area, including geologic materials and associated processes, as they pertain to archaeology and the preservation potential of material culture in the geologic record. The report begins with a general overview of the study area, followed by the setting, which includes climate, physiography, oceanography, and biology. The geologic development of the study area will then be reviewed, followed by modern configuration/processes, and finally archaeological implications.

4.2 OVERVIEW

The study area includes the coastal and inner continental shelf environment of Wallops Island, Virginia. Specifically, the study area extends seaward from the shoreline to approximately 24.1 kilometers (15 miles) offshore. Wallops Island is located in Accomack County, Virginia, immediately south of the Maryland border and just south of the island of Chincoteague, a popular tourist destination. Wallops Island is part of the barrier island system characteristic of the eastern side of the Delmarva Peninsula (Figure 4-1). Barrier islands in this area consist of a band of narrow, sandy islands, separated from the mainland by a series of shallow lagoons, salt marshes, and dissecting channels (Cuffey and Dade 2006). The area is characterized by a variety of neritic and back barrier environments ranging from nearly freshwater to near normal marine, and from high energy and turbulent to calm conditions.

The Delmarva Peninsula, nearby Chesapeake Bay, and offshore marine environments have been the subject of numerous studies, but there have been very few published scientific works dealing specifically with Wallops Island.

4.3 SETTING

4.3.1 Climate

The study area, from a marine perspective, occupies a region known as the Mid-Atlantic Bight, which extends from Cape Cod, Massachusetts south to Cape Hatteras, North Carolina. The weather and climate in this region is influenced by five main factors which include: the warm waters of the Gulf Stream, water flowing southwestward from the Scotian shelf, the winter cold air from central North America, the warm moist air from the Gulf of Mexico, and the position of the jet stream across eastern North America.

The general climate exhibits a substantial annual variation in temperature, but a fairly uniform precipitation rate. Most meteorological elements originate in the west, steered by the dominant eastward flow in the middle and upper troposphere. This basic flow pattern is commonly modified by upstream topography, such as the Appalachian mountain range and other regional and local features. Annual mean temperatures vary considerably. The mean monthly temperature in nearby Norfolk, Virginia ranges from approximately 40 degrees Fahrenheit (F)

(4.4 degrees Celsius [C]) in January to near 90 degrees F (32.2 degrees C) in June through August (Hertzman 1996).

Precipitation, on average, is relatively well distributed at approximately 40 to 44 in (101.6 cm to 111.8 cm) per year, with the highest rates occurring during the summer. Snow is relatively rare with an average of less than two snow days (defined as greater than 2.5 millimeters (mm) water equivalent) annually. Estimates of offshore precipitation are less well known, but the coastal information discussed above can be considered a reasonable first approximation (Hertzman 1996).

Winds are dominant from the south or southwest most of the year. Wind speeds at nearby Norfolk, Virginia vary from a low of 4 to 5 meters per second (m/s) during the summer months to a high of 5 to 6 m/s during the late winter.

The strong temperature difference during the winter contrasts between the relatively cold landmass and warm waters of the nearby Gulf Stream may create strong winter storms. Strong wind and heavy precipitation during the summer may occur along this region of the coast, associated with convective systems that generate local thunderstorms lasting only an hour or two. Atlantic hurricanes occasionally pass along this part of the coast during the summers as well. Hurricanes are accompanied by extremely heavy precipitation extending up to 1500 km (27.3 mi) from the center of the storm. Most hurricanes that reach these mid-latitudes are speeding up and beginning to acquire mid-latitude storm characteristics, and hurricane tracks also show a pronounced turning to the east by the time they reach these latitudes (Hertzman 1996).

4.3.2 Biology

The discussion of the biology will be restricted to the marine environment only. The focus will be on the benthos, as it is this group that stands to be impacted the most by the proposed action. A large-scale, comprehensive study of the benthic invertebrate fauna of the Mid-Atlantic bight region by Wigley and Thoreau (1981) produced a detailed description of the benthic communities on a regional scale. They further subdivided the Mid-Atlantic Bight into three sub-regions known as Southern New England, the New York Bight, and the Chesapeake Bight. The study area, which is located seaward of Wallops Island, resides in the center of the Chesapeake Bight sub region.

Wigley and Thoreau (1981) describe six dominant taxa on the continental shelf: Bivalvia, Annelida, Crustacea, Echinoidea, Ophiuroidea, and Holothuroidea. The density of all taxa (defined as the number of individuals per square meter of seafloor) in the study area is among the highest of those measured for the entire Mid-Atlantic Bight, and more than one order of magnitude greater than adjacent areas on the continental shelf (Figure 4-2). Mollusks are by far the dominant tax throughout Chesapeake Bight, including the study area (Figures 4-3 and 4-4). Mollusks consist almost exclusively of bivalves (Figure 4-5), which is dominated by the surf clam *Spisula solidissima*, especially in coarse, sand-sized sediments (Ramey 2008).

While regional benthic fauna is likely controlled by a combination of factors including temperature, water depth, sediment/bottom type, and nutrients, it is the sediments and bottom types that are the major control. The sediment type in the study area is dominated by sand and shell, which is considerably different from surrounding sediments (Figure 4-6). This bottom type likely is responsible for the unusually large density of benthic fauna (Wigley and Thoreau 1981).

The study area, and the majority of the Mid-Atlantic Bight, has a gently undulating ridge and swale topography (Churchill et al. 1994) composed of soft sediments (primarily sands) and local relict sand and gravel ridges. It is not considered to be an area of substantial hard bottom outcrops. Therefore “hard bottom”, or “reefal” habitats, have not been considered to be important from a volumetric standpoint. Hard bottom habitats, like many micro-environments, are composed of man made materials placed in the marine environment, including shipwrecks, lost cargo, disposed solid materials, shoreline jetties and groins, submerged pipelines, cables, and artificial reefs. Biological communities supported by these features differ significantly from those of the surrounding soft sediment seabed (Steimle and Zetlin 2000). The addition of these materials to the seafloor likely has caused an expansion of habitat type, and has had an effect on living marine resource distributions and fisheries, including the American lobster, cod, red hake, ocean pout and black sea bass (Steimle and Zetlin 2000).

A list of fisheries species commonly found on “reef like” habitats throughout the Mid-Atlantic Bight is shown in Table 4-1. These species, which are typically found in depths less than 25-m (82.0-ft), include boring mollusks, red algae, hydroids, barnacles, blue mussels, horse muscles, and bryozoans. Fish species expected on hard bottom habitats in the study area include black sea bass, pin fish, scup, cunner, red hake, gray trigger fish, black grouper, smooth dogfish, summer flounder, scads, bluefish and Amberjack (Steimle and Zetlin 2000).

Table 4-1. List of Fishery Species Commonly Found in the Mid-Atlantic Bight.

Species	Life Stage/Reef Habitat Use	Notes
Algae (Kelp, *Laminaria* sp, dulse, etc)	All stages grow attached to estuarine/marine hard surfaces.	Grows in inter/subtidal surfaces along southern New England Coast as deep as light penetration allow and provides shelter; some are harvested.
Invertebrates Mollusks Blue mussel *Mytilus edilis*	All stages grow attached to hard surfaces in polyhaline/estuarine waters.	Colonizes intertidal/subtidal surfaces but becomes scarcer towards N.C; important prey for many reef fishery resources; harvested as adults; increases habitat structural complexity and biodiversity.
Eastern Oyster *Crassotrea virginica*	All stages grow attached to hard surfaces in polyhaline/estuarine waters.	Colonizes hard surfaces and/or creates low profile reefs; harvested as juveniles (spat for transplanting) and adults; increases habitat structural complexity and biodiversity.
Longfin Squid *Loligo paelei*	Eggs are attached to hard objects in marine waters.	Hard surfaces of all sizes seem important for egg mass attachment. Eggs and larvae can be prey.
Crustaceans American Lobster *Homarus americanus*	All post-larval stages use shelter in polyhaline-marine waters.	Lobsters are common reef habitat dwellers but are less common south of Delaware Bay; maintain reef habitat structural complexity by cleaning burrows.
Rock Crab *Cancer irroatus*	All post-larval stages use shelter in polyhaline-marine waters.	Common on reef habitats as well as on most other habitat; juveniles or smaller sizes important prey for fish and lobsters; claws are harvested.
Fish American Eel *Auguilla rostrata*	Adults found in estuarine to coastal marine reefs as well as elsewhere.	This eel is found seasonally in estuarine areas, including holes in peak banks; harvested by trap and recreational fishery.
Conger Eel *Conger oceanicus*	Juveniles and adults common on polyhaline-marine structures.	This larger eel preys on smaller reef fish, hard to catch but desirable.
Atlantic Cod *Gadus morhua*	Juveniles and adults common on polyhaline-marine reefs.	This specie feeds on reef organisms; uses structure for shelter; but only found during cooler seasons south of Long Island, NY to about Delaware.
Pollack	Juveniles and adults	Uses structure for shelter or for feeding but only found

Species	Life Stage/Reef Habitat Use	Notes
Pollachius virens	common on polyhaline-marine reefs.	during cooler seasons south of Long Island, NY to about Delaware.
Red Hake *Urophycis chuss*	Juveniles and adults common on polyhaline-marine reefs.	Common reef habitat dweller; preys on small crabs and other organisms found on or near reefs; commercially and recreationally harvested.
Stripe Bass *Morone saxtilus*	Juveniles and adults common on estuarine and coastal reefs.	Juveniles use estuarine structures for shelter; adults find prey near estuarine and coastal structures.
Black Sea Bass *Centropristis striata*	Juveniles and adults on estuarine and coastal reefs.	Juveniles use estuarine and coastal structures, and adults mostly use coastal and midshelf structures during warm seasons.
Gag Grouper *Mycteroperca microlepis*	Juveniles and adults common on southern Bight reefs habitats.	Important but variably available fishery species off Virginia and North Carolina.
Scup *Stenotomus chrysops*	Juveniles and adults common on estuarine and coastal reefs	Small schools of this species visit coastal reefs for prey and shelter during warmer seasons; found offshore and on the south in the winter
Spot *Leiostomus xanthrus*	Juveniles and adults common on estuarine and coastal reefs.	Warm season user of reef habitats north on Chesapeake Bay.
Sheepshead (Porgy) *Archosargus probatocephalus*	Juveniles and adults common on estuarine and coastal reefs.	Common on estuarine (including oyster beds) and coastal reefs mostly south of Delaware Bay.
Atlantic Croaker *Micropogonias undulates*	Juveniles and adults common on estuarine and coastal reefs.	Common on estuarine (including oyster beds) and coastal reefs mostly south of Delaware Bay.
Black Drum *Pogonias cromis*	Juveniles and adults common on estuarine and coastal reefs.	Common on estuarine (including oyster beds) and coastal reefs mostly south of Delaware Bay.
Tilefish *Lopholatilus chamaeleoticeps*	Juveniles/adults use rocky areas or holes in stiff clay at the edge of continental shelf and upper slope	This specie contributes to the creation and persistence of the rough bottom habitat and associated biological community found in certain areas on the outer shelf and upper slope
Cunner *Tautogolabrus adspersus*	All post-larval stages are associated with marine-polyhaline reef habitats.	A very common small reef fish, especially in the northern Bight; prey for other fish found on or visiting reefs. Hibernates on reefs on cold winters.
Tautog *Tautoga onitis*	All post-larval stages are associated with marine-polyhaline reef habitats.	A common larger reef fish that prey heavily upon mussel; youngest juvenile found in estuarine; may hibernate during cold winters off New England.
Gray Triggerfish *Baalisted capriscus*	Juveniles/adults are warm-season reef dwellers.	Found on marine reefs and preys on reef dwellers; growing in popularity and fish food.
Ocean Pout *Macrozoarces americanus*	All life stages found on reef habitat, including eggs which are nested.	Adults make and possibly guard egg nests within reef structures during winter.
Reptilia Sea Turtles *Eucheloniodea*	Juveniles and adults of several species are associated with reefs.	Sea turtles are common visitors to the Bight and are known to use reef structures as sheltered resting areas and can prey on reef crabs.
Mammalia Harbor Seal *Phoca vitulina*	Juveniles and adults use the above water parts of reefs as nesting areas.	Harbor seals are winter visitors to the northern Bight and are commonly observed on dry parts of submerged structures and may prey on associated reef fish.

Table Source: Wigley and Theroux 1981

4.3.3 Physiography

The coastline bordering the Northwest Atlantic Ocean is, to a large extent, a result of glacial scouring. This scouring has left a complex, incised coastline in the northern sections, with rocky headlands separating small estuaries. The southern sections of coastline, which include the study area, appear as a long, sandy shoreline that is occasionally breached by larger estuarine systems, such as the Chesapeake Bay (Townsend et al. 2006). These estuaries are effective at trapping the majority of suspended sediments delivered to the coastline from extensive coastal plain fluvial systems. The coastline in the Chesapeake Bay area is angular, with long, relatively straight sections of shoreline extending away from either side of major estuaries (Townsend et al. 2006).

The continental shelves are generally wide, but vary with location. They generally become narrower in the southern Bight. Progressive narrowing of the shelf from approximately 150 km (93.2 mi) off New York to approximately 30 km (18.6 mi) off Cape Hatteras, has significant influence on the physical oceanography of the area (Townsend et al. 2006). The inner shelf physiography of the Mid-Atlantic Bight has been described as exhibiting a pervasive ridge and swale topography with an abundance of elongate ridges and parallel depressions (swales) that generally parallel the adjacent coast (Shor and McClennen 1988). Some scientists interpret this ridge and swale topography to represent relict barrier/lagoon pairs formed and abandoned during the most recent sea-level rise. Others interpret ridge and swale topography to represent post-transgressive, shoreface-connected ridges. Cross-shelf channels (valleys) and deltas (aprons) often extend the entire width of the continental shelf. Some of these valleys may be partially, or even completely, filled with sediments, while others retain their valley profile. These features are derived from Pleistocene and/or Holocene sea-level lowstands. They represent fluvial pathways to adjacent canyons on the continental slope, which are associated with clusters of ridges and swales superimposed on elevated shelf areas described as shoal retreat and cape retreat massifs. These massifs are associated with the adjacent shoreline feature for which they are named. The shelf valley complexes and associated sand shoal massifs are separated by broad, plateau-like interfluves, and may represent river valleys excavated during previous Quaternary lowstands of sea level that have been infilled with estuarine sediments during an ensuing sea-level rise. The sea-level rise, when coupled with intense wave activity, likely caused erosional shoreface retreat of river forelands or estuary mouths. This resulted in widely spaced cape retreat massifs with broad intervening plateau-like interfluves that contain extensive fields of sand ridges. Modern shelf valleys have occasionally been incised into previous valley fill (Riggs and Belknap 1988).

4.3.4 Oceanography

The shelf waters of the northwest Atlantic are located in a region of abrupt water temperature change at the confluence of the north-flowing Gulf Stream and the south-flowing Labrador Current (Figure 4-7). Mid-latitude cyclones frequently track across North America and converge in this region, which significantly impacts the vertical mixing and nutrient fluxes of shelf waters. A continuous equatorward coastal current system extends southward from Newfoundland to the Mid-Atlantic Bight. The general southerly flow continues south of Cape Hatteras, which is known as Mid-Atlantic Bight Water. Cross shelf mixing of the flow with slope waters and the Gulf Stream become important as shelf width decreases (Townsend at al. 2006). Shelf and slope waters of the Mid-Atlantic Bight have relatively low salinities (< 34 ‰), augmented by various rivers, including those entering Chesapeake Bay. The cross shelf mixing of waters in this area, along with influxes of deep, offshore waters to inner shelf regions, may have important biological implications (Townsend et al. 2006).

The North Atlantic Oscillation (NAO), which is a decadal-scale oscillation of wintertime surface atmospheric pressure over the Arctic and subtropical Atlantic, has recently been found to have an important influence on water mass properties over the entire northwest Atlantic shelf (Townsend et al. 2006). The NAO, to a great extent, dictates the latitudinal displacement of the boundary between the Gulf Stream and Labrador Current, and it may have important ramifications for the physical and biological environments of the entire northwest Atlantic shelf (Townsend et al. 2006).

Coast and shelf waters throughout the Mid-Atlantic Bight support extensive and productive fisheries. The high biological productivity of the area is the result of a number of interacting factors, including cross shelf fluxes of nutrient-rich deep waters and winter convective mixing. Winter mixing replenishes surface nutrient concentrations, resulting in winter and spring plankton blooms, which in turn influences the benthic population. Following the spring bloom, a strong vertical stratification occurs throughout the warmer summer months, established by freshwater influxes from the nearby landmass and solar warming of surface layers. Vertical mixing by tides further stimulates nutrient fluxes that promote high levels of plankton production (Townsend et al. 2006).

The Wallops Island Atlantic coast has a semi-diurnal tide with a 1 to 2 m (3.3 to 6.60 ft) tidal range. This is considered microtidal, but tidal currents have been known to scour backbarrier channels to depths of several meters (Oertel et al. 1989). The predominant and prevailing winds are from the north to northwest and south, respectively. Atlantic storms, generally coming from the northeast, may be intense, and produce strong winds and large waves capable of overwashing barrier islands along this stretch of the coast (Demarest and Leatherman 1985). The dominant winds produce a wave approach from the north, resulting in a net southerly long-shore current (Cuffey and Dade 2006; Finkelstein and Ferland 1987). Both the long-shore current and incoming waves are capable of re-suspending and transporting sand-size sediments throughout the study area (Churchill et al. 1994).

4.4 GEOLOGIC DEVELOPMENT

4.4.5 Structural Geology and Early Geologic Development

The study area, along with the entire Delmarva Peninsula, occupies the central part of the Salisbury Embayment located within the landward extension of the Baltimore Canyon trough (Figures 4-8 and 4-9) (Hansen 1988). The Baltimore Canyon trough is the deepest of six marginal basins located beneath the US Atlantic margin, all of which were formed by extensional forces associated with early rifting phases of continental breakup (Klitgord et al. 1988). Basement rocks, which floor the Salisbury Embayment and adjacent Baltimore Canyon trough are primarily continental in origin and consist of granitic and metasedimentary units of Paleozoic age (Poag and Valentine 1988). The Salisbury Embayment is one of the major Mesozoic to Cenozoic depocenters on the Atlantic continental margin (Foyle and Oertel 1997). They are a thick sequence of Mesozoic to Cenozoic sediments overlying basement rocks that reach greater than 8 km (4.9 mi) in thickness in the southern part of the Baltimore Canyon trough (Poag 1997). Marine waters presumably entered the Baltimore Canyon trough following initial rifting, and eventually deposited evaporite sediments as a result of the early Jurassic arid climate. These likely represent the basal sedimentary units occupying the trough (Poag and Valentine 1988). During the early to Middle Jurassic, shallow-water carbonate sediments were deposited.

Several small, "reef-like" carbonate buildups were identified during this time period as well. A large shelf edge carbonate buildup (barrier reef) appears to have formed at the end of the Middle Jurassic period. Seaward progradation continued during the late Jurassic, and a larger regional carbonate bank system formed a massive shelf edge barrier. Siliciclastic sedimentation, including the fluvio-deltaic units of the Potomac Formation, took over by the early Cretaceous, (Poag 1997; Hansen 1988) and buried the shelf edge barrier, thereby initiating a period of terrigenous sediment accumulation that lasted throughout the entire Cretaceous Period.

During the Paleogene, carbonate sedimentation resumed with the deposition of calcareous shales, chalks, and limestones, primarily of Eocene age. Paleocene and Oligocene strata are also present, but are less persistent, often being completely missing or only partly represented (Poag and Valentine 1988). The relatively continuous deposition in the southern portion of the Baltimore Canyon trough in the late Eocene was interrupted by a bolide impact on the inner-continental shelf beneath the modern position of the Chesapeake Bay mouth. According to Poag (1997), this event created a large, complex, impact crater, which generated a gigantic tsunami, and fundamentally altered the geological, geo-hydrological, and geographical evolution of the Virginia segment of the Atlantic coastal plain. It also created a structural and topographical low, and may have predetermined the location of modern Chesapeake Bay.

4.4.6 Recent Development and Modern Configuration

The recent geologic evolution of the coastal and nearshore marine environment off Wallops Island can be tied directly to the development and growth of the Delmarva Peninsula and the major sea-level fluctuations of the late Tertiary and Quaternary. Both the terrestrial and marine stratigraphy have been reasonably well documented (see Shideler et al. 1972; Owens and Denny 1979; Mixon 1985; Finklestein and Ferland 1987; Johnson and Berquist 1989; Toscano and York 1992; Hobbs 2004) and are presented in Table 2. The discontinuous nature of the strata proves problematic when attempting to correlate units, especially terrestrial with marine. Consequently, the stratigraphy of the Delmarva Peninsula and the inner continental shelf will be discussed separately. The two will then be correlated in a discussion of the geologic evolution of the study area.

4.4.6.1 Delmarva Peninsula Stratigraphy

The Virginia portion of the Delmarva Peninsula has evolved as a southerly growing spit (Figure 4-10; Hobbs). The base of the Delmarva Peninsula is interpreted to consist of fluvio-deltaic sands of the Pensauken and/or Yorktown Formations of early Pliocene age (Owens and Denny 1979). The Beaver Dam Formation partially overlies these units and occupies the region south of the Maryland to Virginia border (Owens and Denny 1979). The Beaver Dam Formation is thought to represent a river-dominated deltaic system deposited during a late Pliocene sea-level transgression and regression sequence. The overlying Walston Silt is believed to be of marine origin, likely deposited under a single transgression during the Pliocene (Owens and Denny 1979). The Omar Formation partially overlies the Yorktown Formation and is interpreted as lagoonal and estuarine deposits encompassing most of the Pleistocene section of the Delmarva Peninsula (Mixon 1985).

The Omar in Virginia, however, has been described as a high-energy barrier, and nearshore shelf deposit. The Pleistocene Era Ironshore Formation consists of a narrow, discontinuous band of sand and gravelly sand stretching from Delaware to the southern tip of the Delmarva Peninsula. This formation has been largely eroded south of Chincoteague Island (Hobbs 2004, Owens and

Denny 1979). The overlying Sinepuxent Formation has been described as a Pleistocene marginal marine unit that likely represents a major transgression in sea level (Owens and Denny 1979). The overlying Nassawadox and Kent Island Formations, which are identified in southern Virginia, likely represent ancestral Chesapeake Bay sediments (Owens and Denny 1979; Mixon 1985; Hobbs 2004). The Joynes Neck Sand is the surficial unit that overlies the Omar and Nassawadox Formations along the eastern shore of the southern Delmarva Peninsula. Joynes Neck Sands are interpreted to have been deposited during a single marine transgression (Mixon 1985) and were likely deposited during the late Pleistocene (Hobbs 2004).

4.4.6.2 Inner Continental Shelf Stratigraphy

The inner continental shelf seaward of the Virginia portion of the Delmarva Peninsula has been described as having four stratigraphic units, termed Units A, B, C, and D (Shideler et al. 1972). Unit A, the deepest and oldest, is interpreted to represent the top of the Miocene, although some suggest that it may actually represent the Yorktown Formation, which is now considered to be Pliocene in age. The overlying Unit B is considered to be a complex of fluvial, estuarine, lagoonal tidal channels and barrier ridges. Although the exact age is uncertain, it is believed to have formed some time during the late Pleistocene. Unit C has been described as consisting of relatively uniform horizontal strata, with only occasional indications of minor local channeling. No other interpretation has been given. The surficial and youngest sedimentary unit, Unit D, represents the modern seafloor, and was likely deposited as a transgressive sand sheet during the most recent rise in sea level.

4.4.6.3 Neogene/Quaternary Geologic Evolution

The recent geologic evolution of the study area is tied to the southerly progradation of the Delmarva Peninsula, coupled with the late Tertiary/Quaternary fluctuations in sea level. The southerly progradation of Delmarva Peninsula has been a major control on the evolution of Chesapeake Bay. Major drainage systems entering modern Chesapeake Bay substantially predate the development of the estuary, and originally emptied directly into the open ocean (Hobbs 2004). The first indication of a bay, separated from the open ocean, appeared in the late Pleistocene with the initial growth of the Delmarva Peninsula from the Pleistocene deltas of these ancestral rivers. During early Pleistocene sea-level highstands, the older, deltaic peninsula prograded seaward and southward as a major barrier spit, beginning the processes that have continued to the present (Hobbs 2004). The peninsula/spit continued to grow during ensuing sea-level highstands by lengthening southward. The more northerly river systems could no longer flow directly southeast across a wide continental shelf during each sea-level regression, and were diverted southward around the tip of the lengthening peninsula. Consequently, deep river channels were incised into what is now the continental shelf.

The inner shelf has been sediment starved throughout the Pleistocene because of the limited amount of sediments available for deposition, and the time available for strata formation has been relatively short (on the order of tens of thousands of years). The resultant strata on the inner shelf are quite thin and discontinuous as a result, and are difficult to correlate with units on the nearby Delmarva Peninsula and coastal plain (Hobbs 2004). Correlation is made even more difficult because these inner shelf strata are primarily derived from older, reworked sediments, and many are lacking diagnostic fossils. The surficial unit consists of a thin, transgressive sand sheet mantling the inner shelf and overlying the incised channels discussed above. This configuration has important ramifications for the modern morphology of the coast/inner shelf and preservation potential of material culture.

4.4.6.4 Modern Configuration

The morphology of the present day barrier beaches and adjacent inner continental shelf off the Delmarva Peninsula, including the study area, is controlled by wave climate, tidal energy, sediment texture, and sand supply (Demarest and Leatherman 1985). The actual position of the barrier islands and associated inlets are more a function of antecedent topography (Oertel et al. 1989; Finkelstein and Ferland 1987). Topographic lows provide pathways for drainage and inlet formation, while topographic highs create sites for barrier island development (Oertel et al. 1989). Evidence indicates that between 3 to 7 m (9.8 to 22.9 ft) of relief probably existed on the pre-transgressional surface of the southern Delmarva Peninsula, creating ideal sites for barrier development (Finkelstein and Ferland 1987).

Demarest and Leatherman (1985) discuss four main types of barriers on the Delmarva Peninsula. The study area is located in the zone of drumstick (short, bulbous) barriers characteristic of the Virginia shoreline (Figure 4-11). These barriers are likely related to the relative stability of major tidal inlets and largely infilled lagoons. These stable tidal inlets have resulted in the evolution of large, well-developed ebb tidal deltas, which in turn are believed to have a pronounced effect on barrier dynamics and island morphology (Demarest and Leatherman 1985). These island types were originally described for mesotidal (2 to 4 m tidal range) environments, but exist here in a microtidal environment. These islands are also generally formed where there are no updrift headlands to supply sand, which suggests that new sediment is supplied from shore face erosion and moved onshore to replace sand lost to littoral drift or inlet deposition (Demarest and Leatherman 1985).

The study area is located in what Demarest and Leatherman (1985) refer to as the “arc of erosion” (Figure 4-11). The lack of updrift headlands means that there is no source of sediment to input onto the shoreline, except for new sediments supplied by shoreface erosion and moved onshore. Finkelstein and Ferland (1987) maintain that the net sand deficit in the study area has occurred because sands are trapped at the southern tip of Assateague Island rather than transported downdrift to nourish the islands to the south. They also maintain that relatively little sand is extracted from the underlying substrate by shoreface erosion in the study area (Finkelstein and Ferland 1987). Sediment supply to the beaches by shoreface erosion has not happened, and the Wallops Island beach and nearshore can be expected to be highly erosional in nature. There is no evidence that any of the Delmarva beaches receive coarse grain sediments from the rivers directly, as most of the material is trapped in the estuarine and lagoonal systems.

4.5 ARCHAEOLOGICAL IMPLICATIONS

The majority of physical oceanographic, stratigraphic, sedimentologic, and geomorphologic data concerning the coastal and inner continental shelf off Wallops Island, Virginia is consistent with low to very low preservation potential of cultural materials in inner shelf sediments. Thin layers of sediments have been deposited during sea-level highstands throughout the Quaternary, and only a thin sediment veneer has been deposited since the last low stand approximately 20 thousand years ago. Therefore, the sedimentary record during this time is very thin. Also, the deposition of this transgressive sand sheet during sea-level rise has occurred by continuous reworking of sediments by physical processes (which continues to the present), which would likely disturb any materials that were originally buried. Sediments in the study area, which consist of shells and sand, are coarser than sediments to the north and south, suggesting higher energy, which is consistent with even more intense bottom sediment reworking. The location of the study area in the "arc of erosion" suggests that the sediment supply to the study area is even lower than for surrounding areas, once again inconsistent with preservation of materials by sediment burial. The sediment supplied to the beaches is derived from previous shoreface erosion, which would not be conducive with preservation in the sedimentary record.

The most likely regions of preservation would be the thicker sedimentary units associated with buried channels originally cut by rivers traversing the continental shelf during sea-level lowstands. Deposition is generally promoted in these areas (since they represented bathymetric depressions), sediment accumulation rates were likely higher, and sediments are less subject to reworking. This would only apply to the last sea-level transgression, and major buried valleys have not been described in the study area. The preservation potential may be greater in buried channels, but it should still be considered relatively low for the objectives of this study.

5.0 RESEARCH DESIGN

5.1 OBJECTIVES

The remote sensing survey was designed to locate and identify magnetic and acoustic anomalies that could represent potentially significant submerged cultural resources, such as shell middens or other prehistoric sites, shipwrecks, or historic maritime structures. The project consists of two survey blocks located northeast of Chincoteague Inlet east of Blackfish Bank in U.S. waters. Each block measures two square mi (5 square km) (Figures 5-1A, 5-1B, 5-2A, and 5-2B). Block One, centered upon Unnamed Shoal A, is directly adjacent to Blackfish Bank, and measures approximately 15,300-ft long (4664-m) by 4,400-ft wide (1,341-m), or 1,545.6 acres. Block One has 80 transects spaced at 50-ft (15.2-m) intervals, which yields 1,144,861 linear survey ft (348,953.6-m) or 216.8 survey mi (348.9-km). Block Two, centered upon Unnamed Shoal B, is located 2.25 mi (3.62 km) to the northeast of Block One, and measures approximately 13,300-ft (4055-m) long by 4,000-ft (1220-m) wide, or 1,221.4 acres. This parcel has 84 transects spaced at 50-ft (15.2-m) intervals, which yields 1,044,421 linear ft (318,339.5 m) or 197.8 linear survey mi (318.3 km).

5.2 METHODS

5.2.1 Background Research

The purpose of background research was to develop cultural contexts for identifying and evaluating archaeological sites that may be encountered within the project area. Research was conducted at the National Archives in Washington, D.C. and at various online repositories. Reports of previous cultural resources investigations and previously recorded architectural and archaeological sites as well as known shipwrecks were obtained from the Virginia Department of Historic Resources. Historic maps and accounts of the development of Wallops Island were obtained from the National Archives and through books and periodicals.

5.2.2 Remote Sensing Methods

The process of land inundation and shipwreck site formation distributes ship remains and other artifacts (cargo, fittings, and ballast) in relatively large clusters based on water depth, artifact size, seafloor topography, and water currents. Submerged prehistoric features, such as hearths and shell middens, can also survive the ravages of the sea intact if protected by certain sediment types. A well-designed survey that is conducted with sensitive, high resolution sensors can detect submerged habitation sites and shipwreck debris, and can reliably differentiate these finds from the earth's ambient magnetic field and natural bottom topography.

A well-defined set of criteria were used to distinguish naturally occurring magnetic and acoustic anomalies from significant cultural resources. Magnetic anomalies were evaluated based on data points that include anomaly duration (both time and distance), magnetic amplitude in nanoTesla (nT), and magnetic signature. Magnetic signatures were denoted as dipoles (D), monopoles (±M) or multi-components (MC) (Figure 5-3). Positive and negative monopoles refer to one half of a dipolar perturbation, and usually indicate an isolated magnetic source located some distance from the sensor. Monopoles produce either a positive or negative deflection from the ambient magnetic field. The polar signature depends on whether the positive or negative pole of the object is oriented toward the magnetometer sensor. Dipolar signatures display both a rise and a fall from the ambient field, and they are generally associated with single source anomalies located directly under the magnetic sensor. Multi-component magnetic perturbations represent several, randomly scattered ferrous objects with different magnetic orientations. Anomalies with these signatures are likely associated with man-made objects, possibly shipwrecks. The last two criteria are the location of the anomaly center, and the distribution and patterning of anomalies within the survey area.

Side scan sonar data were used to image the sea floor or river bed, to locate and identify culturally significant materials, and to map the geomorphic and bathymetric anomalies within each survey area. A sub bottom profiler was used to detect buried structures or geomorphic features, such as buried relict channels, shell middens, shipwrecks, or buried cables and pipelines.

Data acquired from these instruments were first evaluated separately, and then as an integrated data set. Potential cultural targets are often comprised of related magnetic and acoustic anomaly groups. Targets are identified as significant if the various anomaly groups reflect parameters established for shipwrecks and other significant cultural features.

The survey array used for the WFF SRIPP survey consisted of the following: a Differential Global Positioning System (DGPS), a cesium vapor marine magnetometer, side scan sonar, a continuous transmission FM chirp sub bottom profiler, and an echo sounder (Plates 5-1 and 5-2). Hydrographic and navigational controls were achieved by the use of Hypack's® survey software.

5.2.2.1 Positioning

A Hemisphere Crescent R130 DGPS with inertial navigation corrections (for up to 45 minutes after loss of signal) was used for this survey. The Hemisphere system transmits information in NMEA 0183 code to a computer navigation system using the *Hypack® 2009a* survey software. The *Hypack®* software incorporates the NMEA 0183 data string and displays vessel position on a computer screen relative to pre-programmed track lines and each instrument sensor. It also performs instantaneous data translations between various geodetic projections, which combine all incoming data with accurate positions for seamless data integration and post acquisition processing. Navigation files within *Hypack® 2009a* can be utilized to produce track line maps and derive X, Y, and Z data sets for analysis and contour plotting. Positioning control points were obtained every 30.5 meters (100 feet) along survey transects. The Hemisphere Crescent 130 DGPS is considered to be accurate to within 20.3 centimeters (8 inches) Root Mean Square (RMS) values under optimal conditions.

5.2.2.2 Magnetometer

A Geometrics G882 marine magnetometer was used for the magnetic survey. The G882 magnetometer is a 0.01 nT (RMS) sensitivity cesium magnetometer that is linked to *Hypack® 2009a*, which enables precise, real-time positions for recorded magnetic data. Survey was terminated if induced magnetic background noise exceeded +/-3 nanoTesla (nT). The magnetometer sensor was towed a sufficient distance from the transom of the survey vessel to avoid magnetic interference from the propulsion and electrical systems.

5.2.2.3 Side Scan Sonar

A MarineSonic 600 kHz side scan sonar system was used to collect acoustic data for this survey. The 600 kHz system produces high resolution images with moderate ranges of a few hundred feet. Navigation fixes are imbedded with the acoustic data in real time, which allows images to be geo-referenced and side scan mosaics created for analysis.

5.2.2.4 Sub Bottom Profiler

A Benthos Chirp III sub bottom profiler was used to record sediment structure and any cultural material deposited beneath sediments. The Benthos system uses a continuously transmitted acoustic pulse that begins at 2 kHz and continues to a maximum of 20 kHz. This swept frequency can image sediment structure with up to 2 centimeters (0.78inches) resolution. The DGPS system feeds positioning data to the sub bottom profiler receiver and is used to control recording speed and data point position.

5.2.2.5 Echo Sounder

An ODEM Hydrotrac digital echo sounder was used to record bathymetric data for each survey transect. *Hypack® 2009a* recorded the position and bottom depth every tenth of a second and corrected for transducer layback and offset values. The bathymetric data is used to better understand the geomorphology of the survey area and how that affects the distribution of magnetic and acoustic anomalies, as well as to delineate any features sitting above the sediment surface.

5.2.2.6 Data Collection and Position Control

Hypack® 2009a survey software was used for survey planning and data collection. Once the survey was designed and track lines planned, *Hypack®* survey module was used to establish survey control and data collection and correction. While surveying, the planned transects were projected onto the navigation screen and the data being collected, which permits “real time” quality control and field data logging of anomalous data.

All remote sensing data were correlated with DGPS positioning data and time through *Hypack® 2009a*. Positions for all data were then adjusted for sensor layback and offsets. Positioning was recorded using Virginia State Plane North, US Survey foot, referencing the North American Datum of 1983 (NAD-83), and US survey feet were the units of measure.

5.2.3 Marine Data Analysis

Magnetic and acoustic data were reviewed for anomalies during data collection, and those data were reviewed again during post-processing using *Hypack®* data review module, Chesapeake Technology’s *SonarWiz.Map®* 4.04, and Golden Software’s *Surfer®* (Version 8). These computer programs were used to assess the duration, amplitude, and complexity of individual magnetic disturbances, and to review side scan sonar (SSS) and sub bottom profiler (SBP) data for anomalies. The software was also used to plot anomaly positions within the project area to better understand their spatial distribution and association with other anomalies.

Nautical archaeologists maintained field notes on the locations of modern sources of ferrous material, such as pipeline and cable corridors as well as fishing grounds and charted shipwrecks that would have altered regional magnetic field readings. Magnetic perturbations of 3 nT or greater with durations greater than 3 meters (10 feet) were cataloged for further analysis. Acoustic imaging was reviewed for anomalous returns that could be associated with significant submerged cultural resources. SBP data were reviewed for buried shipwrecks, submerged prehistoric features, and relict landforms that have potential to contain intact prehistoric deposits.

All data sets were cross-checked for relevant correlations. Anomalies in clear association were identified as targets and underwent further analysis. The presence of known shipwrecks in the vicinity of Blackfish Bank suggested that the area has a moderate potential for containing shipwrecks and other maritime cultural resources.

5.3 EXPECTED RESULTS

Research and analysis presented in Sections Two through Four suggested that there was a moderate probability to encounter historic shipwrecks or other historic maritime cultural materials, and a very low potential to encounter buried prehistoric sites. It was also anticipated that the actual results of the survey represent modern fishing and trawling activities that constantly take place on or near the sand borrow areas. Acoustic, magnetic, sub bottom profiler anomalies were anticipated to depict debris associated with modern fishing activities, such as anchors, cables, chains, and trawls. The survey array was also expected to detect debris deposited by recent storm events, such as saturated logs and dock and pier construction elements. The majority of vessel traffic in the region has taken place over the last 75 to 100 years and shipwrecks encountered within the project area would likely be fishing or recreational craft lost during those decades.

6.0 RESULTS OF ARCHAEOLOGICAL INVESTIGATIONS

Magnetic and acoustic (side scan sonar, sub bottom profiler, and echo sounder bathymetric) data were reviewed during data collection for anomalies, and reviewed a second time during post-processing efforts using the *Hypack*® (version 2009a) data review module and Golden Software's *Surfer*® (Version 8). These software programs were used to assess the duration, amplitude, and complexity of individual magnetic disturbances, and to plot the positions of these anomalies within the survey areas to better understand spatial patterning and their association with acoustic and bathymetric anomalies.

Archaeologists maintained field notes on the locations of modern sources of ferrous material such as underwater cables, pipelines, and discarded or lost fishing equipment (clamming and crab trawls, anchors, or other jettisoned debris). Any magnetic perturbation of 3 nT or greater, with durations longer than 6.1 meters (20 feet), was cataloged for further analysis. Acoustic imaging data were reviewed for anomalous returns that could be associated with significant submerged cultural resources. Acoustic images and magnetic contouring were checked against bathymetric data for potential correlation.

6.1 SURVEY RESULTS

The project consists of two survey blocks, Block One and Block Two, that each measure approximately 5 square kilometers (2 square miles). They are located northeast of Chincoteague Inlet in the vicinity of Blackfish Bank in U.S. waters (Figure 1-1 and 1-2). Both areas are regularly transited by commercial fishing vessels, barges, sport and charter fishing boats. Large commercial trawling vessels (clam and crab d raggers) and sport fishing boats were seen on and near the survey blocks during the survey, but moved to other areas once survey operations began. A total of 28 magnetic anomalies (Table 6-1) and 30 acoustic anomalies (Table 6-2) were recorded during the survey of Blocks One and Two. Each anomaly was assigned a number preceded by A (acoustic anomaly) or M (magnetic anomaly).

6.2 BLOCK ONE

Block One measures approximately 4,664 meters (15,300 feet) by 1,341 meters (4,400 feet), or 1,545.6 acres. It was divided into 80 transects spaced at 15.2 meter (50 foot) intervals, which yielded 348,953.63 linear survey meters (1,144,861 feet) or 348.9 linear survey kilometers (216.8 miles). This area is centered upon an unnamed sand shoal that ranges in depth between 7.62 meters (25 feet) and 20.4 meters (67 feet) (Figures 1-2 and 5-1). Block One contained 24 magnetic anomalies and 18 side scan sonar anomalies, which account for 85.7 percent of the total magnetic perturbations, and 64.3 percent of the total acoustic anomalies (Figure 6-1). A total of five target clusters were identified from these anomalies in Block One; these are discussed in detail below (Table 6-3, Figure 6-1).

Table 6-1. Magnetic Anomalies

Anomaly #	Block #	Line #	Virginia State Plane S, US Srv Ft X (Center)	Virginia State Plane S, US Srv Ft Y (Center)	Latitude (Degree Min Dec Sec NAD83)	Longitude (Degree Min Dec Sec NAD83)	Amplitude (nT)	Sign	Duration (ft)	Height of Sensor (ft)	Ferrous Mass (lbs) Dipole	Ferrous Mass (lbs) Monopole
M1	2	44	12459112.95	3856689.81	37.86688595	75.11767794	30	+M	110	20	249.2	12.5
M2	2	50	12458563.47	3855950.805	37.86491188	75.1196718	10	D	136	17	51.0	3.0
M3	2	54	12458259.81	3855505.385	37.86371932	75.12077821	3	D	130	17	16.0	0.9
M4	2	62	12457063.76	3854211.194	37.86028502	75.1250788	10	D	38	15	35.9	2.4
M5	1	59	12434102.92	3848914.341	37.84797506	75.2052012	12	D	153	15	42.4	2.8
M6	1	58	12436133.56	3850807.515	37.85297605	75.19794374	3	D	192	15	10.4	0.7
M7	1	51	12432532.81	3848032.923	37.84570634	75.21074181	14	D	155	12	25.5	2.1
M8	1	51	12436870.81	3851934.793	37.855999	75.19525526	4	D	177	12	7.2	0.6
M9	1	50	12436792.32	3851926.231	37.85598305	75.19552799	5	M-	101	12	9.5	0.8
M10	1	50	12432691.1	3848249.244	37.84628489	75.21016787	4	D	808	8	2.1	0.3
M11	1	45	12430051.54	3846203.226	37.84092178	75.21954959	17	D	139	15	59.2	3.9
M12	1	46	12438055.09	3853335.923	37.85973046	75.1909859	2	M-	143	25	32.3	1.3
M13	1	46	12432988.33	3848796.139	37.8477574	75.20907315	3	D	722	20	28.9	1.4
M14	1	46	12430033.47	3846133.658	37.84073258	75.21962049	4	D	311	20	31.3	1.6
M15	1	47	12432728.31	3848471.545	37.84689143	75.21001226	4	D	333	20	34.0	1.7
M16	1	42	12436094.73	3851850.277	37.85584161	75.19795185	3	M-	296	25	46.7	1.9
M17	1	42	12431368.87	3847587.257	37.84459449	75.21482388	3	M-	96	20	24.3	1.2
M19	1	39	12435347.21	3851369.413	37.85459365	75.20059753	3	M+	355	20	22.1	1.1
M20	1	37	12429231.17	3846005.345	37.84045693	75.22241248	6	D	124	15	22.0	1.5
M21	1	36	12429137.53	3845982.409	37.84040291	75.22273931	6	D	110	15	21.0	1.4
M22	1	35	12435795.04	3852041.344	37.85639477	75.19896607	4	D	655	15	13.7	0.9
M23	1	32	12432918.68	3849665.319	37.85014952	75.2092093	20	D	230	18	118.2	6.6
M24	1	31	12432908.65	3849725.236	37.85031493	75.20923679	57	D	149	20	474.4	23.7
M25	1	24	12432854.9	3850127.046	37.85142283	75.20937433	21	D	109	20	171.6	8.6

Anomaly #	Block #	Line #	Virginia State Plane S, US Srv Ft X (Center)	Virginia State Plane S, US Srv Ft Y (Center)	Latitude (Degree Min Dec Sec NAD83)	Longitude (Degree Min Dec Sec NAD83)	Amplitude (nT)	Sign	Duration (ft)	Height of Sensor (ft)	Ferrous Mass (lbs) Dipole	Ferrous Mass (lbs) Monopole
M26	1	15	12435718.04	3853319.502	37.85991004	75.19907784	5	D	226	24	69.5	2.9
M27	1	14	12434212.06	3852023.991	37.85649899	75.20444759	5	D	194	25	74.0	3.0
M28	1	14	12438094.13	3855518.353	37.86571631	75.19058581	5	D	543	25	74.3	3.0
M29	1	33	12429808.24	3846792.861	37.84256325	75.22032067	3	D	405	18	19.6	1.1

Table 6-2. Acoustic Anomalies

Anomaly Number	Block/ Line	Magnetic Association	Dimensions L x W x H (Ft)	Shape	Latitude NAD 83 Coordinates (in decimal degrees)	Longitude NAD 83 Coordinates (in decimal degrees)	Minimum Avoidance Distance (Ft)	Identification	Anomaly Number	Block/ Line	Magnetic Association
A1	B1L7	No Association	24ft x 12ft x 3ft	Amorphous	37 51.5671	75 12.1455	NA	Debris Field	A1	B1L7	No Association
A2	B1L10(06)	No Association	2ft x 3ft x 1 ft (2 Pieces)	Roughly Circular	37 50.9082	75 13.0137	NA	2 Pieces of Debris	A2	B1L10(06)	No Association
A3	B1L10(18)	No Association	52ft x 27ft x 2ft	Amorphous	37 51.7131	75 11.8008	NA	Debris Field	A3	B1L10(18)	No Association
A4	B1L14(01)	No Association	1ft x 1ft x 2ft (2 Pieces)	Linear	37 50.5139	75 13.5527	NA	Two linear objects protruding from sea floor	A4	B1L14(01)	No Association
A5	B1L15(17)	No Association	4.5ft x 4.5ft x 2ft	Circular	37 51.0286	75 12.8350	NA	Debris	A5	B1L15(17)	No Association
A6	B1L17(00)	No Association	3ft x 2ft x 1 ft	Oblong	37 50.4863	75 13.5659	NA	Debris	A6	B1L17(00)	No Association
A7	B1L19(05)	No Association	16ft x .5ft x 1.5 ft	Linear	37 50.7925	75 13.047	NA	Pipe Fragment	A7	B1L19(05)	No Association
A8	B1L23(04)	No Association	14.5ft x .5ft x 2ft	Linear	37 50.6855	75 13.1465	NA	Pipe Fragment	A8	B1L23(04)	No Association
A9	B1L44(20)	No Association	2.5ft x 2.5ft x 1 ft	Circular	37 50.6199	75 12.9780	NA	Possible Tire	A9	B1L44(20)	No Association
A10	B1L50(19)	No Association	9ft x 9ft x 2ft	Circular	37 50.610	75 12.8110	NA	Encrusted Ring	A10	B1L50(19)	No Association
A11	B1L59(50)	No Association	1ft x 1ft x 2ft	Linear	37 51.8257	75 10.9561	NA	Linear object protruding from sea floor	A11	B1L59(50)	No Association
A12	B1L59(69)	No Association	13ft x .6ft x 3ft	Linear	37 50.5486	75 12.8687	NA	Linear object protruding from sea floor	A12	B1L59(69)	No Association

Anomaly Number	Block/ Line	Magnetic Association	Dimensions L x W x H (Ft)	Shape	Latitude NAD 83 Coordinates (in decimal degrees)	Longitude NAD 83 Coordinates (in decimal degrees)	Minimum Avoidance Distance (Ft)	Identification	Anomaly Number	Block/ Line	Magnetic Association
A13	B1L59(153)	No Association	.5ft x .5ft x 2ft	Linear	37 51.4231	75 11.6128	NA	Linear object protruding from sea floor	A13	B1L59(153)	No Association
A14	B1L60(05)	No Association	11.2ft x 2ft x 1.5 ft	Linear	37 50.4917	75 12.8325	NA	Linear object on sea floor	A14	B1L60(05)	No Association
A15	B1L61(13)	No Association	6.1ft x 6ft x 1 ft	Circular	37 50.9885	75 12.1519	NA	Encrusted Debris	A15	B1L61(13)	No Association
A16	B1L78(11)	No Association	20.5ft x 6ft x 3ft	Amorphous	37 50.9822	75 11.8848	NA	Debris	A16	B1L78(11)	No Association
A17	B1L78(15)	No Association	17.1ft x 3ft x 1 ft	Amorphous	37 50.7378	75 12.2568	NA	Debris	A17	B1L78(15)	No Association
A18	B1L75(48)	No Association	10ft x .5ft x 2ft	Linear	37 51.5405	75 11.0098	NA	Linear object protruding from sea floor	A18	B1L75(48)	No Association
A19	B2L4(04)	No Association	13.5ft x 13ft x 2ft	Amorphous	37 52.5942	75 06.6265	NA	Clam Dredge	A19	B2L4(04)	No Association
A20	B2L6(14)	No Association	6ft x 6ft x 1 ft	Circular	37 52.1309	75 07.5112	NA	Encrusted Debris	A20	B2L6(14)	No Association
A21	B2L12(040	No Association	25ft x 1.5ft x 1ft	Linear	37 52.6790	75 06.4004	NA	Possible Cable Section	A21	B2L12(040	No Association
A22	B2A22	No Association	15ft x 13ft x 2ft	Amorphous	37 52.0923	75 07.4873	NA	Possible Clam Dredge	A22	B2A22	No Association
A23	B2L36(20)	No Association	4ft x 1ft x 1ft	Linear	37 51.6208	75 07.9707	NA	Debris	A23	B2L36(20)	No Association
A24	B2L39(00)	No Association	9ft x 6ft x 2ft	Amorphous	37 52.6882	75 05.8325	NA	Debris	A24	B2L39(00)	No Association
A25	B2L40(01)	No Association	2.33ft x 1ft x 2ft	Linear	37 52.7129	75 05.7803	NA	Debris	A25	B2L40(01)	No Association
A26	B2L49(06)	No Association	1.67ft x .5ft x 1.5ft	Linear	37 52.4089	75 06.3760	NA	Debris	A26	B2L49(06)	No Association

Anomaly Number	Block/ Line	Magnetic Association	Dimensions L x W x H (Ft)	Shape	Latitude NAD 83 Coordinates (in decimal degrees)	Longitude NAD 83 Coordinates (in decimal degrees)	Minimum Avoidance Distance (Ft)	Identification	Anomaly Number	Block/ Line	Magnetic Association
A27	B2L42(02)	No Association	2.33ft x 1ft x 2ft	Linear	37 52.6582	75 05.8438	NA	Debris	A27	B2L42(02)	No Association
A28	B2L44(03)	No Association	2.6ft x 1ft x 2ft	Linear	37 52.5747	75 05.9619	NA	Debris	A28	B2L44(03)	No Association
A29	B2L45(18)	No Association	87ft x 27ft x 2ft	Amorphous	37 52.4946	75 06.0278	NA	Biological	A29	B2L45(18)	No Association
A30	L46	No Association		Amorphous	37 52.0310	75 06.5884	NA	Debris	A30	L46	No Association

Table 6-3. Identified Targets within the WFF Offshore Sand Borrow Survey Project

Target No.	Magnetic Anomalies Associated with Each Target	Associated Acoustic Anomalies
T1	M23, M24	N/A
T2	M7, M10, M13, M15	N/A
T3	M20, M21	N/A
T4	M11, M14	N/A
T5	M8, M9	N/A

6.2.1 Block One Target Descriptions

Each target cluster is comprised of associated acoustic or magnetic anomalies, or combinations of both. These data were grouped based on proximity, spatial patterning, and magnetic signature, amplitude, or duration. Each target was assigned the prefix T to aid in plotting and differentiation.

6.2.1.1 Target 1

Target 1 is comprised of magnetic perturbations M23 and M24. Anomaly M23 is a dipolar anomaly with a low amplitude of 20 nT, a long duration of 70.1 meters (230 feet), and a calculated ferrous mass of approximately 53.5 kilograms (118 pounds) with the height of sensor at 5.5 meters (18 feet) off the bottom (Tables 6-1 and 6-3, Figure 6-1). Anomaly M24 is a dipolar anomaly with a medium amplitude of 57nT, a medium duration of 44.8 meters (147 feet), and an estimated ferrous mass calculated to be 215 kilograms (474 pounds) with the height of sensor at 6.1 meters (20 feet) off the bottom. The data was reviewed for magnetic pattern analysis and magnetic contouring (Figure 6-2).

Analysis indicates that this anomaly consists of a single large ferrous mass with material extending onto an adjoining survey line. It likely represents lost trawling equipment or other ground tackle. Target One is located on a bathymetric rise where trawlers run parallel to the long axis of the sand feature. It is common for fishermen to lose, or “hang”, trawling equipment if they are unaware of abruptly changing bathymetry and moving too fast.

Acoustic data recorded in the vicinity of Target 1 does not reveal any anomalous acoustic images. The lack of side scan sonar correlates and the simple magnetic signatures of the anomalies indicate that Target 1 is likely buried ferrous debris associated with lost commercial fishing gear or ground tackle. No avoidance or further work is recommended for Target 1.

6.2.1.2 Target 2

Target 2 is composed of magnetic perturbations M7, M10, M13, and M15 (Tables 6-1 and 6-3, Figure 6-1). Anomaly M7 is a dipole with a medium duration of 47.5 meters (156 feet), a low amplitude of 14 nT, and an calculated ferrous mass of 11.3 kilograms (25 pounds). Anomaly M10 is a dipolar anomaly with a low amplitude of 4 nT, a long duration of 246.3 meters (808 feet), and a calculated ferrous mass of 0.9 kilograms (2.1 pounds). Anomaly M 13 is a dipole with a low amplitude of 3 nT, a long duration of 220 meters (722 feet), and a calculated ferrous mass of 12.7 kilograms (28 pounds). Anomaly M 15 is a dipole with a long duration of 101.5

meters (333 feet), a low amplitude of 4 nT, and a calculated ferrous mass of 15.4 kilograms (34 pounds). The data was reviewed for magnetic pattern analysis and magnetic contouring (Figure 6-3). The dipolar signature of all perturbations indicates that the magnetic sensor passed directly over or just next to the detected ferrous mass. Magnetic analysis indicates that Target 2 is a simple isolated ferrous object, such as a section of wire rope or cable that has drifted along the margin of the sand rise in Block One. Sudden changes in the aspect ratio of the magnetic sensor to the seafloor (i.e. depth changes), will create a low amplitude deflection along the region of bathymetric change in areas that are magnetically inert. The acoustic data recorded in the vicinity of Target 2 shows a featureless surface adjacent to a drop off of the sand ridge. Target 2 does not represent a significant submerged cultural resource and no further avoidance or work is recommended.

6.2.1.3 Target 3

Target 3 is comprised of magnetic anomalies M20 and M21 (Tables 6-1 and 6-3, Figure 6-1). Anomaly M20 is a dipolar anomaly with a low amplitude deflection of 6 nT, a medium duration of 37.8 meters (124 feet), and a calculated ferrous mass of 10 kilograms (22 pounds). Anomaly M21 is a dipole with a low amplitude deflection of 6 nT, a medium duration of 33.5 meters (110 feet), and a calculated ferrous mass of 9.5 kilograms (21 pounds). The data were reviewed for magnetic pattern analysis and magnetic contouring (Figure 6-4). The magnetic analysis of this Target 3 indicates that it is a simple dipolar anomaly that lacks the complexities associated with submerged cultural resources. This target, much like Target 2, is probably a section of wire rope or chain lost or discarded by fishing vessels. It could also represent sudden changes in the aspect ratio between the magnetic sensor and the seafloor. Acoustic data recorded in this vicinity does not show any anomalous surface features. Target 3 is clearly not associated with any significant cultural resource; no further work is recommended.

6.2.1.4 Target 4

Target 4 consists of magnetic anomalies M11 and M14 (Tables 6-1 and 6-3, Figure 6-1). Anomaly M11 is a dipolar perturbation with a low amplitude deflection of 17 nT, a medium duration of 58.8 meters (139 feet), and a calculated ferrous mass of 26.8 kilograms (59 pounds). Anomaly M14 is a dipolar anomaly that has a low magnetic deflection of 4 nT, a long duration of 94.8 meters (311 feet), and a calculated ferrous mass of 14.4 kilograms (31 pounds). The data was reviewed for magnetic pattern analysis and magnetic contouring (Figure 6-5). Acoustic data recorded in this area shows a seafloor covered in shallow sand waves and deep trawl scarring. Analysis of this target indicates that it has a simple magnetic pattern indicative of a lost modern anchor and chain, and not a significant cultural resource. No further avoidance or work is recommended for Target 4.

6.2.1.5 Target 5

Target 5 consists of magnetic anomalies M8 and M9 (Tables 6-1 and 6-3, Figure 6-1). Anomaly M8 is a dipolar perturbation with a low magnetic deflection of 4 nT, a medium duration of 53.9 meters (177 feet), and a calculated ferrous mass of 3.6 kilograms (8 pounds). Anomaly M 9 is also a simple dipolar anomaly with a low magnetic deflection of 5 nT, a long duration of 30.5 meters (100 feet), and a calculated ferrous mass of 3.6 kilograms (8 pounds). Data was reviewed for magnetic pattern analysis and magnetic contouring (Figure 6-6). Side Scan Sonar did not record any anomalous surface features in this area other than low amplitude sand waves. Analysis of Target 5 indicates that anomalies M8 and M9 likely represent isolated ferrous material lost or jettisoned from sport or commercial fishing vessels. Target 5 lacks the characteristics of a sunken ship or other significant submerged cultural resource. No further avoidance or work is recommended for Target 5.

6.2.1.6 Sub Bottom Profiler

Sub bottom data recorded in Block One did not reveal any buried cultural resources. Transect 1 (B1L01) shows approximately 20- t (6.1 m) of penetration with minor bedded sands and no other structure (Figure 6-7). Transects 20 and 40 also depict comparably bedded sands with no other structure (Figures 6-8 and 6-9). No structures or geomorphic features likely to be associated with buried maritime cultural resources or prehistoric habitation or activity sites were recorded in Block One.

6.3 BLOCK TWO

Block Two is located 3.6 kilometers (2.25 miles) to the northeast of Block One, and measures approximately 4,055 meters (13,300 feet) by 1,220 meters (4,000 feet), or 1,221.4 acres. It was divided into 84 transect lines spaced at 15.2 meter (50 foot) intervals, which yields 318,339.5 linear survey meters (1,044,421 feet), or 318.3 linear survey kilometers (197.8 miles). (Figures 1-2 and 5-2). Block Two contained 12 side scan sonar anomalies and four magnetic anomalies, which account for 14.3 percent of the total magnetic perturbations and 35.7 percent of the total acoustic anomalies (Tables 6-1 and 6-2, Figure 6-10). No target clusters were identified from the anomalies in Block 2.

Acoustic and magnetic anomalies recorded in Block Two represent debris jettisoned from passing vessels or deposited by storm events. Objects include possible tires, logs, wire rope, chain, and pipe sections. Acoustic anomalies A19 and A22 in Block Two are thought to be the remains of clam dredges that have been snagged and pulled apart (Table 6-2). These clam dredges appear modern in design, and given the amount of clam draggers operation in the local area (Plate 6-1), it is not surprising that there are remains of both clam and crab trawls lost on these submerged sand platforms.

6.3.2 Sub Bottom Profiler

Sub Bottom Profiler data from Block Two was similar to Block One. Approximately 4.6 meters (15 feet) of penetration was achieved with comparable resolution. A good example of this is seen on Line B2L02, where penetration reaches approximately 4.6 meters (15 feet) into sediments. The acoustic signal is attenuated after this depth, and only AC interference and surface reflections (duplet) are recorded (Figure 6-11). No structures or geomorphic features likely to be associated with buried maritime cultural resources or prehistoric habitation or activity sites were recorded in Block Two.

6.4 DISCUSSION

The magnetic and acoustic anomaly distribution numbers in Blocks One and Two are heavily skewed toward Block One (85.7 percent of the total magnetic perturbations, and 64.3 percent of the total acoustic anomalies). The proximity of Blackfish Bank to Block One may indicate that some anomalies represent loss or trash originally discarded on or near that submerged landform and the heavily fished artificial reef that was created there. These objects would have then slowly migrated and hung up on the sand shoals of Block One and later Block Two. This theory is supported by the fact that there are far fewer anomalies in Block Two, which lies over two mi (3.2 km) from Block One. The greater the distance from the more commonly trafficked and fished banks, the lower the number of recorded ferrous materials and acoustic anomalies.

Sub bottom profiler data indicated that subsurface sediment patterns varied little between Blocks One and Two. Weak bedding within sediments in these areas is indicative of a homogenous sediment package created by preferential grain sorting that resulted from normal currents and wave action, and more dramatic storm events. This homogeneity, as stated in Section Four, has resulted from preferential grain sorting that has taken place since the most recent sea level rise. This sorting has reduced to almost nothing the potential for these sand features have to contain intact maritime cultural resources and prehistoric features.

7.0 SUMMARY AND RECOMMENDATIONS

This chapter offers recommendations for the cultural resources survey of two proposed sand borrow sites, Unnamed Shoal A and Unnamed Shoal B, located northeast of Chincoteague Inlet in the vicinity of Blackfish Bank in U.S. waters (Figures 1-1 and 1-2). This survey was undertaken as a part of the proposed NASA WFF SRIPP, Wallops Island, Virginia.

Comprehensive analysis of survey data was conducted using criteria that included magnetic complexity, amplitude, duration, and contouring, along with the spatial patterning of all anomalies. Analysis included review of all side scan sonar and sub bottom profiler data to identify any structures or geomorphic features associated with submerged historic cultural materials and prehistoric habitation or activity sites.

A total of 28 magnetic anomalies (Table 6-1) and 30 acoustic anomalies (Table 6-2) were recorded during the survey of Block One (Unnamed Shoal A) and Block Two (Unnamed Shoal B). Block One contained 18 side scan sonar anomalies and 24 magnetic anomalies, which yielded five target clusters for further analysis (Tables 6-1, 6-2, and 6-3, Figure 6-1). Block Two contained 12 side scan sonar anomalies, four magnetic anomalies, and no target clusters (Tables 6-1 and 6-2, Figure 6-10). A total of 85.7 percent of the recorded magnetic anomalies were found in Block One, while only 14.3 percent were located within Block Two. The distribution of acoustic anomalies followed a similar pattern, in that 64.3 percent of acoustic anomalies were located in Block One, and the remaining 35.7 percent were found in Block Two (Figures 6-1 and 6-7).

Sub bottom profiler data analysis for Blocks One and Two indicated that these sand features have relatively poor bedding, which indicates that the sands are homogenous in nature. This sediment homogeneity has likely resulted from long term preferential grain size sorting by current, wave action, and large storm events.

Overall, the greatest the amount of material was detected in Block One, which is located closer to Blackfish Bank and the adjacent fish haven. The acoustic and magnetic signatures from the five targets and isolated anomalies are consistent with modern debris that originated from two sources. The first source was sport and commercial fishermen, who often lose anchors, chains, wire rope sections, trawls, and general flotsam in areas they frequent. The second source is barges, which have transported and dropped a variety of ferrous debris intended as structure for fish haven locations near Blackfish Bank (Figure 1-2). Data analysis, when coupled with the fishing that takes place on or near the survey areas, indicated that none of the detected anomalies have potential to represent significant submerged cultural resources. No further avoidance or work is recommended for the isolated anomalies or five target clusters identified in Blocks One and Two.

7.1 UNANTICIPATED DISCOVERY

While it is unlikely that any cultural material will be discovered during dredging operations, an unanticipated discovery of archaeological resources would result in the immediate cessation of operations within 1,000 feet of the area of the discovery. NASA is then required to report said discovery to the Regional Supervisor, Leasing and Environment, Gulf of Mexico Region within 72 hours of discovery. The Regional Supervisor would then inform NASA as to how to proceed.

7.1.1 MMS Project Review

AS part of the MMS review of the proposed offshore sand borrows, all of the required data was provided to MMS for review as promulgated in NTL No. 2005-G07. Two large digital geo-tifs were provided to the MMS reviewers and were not reproduced for this report due to the size of the high resolution acoustic images (100 gigabytes each). Since the MMS is a cooperating agency with NASA in regards to this project, MMS reviewed the draft report and has concurred with the findings of the report, and stated that archaeological mitigation is not required for this project (Dirk Herkhof [Meteorologist-MMS], Email to Joshua A. Bundick [Lead, Environmental Planning- NASA Wallops Flight Facility], December 15, 2009, 16:13).

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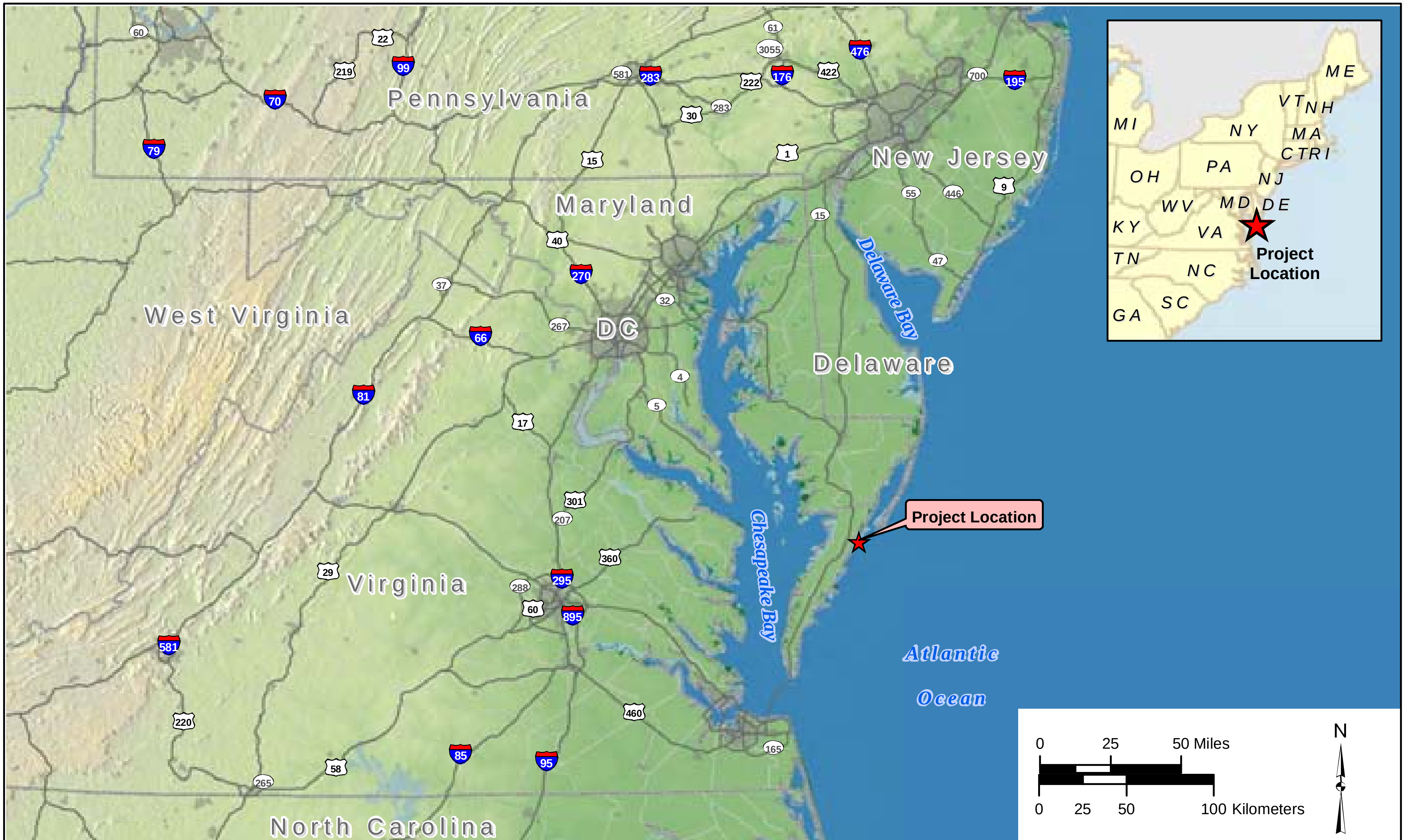
Addendum:

Report Figures and Plates



PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 50 miles
SOURCE	ESRI, USGS

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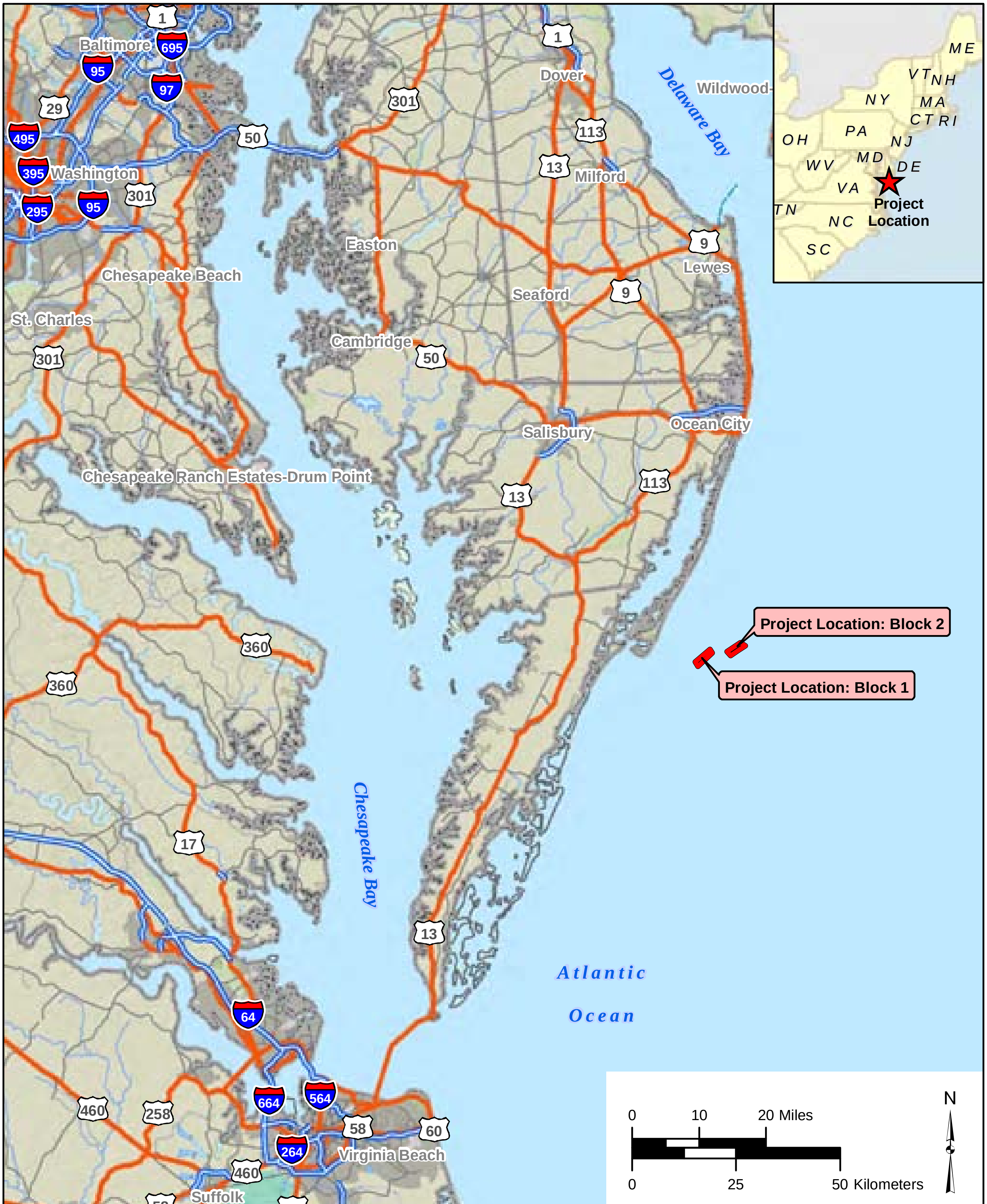
Project Location

PROJECT NO.	15299035
FIGURE NO.	1-1



PROJECT WFF SRIPP Offshore Sand Borrow Survey

SCALE 1 inch = 20 miles

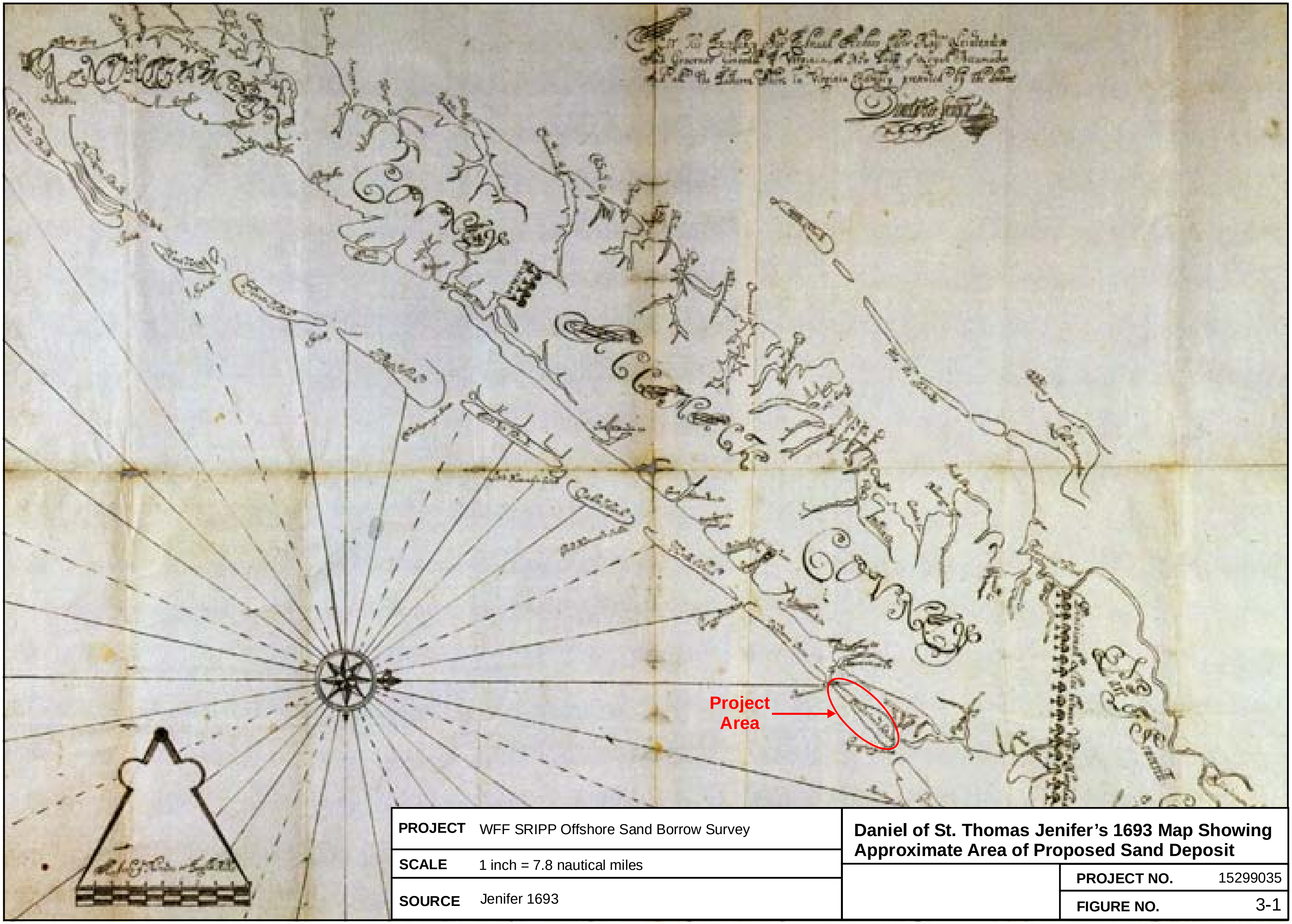
SOURCE ESRI, USGS

\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB
\mag_accoustic_anomolies\GIS_Projects\fig1_2_location_20090918.mxd

Location of Proposed Sand Borrow Areas in Chincoteague Inlet of Blackfish Bank in U.S. Federal Waters

PROJECT NO. 15299035

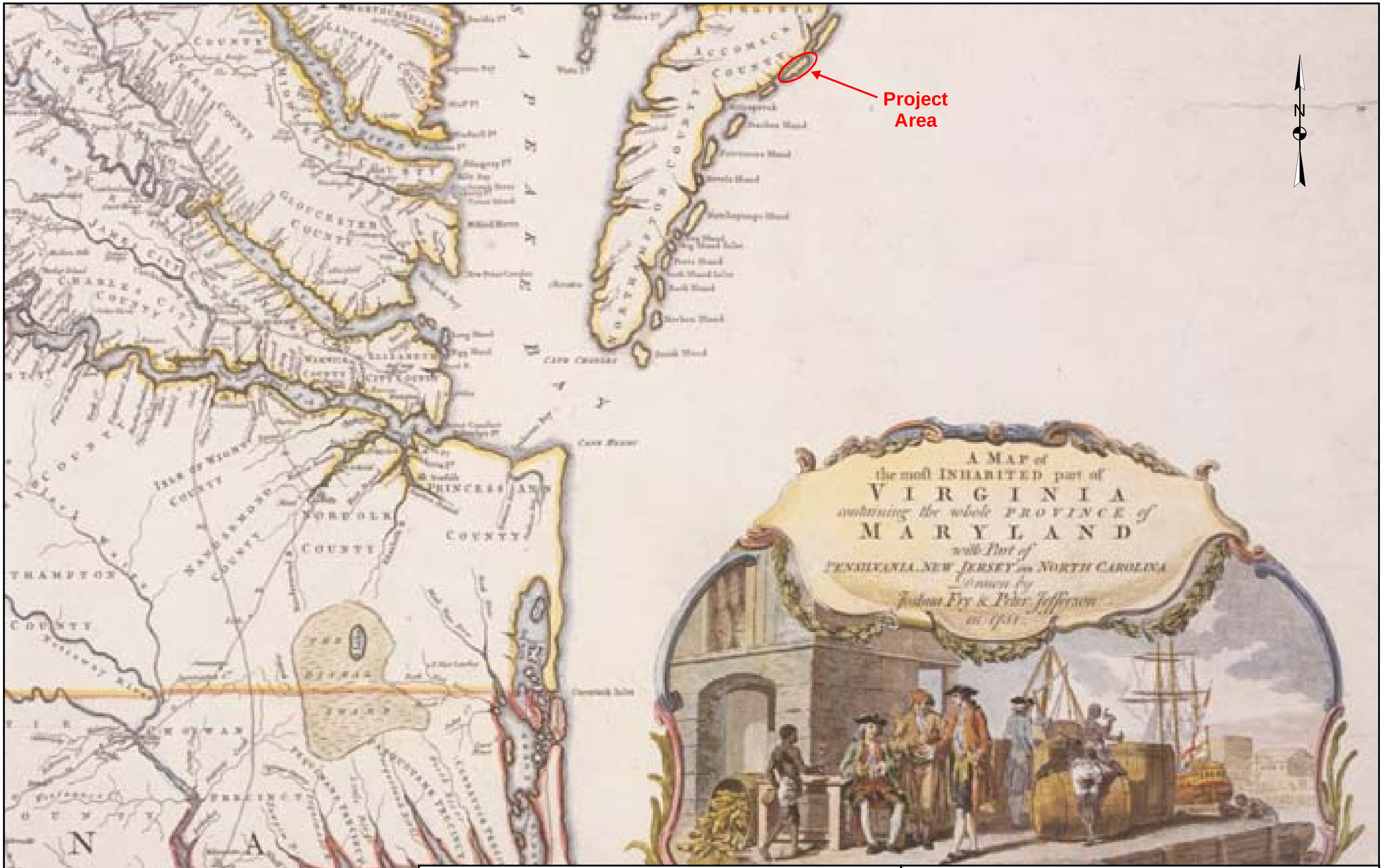
FIGURE NO. 1-2



PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 7.8 nautical miles
SOURCE	Jenifer 1693

Daniel of St. Thomas Jenifer's 1693 Map Showing Approximate Area of Proposed Sand Deposit

PROJECT NO.	15299035
FIGURE NO.	3-1

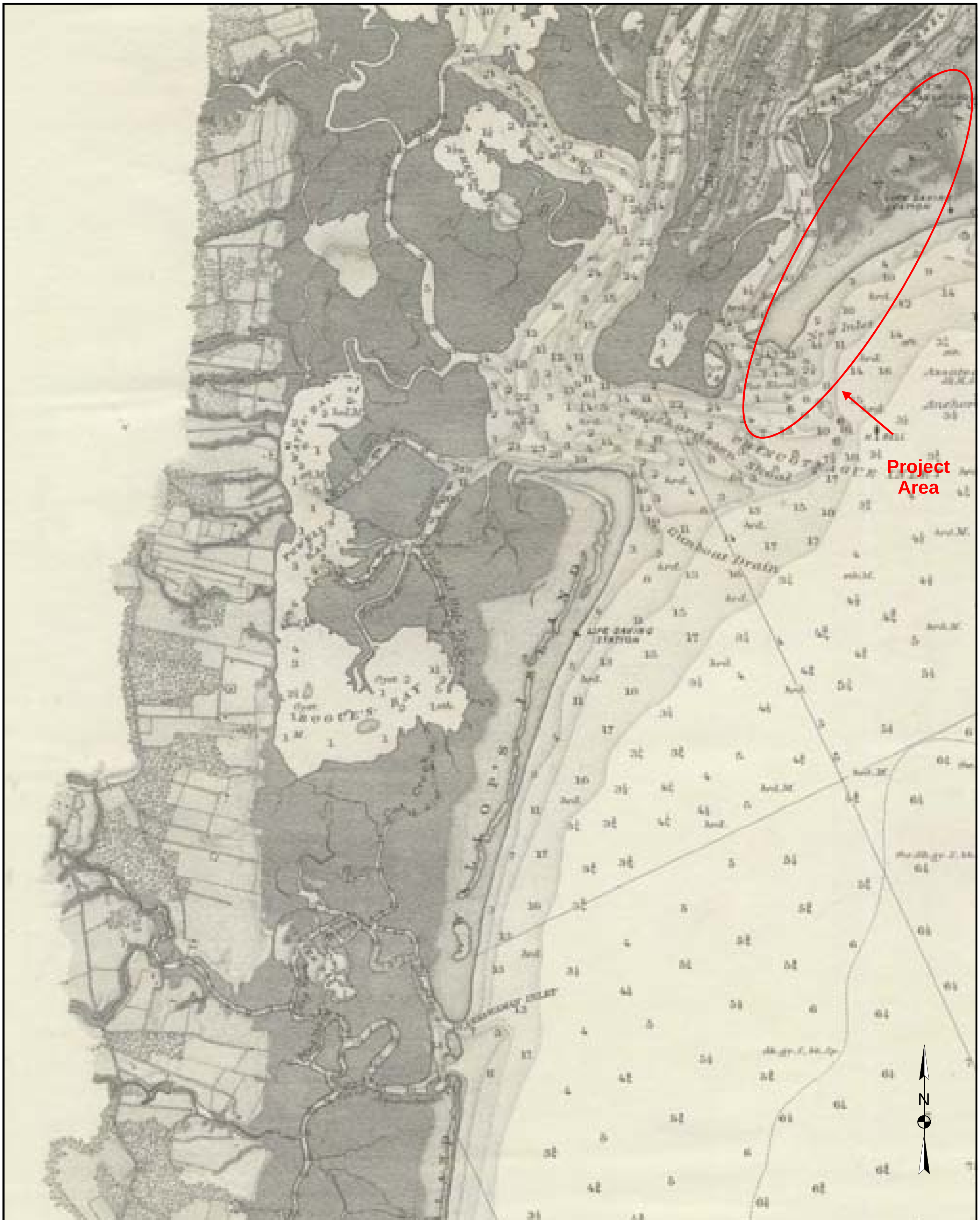


PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Fry and Jefferson's 1751 Map Showing Approximate Location of Sand Deposit**	
SCALE	1 inch = 22 1/3 nautical miles	**PROJECT NO.**	15299035
SOURCE	Fry and Jefferson 1751	**FIGURE NO.**	3-2

PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 20 nautical miles
SOURCE	Madison 1807

Madison's 1807 Map of Virginia Showing Approximate Location of Proposed Sand Deposit

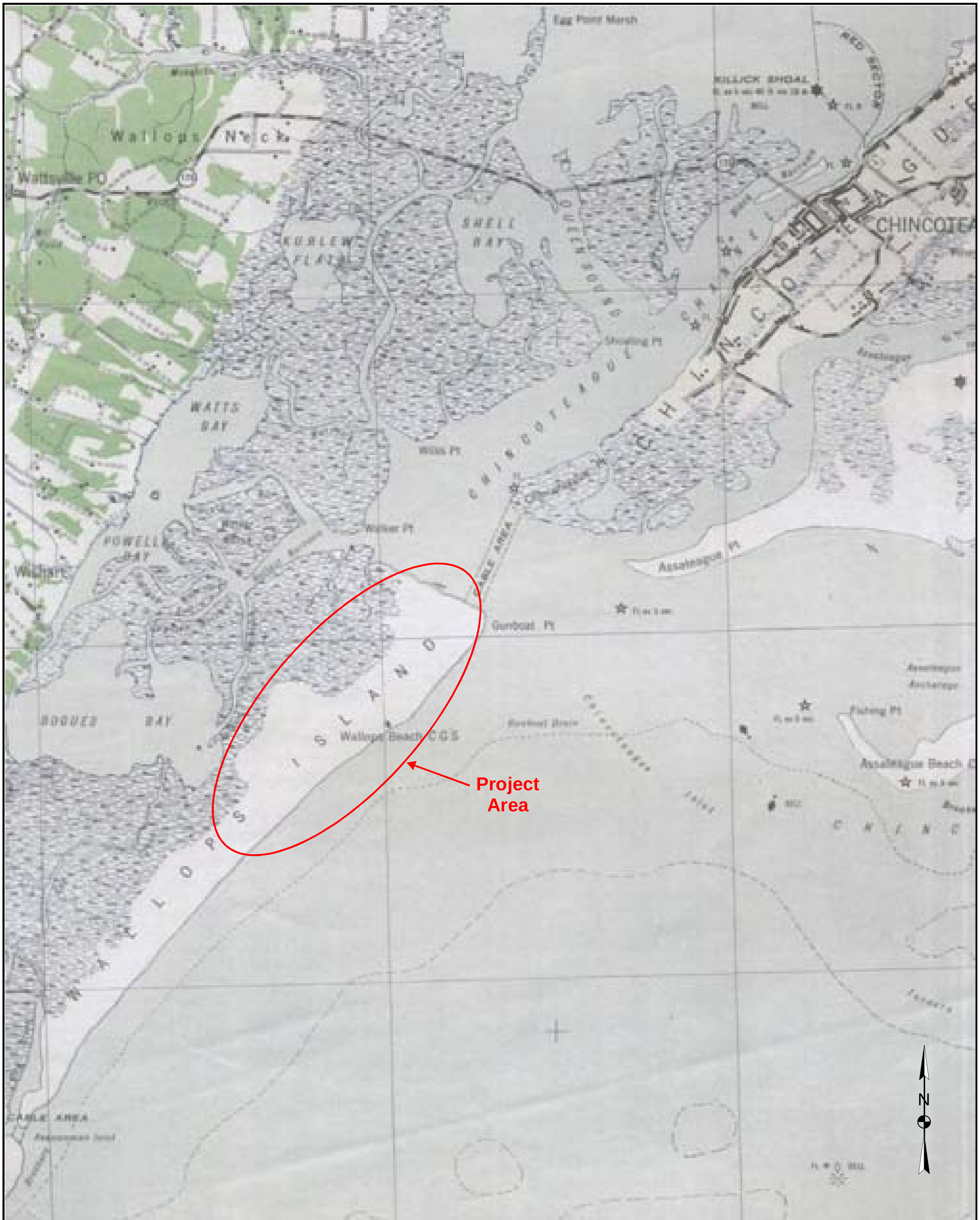
PROJECT NO.	15299035
FIGURE NO.	3-3



PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	3.5 inches = 5 nautical miles (1 to 80,000)
SOURCE	USC&GS Coast Chart No.129, 1892

US Coast and Geodetic Survey 1892 Map Showing Area of Proposed Sand Deposit

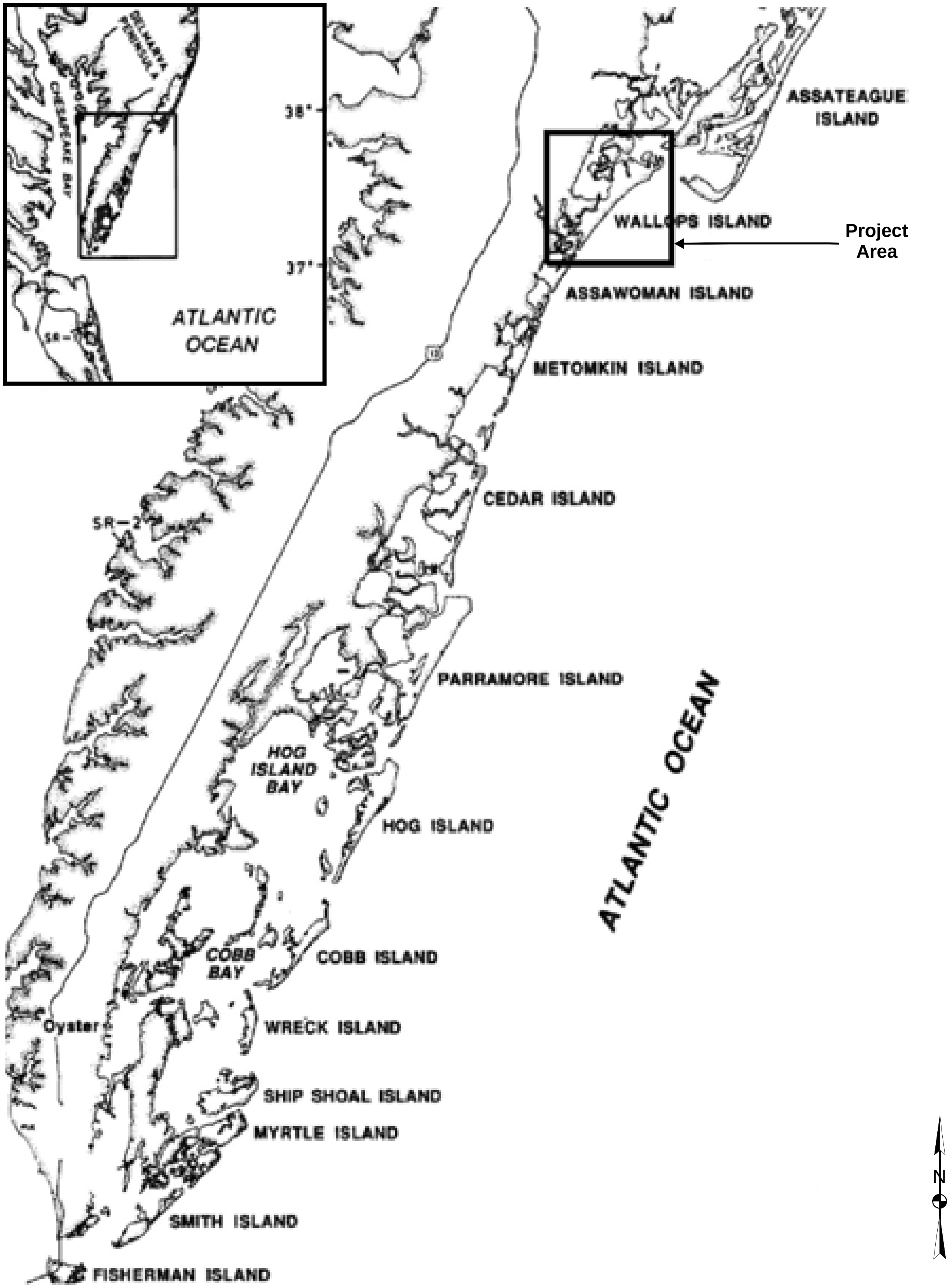
PROJECT NO.	15299035
FIGURE NO.	3-4



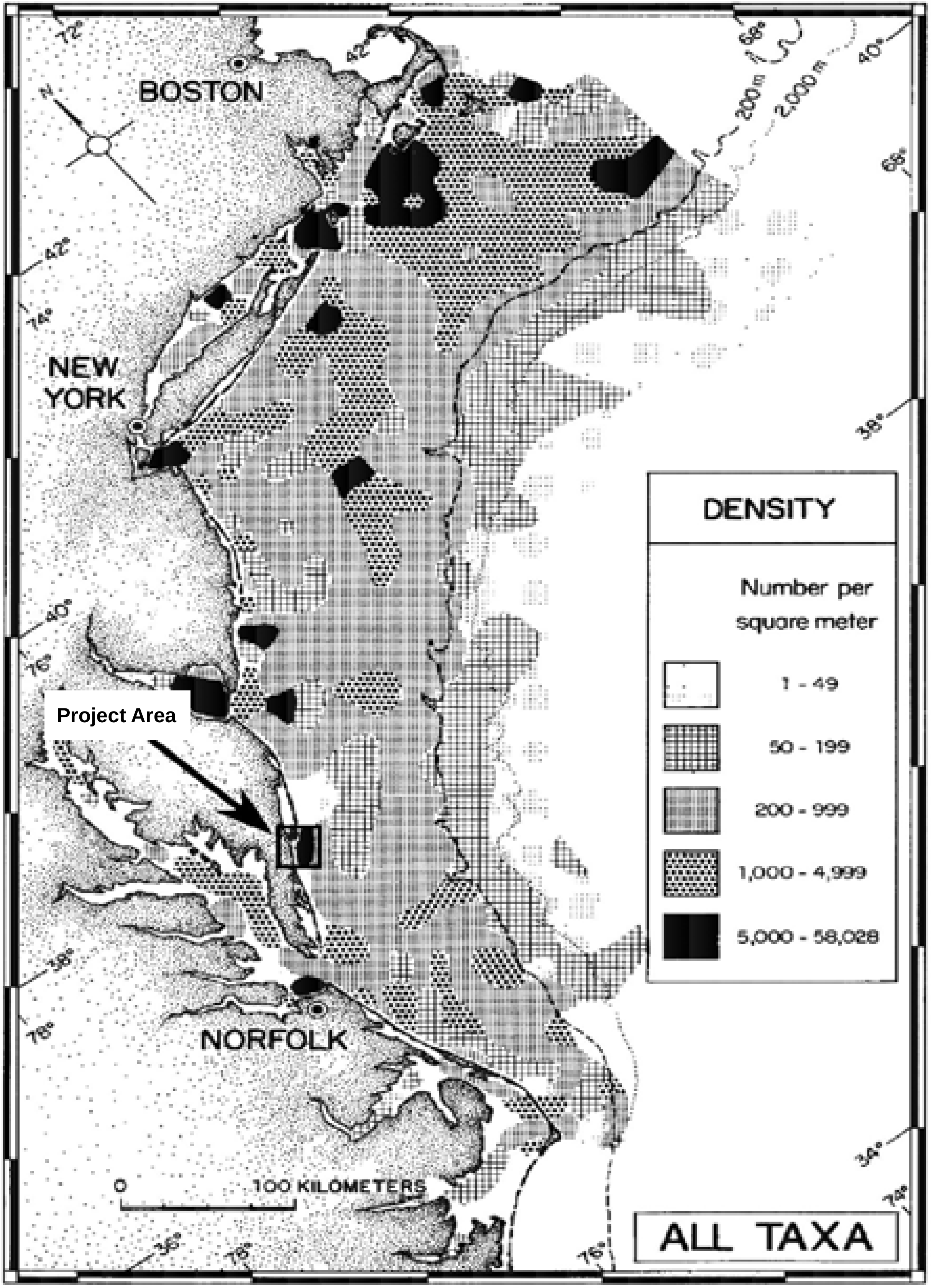
PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 1 mile
SOURCE	USGS 15 Minute Series, 1937

USGS 1937 Map Showing Approximate Location of Proposed Sand Deposit

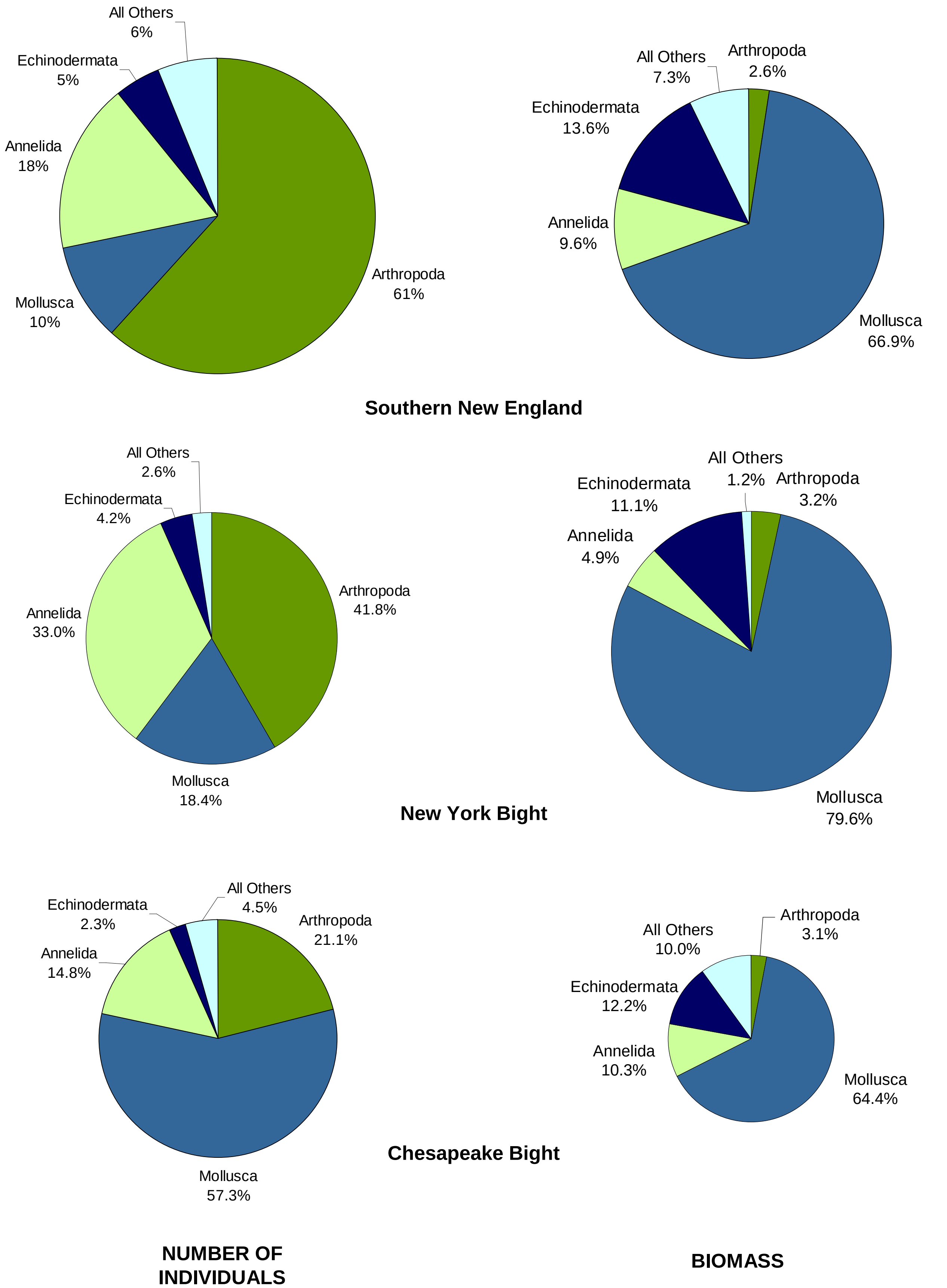
PROJECT NO.	15299035
FIGURE NO.	3-5



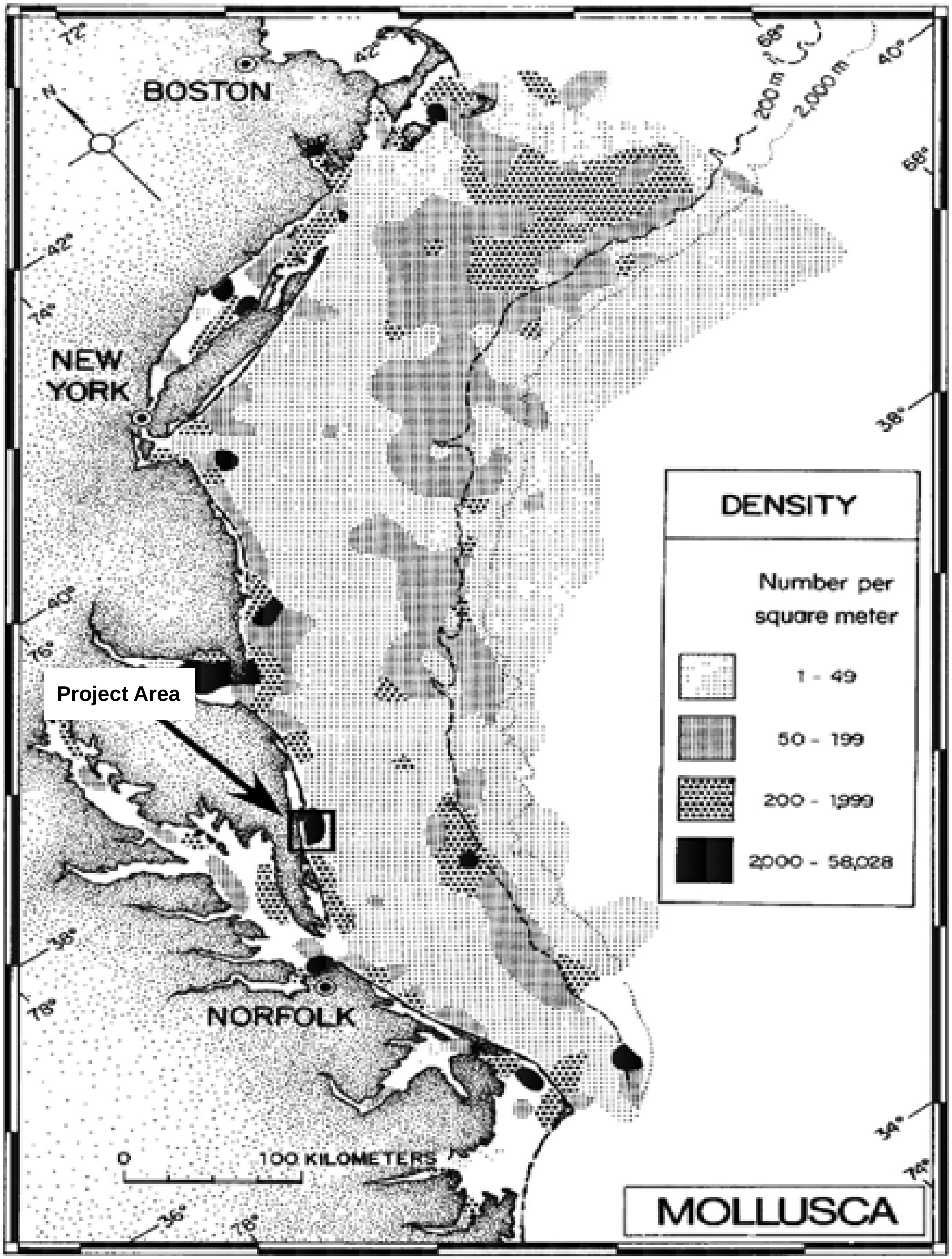
PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Location Map of the Delmarva Peninsula Showing Study Area**	
SCALE	Unknown	**PROJECT NO.**	15299035
SOURCE	Oertel et al. 1989	**FIGURE NO.**	4-1



PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Map of Density of Taxa in Mid-Atlantic Bight Bottom Sediments (Note High Density of Taxa in Project Area)**	
SCALE	1 inch = 52 miles (84 kilometers)	**PROJECT NO.**	15299035
SOURCE	Wigley and Theroux 1981	**FIGURE NO.**	4-2



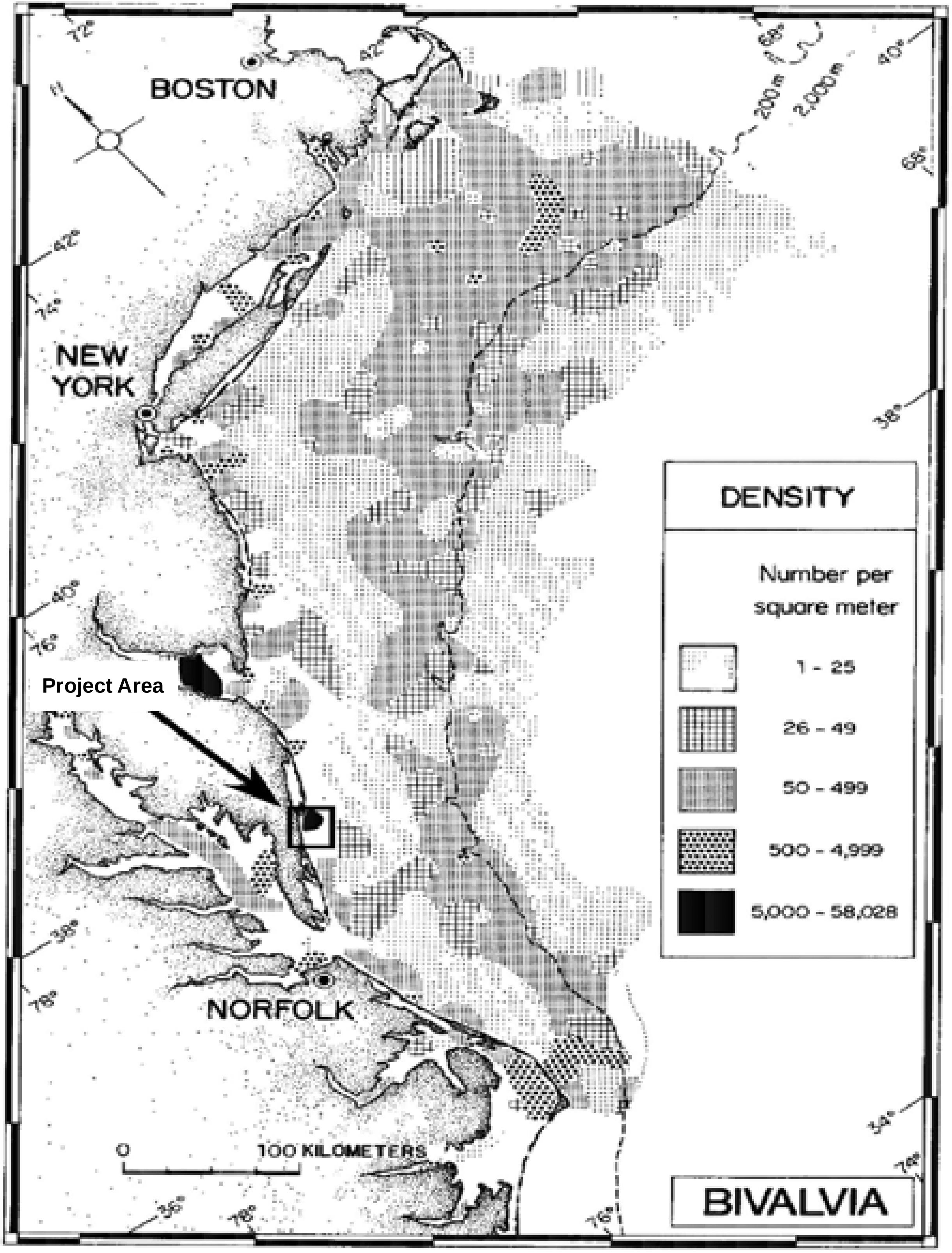
PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Diagram Showing Benthos Dominated by Mollusca in the Chesapeake Bight**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	Wigley and Theroux 1981	**FIGURE NO.**	4-3



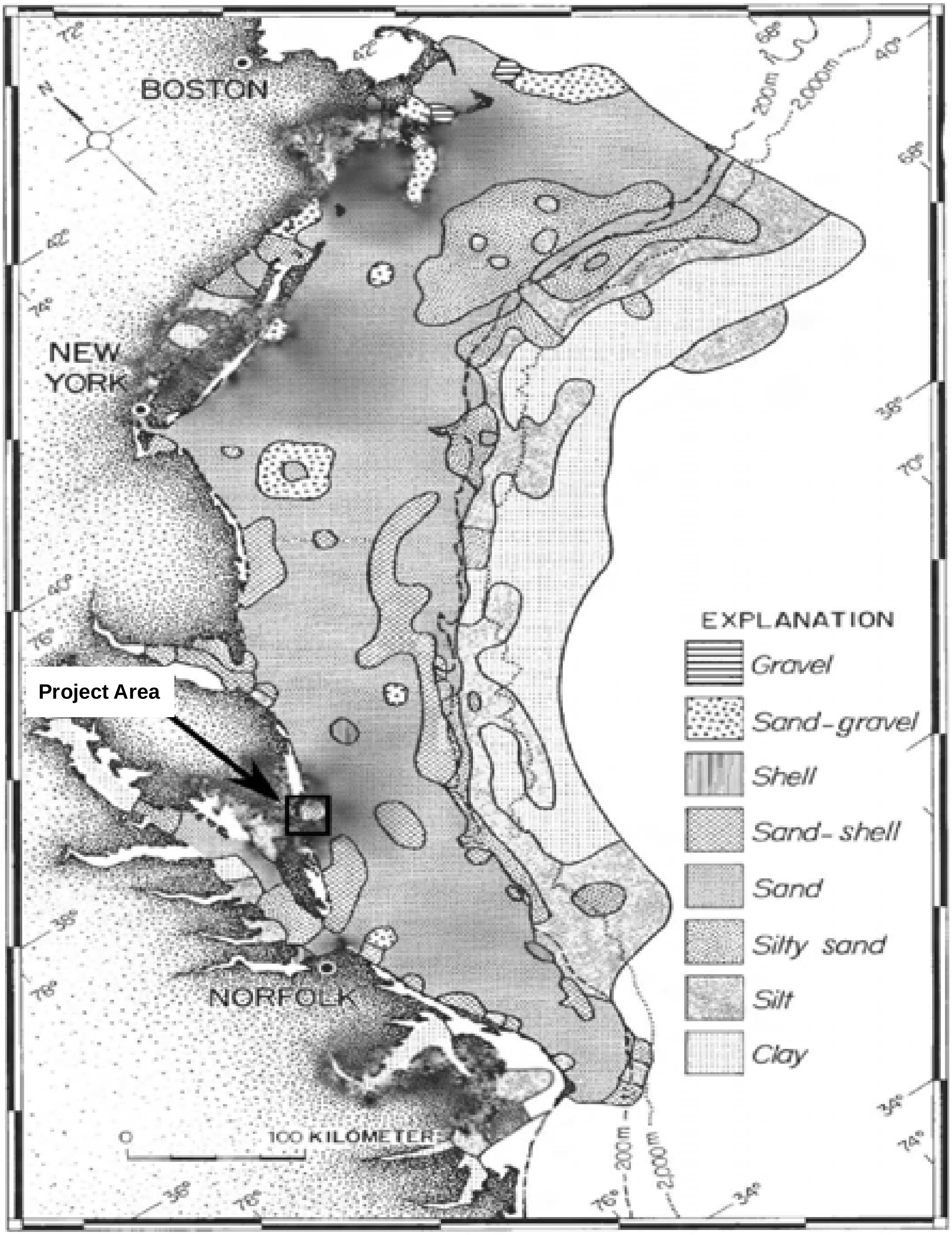
PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 52 miles (84 kilometers)
SOURCE	Wigley and Theroux 1981

Map Showing Density of Mollusca in Bottom Sediments of the Mid-Atlantic Bight

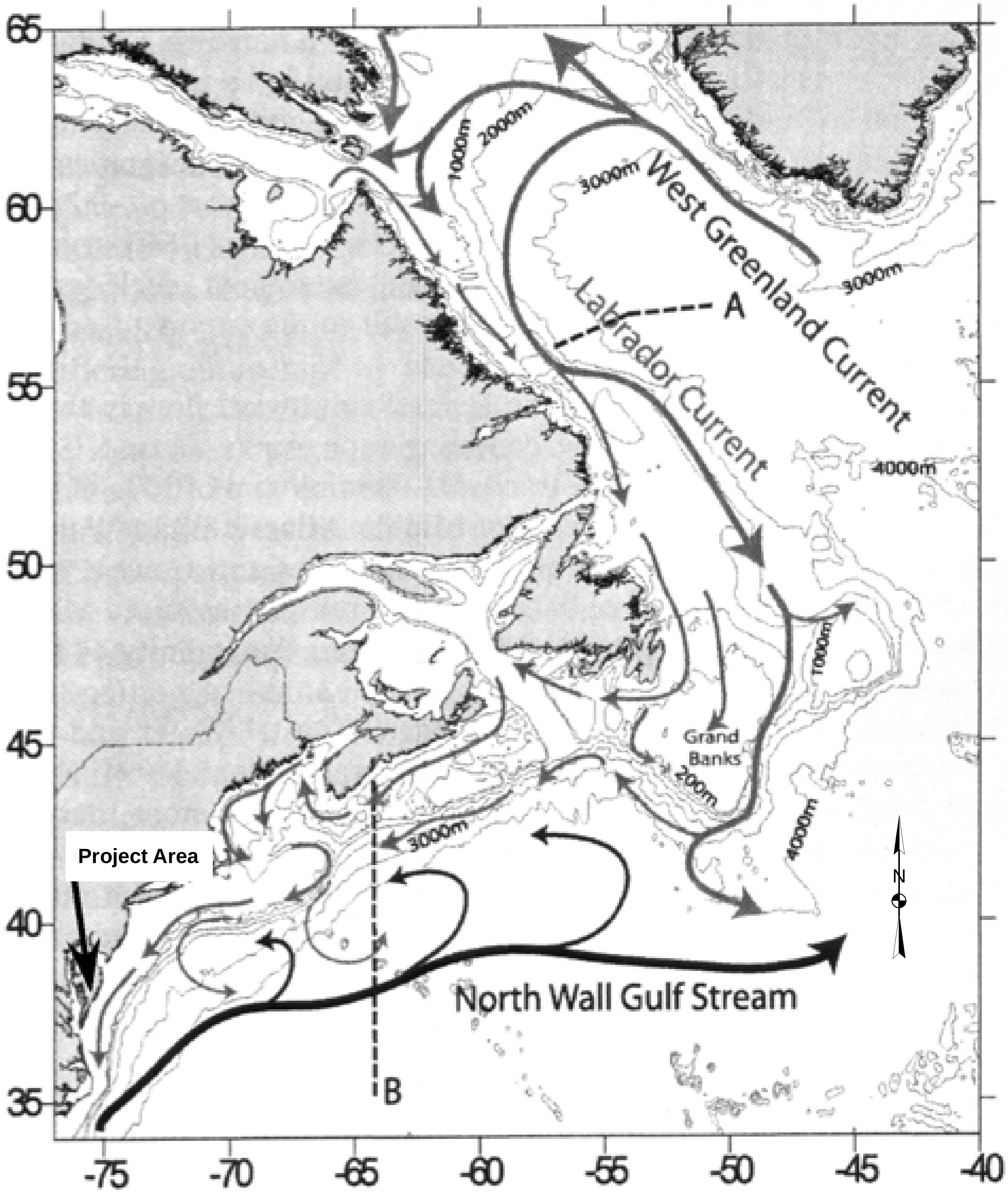
PROJECT NO.	15299035
FIGURE NO.	4-4



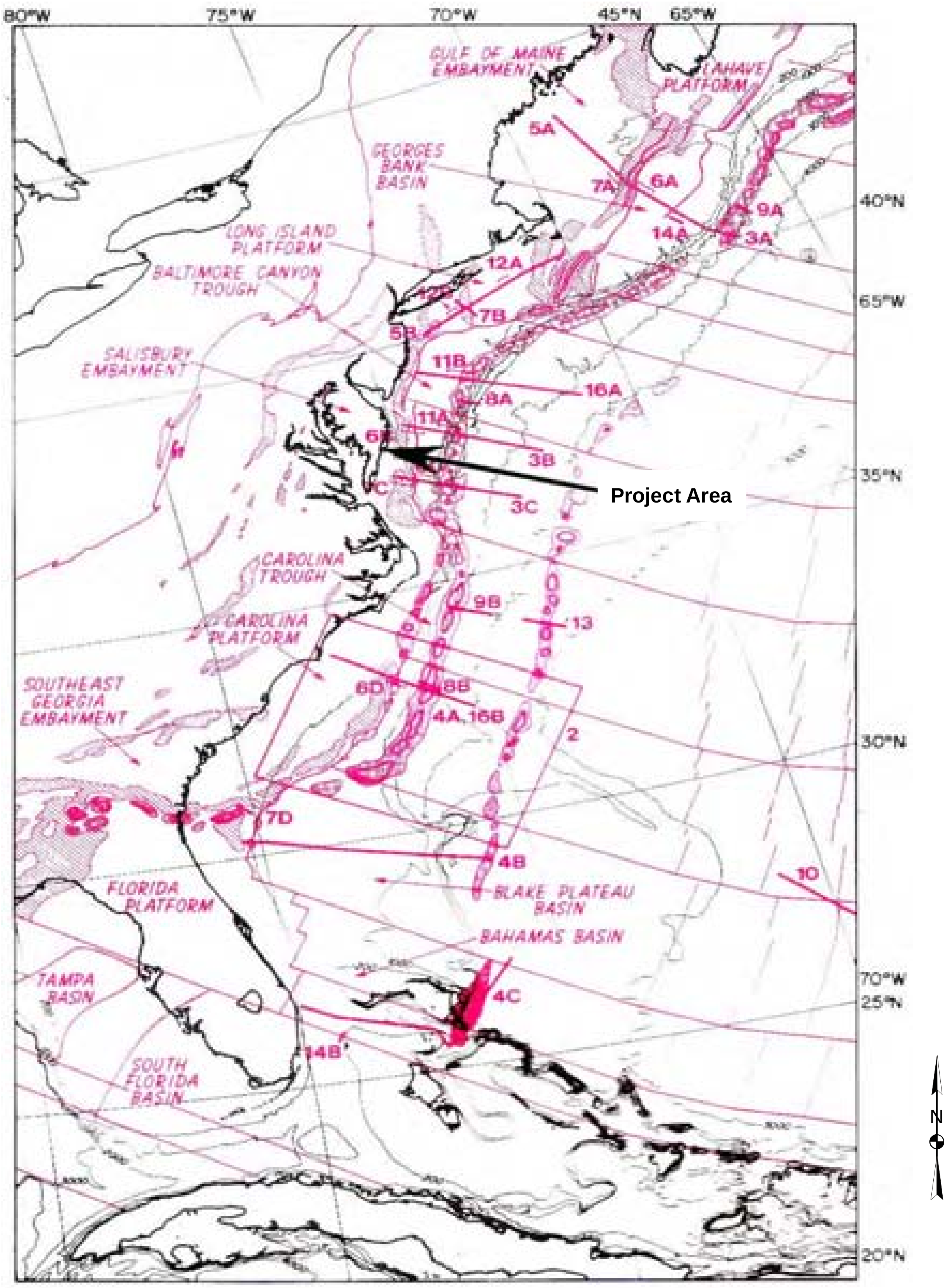
PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Map Showing Density of Bivalvia in Bottom Sediment of the Mid-Atlantic Bight**	
SCALE	1 inch = 52 miles (84 kilometers)	**PROJECT NO.**	15299035
SOURCE	Wigley and Theroux 1987	**FIGURE NO.**	4-5



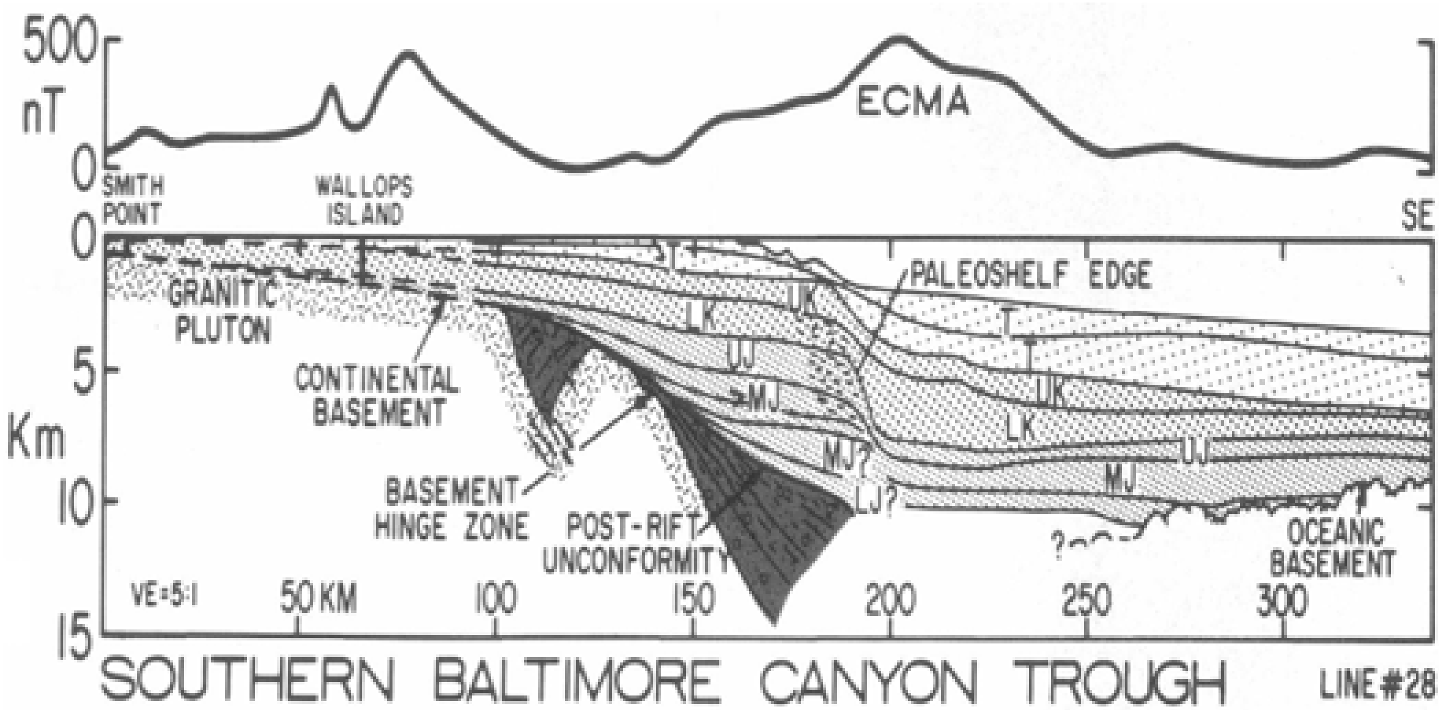
PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Map of Bottom Sediment Types in the Mid-Atlantic Bight (Note Patch of Sand-shell Sediment in Project Area)**	
SCALE	1 inch = 52 miles (84 kilometers)	**PROJECT NO.**	15299035
SOURCE	Wigley and Theroux 1981	**FIGURE NO.**	4-6



PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Major Oceanographic Currents Influencing the Northwest Atlantic Ocean**	
SCALE	N/A		
		PROJECT NO.	15299035
SOURCE	After Townsend et al. 2006	**FIGURE NO.**	4-7



PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Major Structural Features of the US Atlantic Coast. Project Area Resides in Salisbury Embayment Underlain by the Baltimore Canyon Trough**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	Klitgord et al. 1988	**FIGURE NO.**	4-8



PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Profile of the South Baltimore Canyon Trough Through Wallops Island Area**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	Klitgord et al. 1988	**FIGURE NO.**	4-9

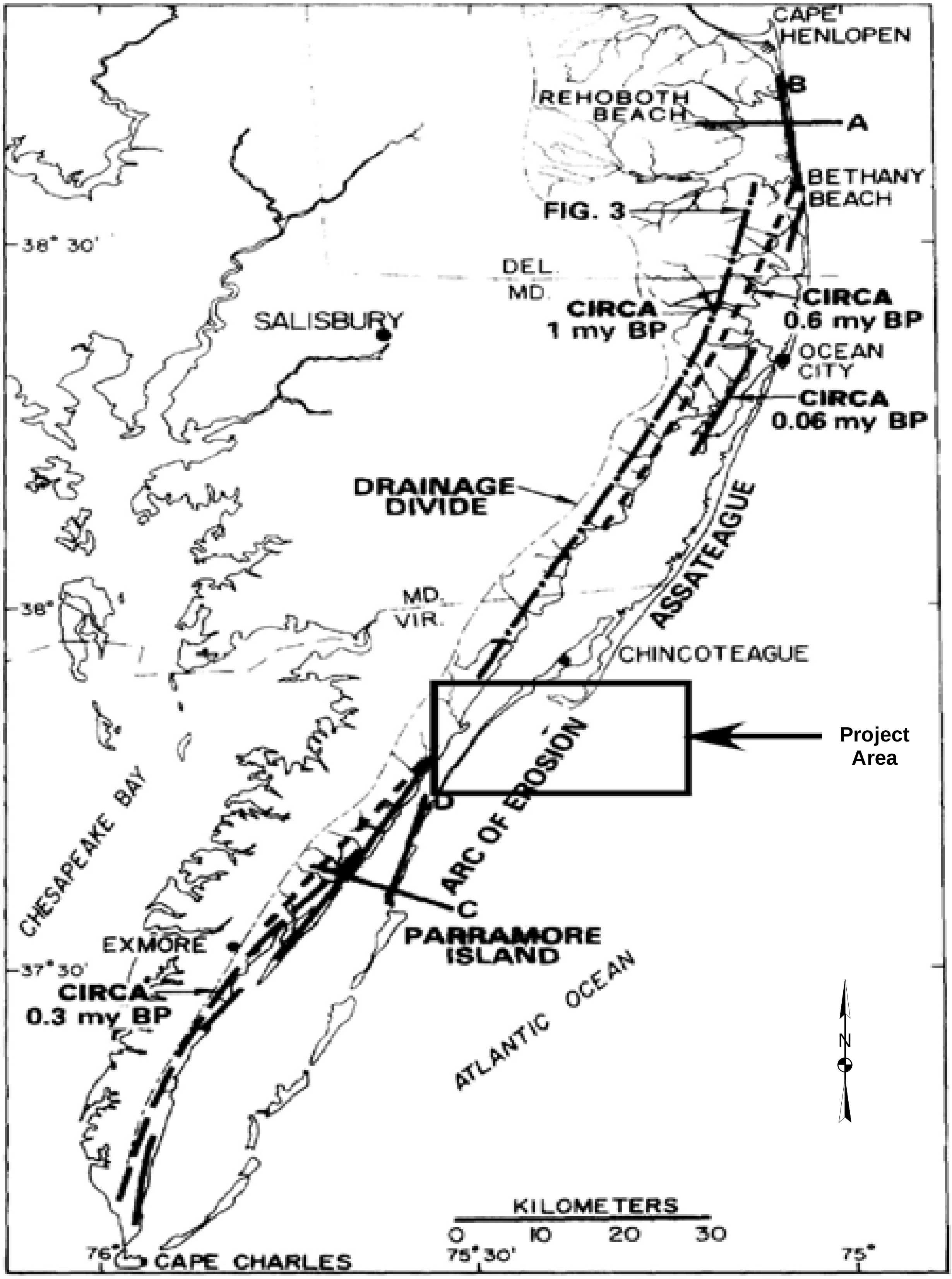
<table>
<tr><td rowspan="2"></td><td colspan="4">Southern and Central Delmarva Peninsula
(Mixon 1985)</td><td colspan="2">VA West of Chesapeake Bay
(Johnson and Berquist 1989)</td><td colspan="4">Delmarva and Offshore
(Toscano and York 1992)</td><td>Offshore Virginia
(Shideler et al. 1972)</td></tr>
<tr><td>Eastern Maryland Part</td><td>Eastern Virginia Part</td><td colspan="2">Central and Western Parts
Virginia and Maryland</td><td colspan="2"></td><td colspan="4"></td><td></td></tr>
<tr><td>Holocene</td><td></td><td></td><td colspan="2"></td><td colspan="2"></td><td colspan="4"></td><td>Unit D
Reflector 3</td></tr>
<tr><td rowspan="9">Pleistocene</td><td rowspan="2">Sinepuxent and
Ironshire Formations</td><td rowspan="2">Wachapreague Formation</td><td colspan="2" rowspan="2">Kent Island Formation</td><td rowspan="3">Tabb Formation</td><td>Poquoson Member</td><td rowspan="4">Nassawadox Formation</td><td rowspan="2">Occohannock Member</td><td rowspan="2">Kent Island Formation</td><td rowspan="2">Wachapreague Formation</td><td rowspan="9">Unit C</td></tr>
<tr><td>Lynnhaven Member</td></tr>
<tr><td rowspan="4"></td><td>Joynes Neck Sand</td><td rowspan="4">Nassawadox Formation</td><td>Occohannock Member</td><td>Sedgefield Member</td><td rowspan="2">Butlers Bluff</td><td rowspan="2">Joynes Neck</td><td rowspan="2">Iron-shire</td></tr>
<tr><td rowspan="3"></td><td rowspan="2">Butlers Bluff Member</td><td colspan="2" rowspan="3">Shirley Formation</td></tr>
<tr><td colspan="4" rowspan="5">Omar Formation</td></tr>
<tr><td>Stumptown Member</td></tr>
<tr><td rowspan="3">Omar Formation

(as restricted by Owens and Denny 1979)</td><td rowspan="3">Omar Formation

(Accomack Member)</td><td colspan="2" rowspan="3">Omar Formation

(Accomack Member)</td><td colspan="2">Chuckatuck Formation</td></tr>
<tr><td colspan="2">Charles City Formation</td></tr>
<tr><td colspan="2">Windsor Formation
(restricted)</td></tr>
<tr><td>Pliocene</td><td></td><td></td><td colspan="2"></td><td colspan="2">"Moorings" unit</td><td colspan="4">Yorktown Formation and
Beaverdam Sand</td><td>Reflector 2
Unit B</td></tr>
</table>

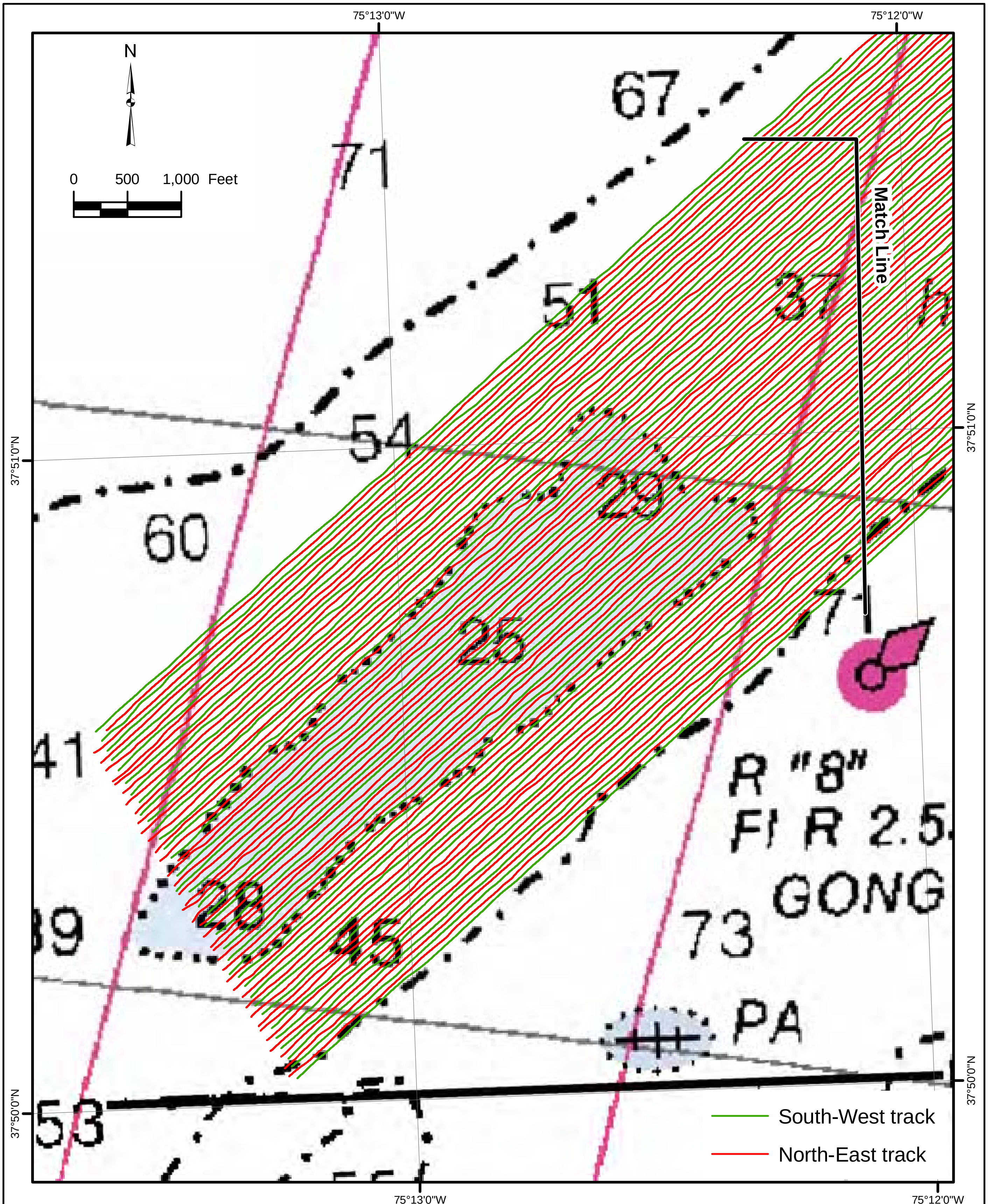
PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Temporal Relationships of Strata in the Chesapeake Bay, Delmarva Peninsula and Inner Continental Shelf**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	Hobbs 2004	**FIGURE NO.**	4-10



PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 10.9 miles (17.5 kilometers)
SOURCE	Demarest and Leatherman 1985

Map Showing Project Area in "Arc of Erosion"

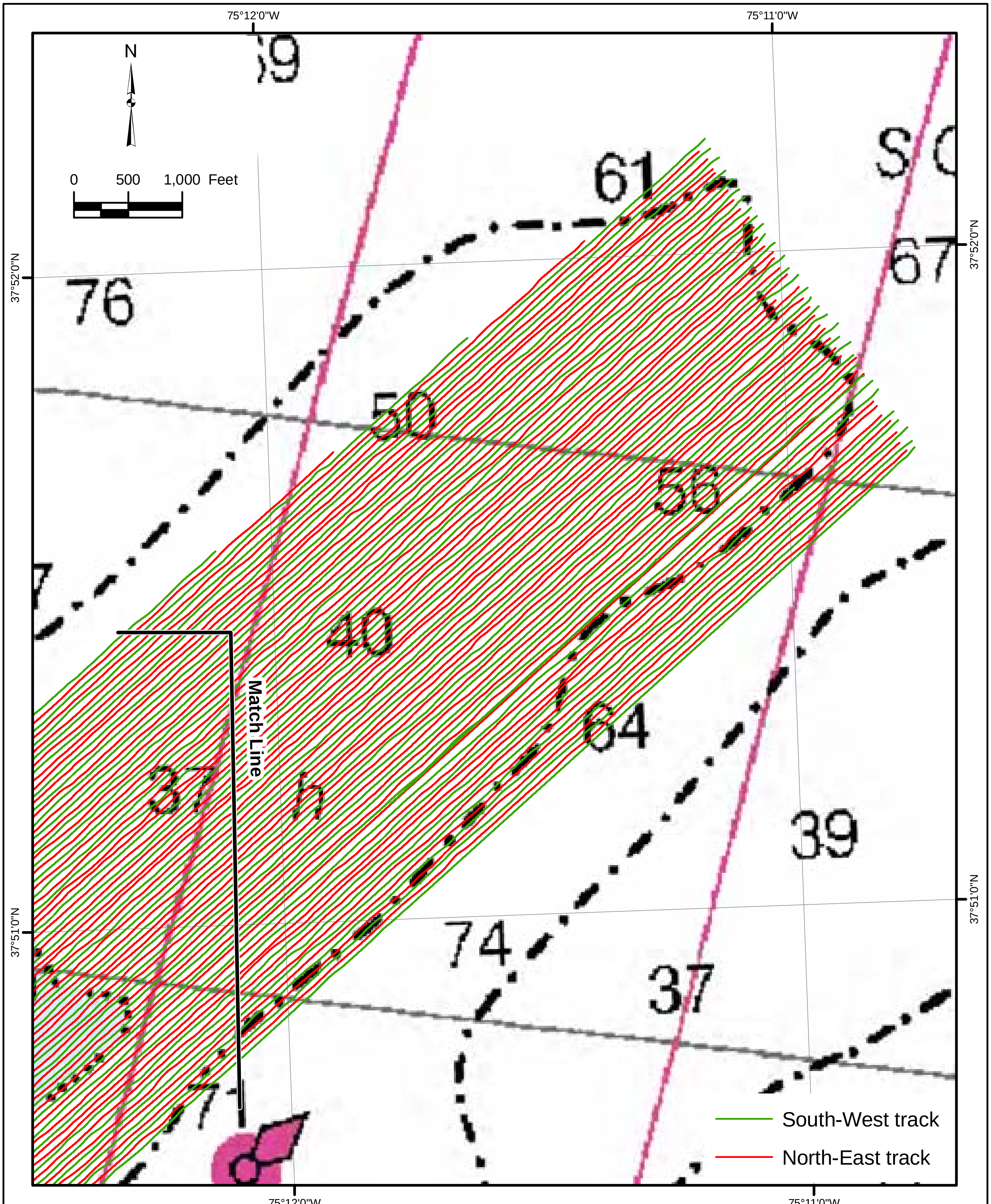
PROJECT NO.	15299035
FIGURE NO.	4-11



PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 1250 ft
SOURCE	NOAA, URS
\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB \mag_accoustic_anomolies\GIS_Projects\fig5_1_block_one_20090918.mxd	

Location of Block One with Survey Lines on NOAA Chart 12210 (Part A)

PROJECT NO.	15299035
FIGURE NO.	5-1A

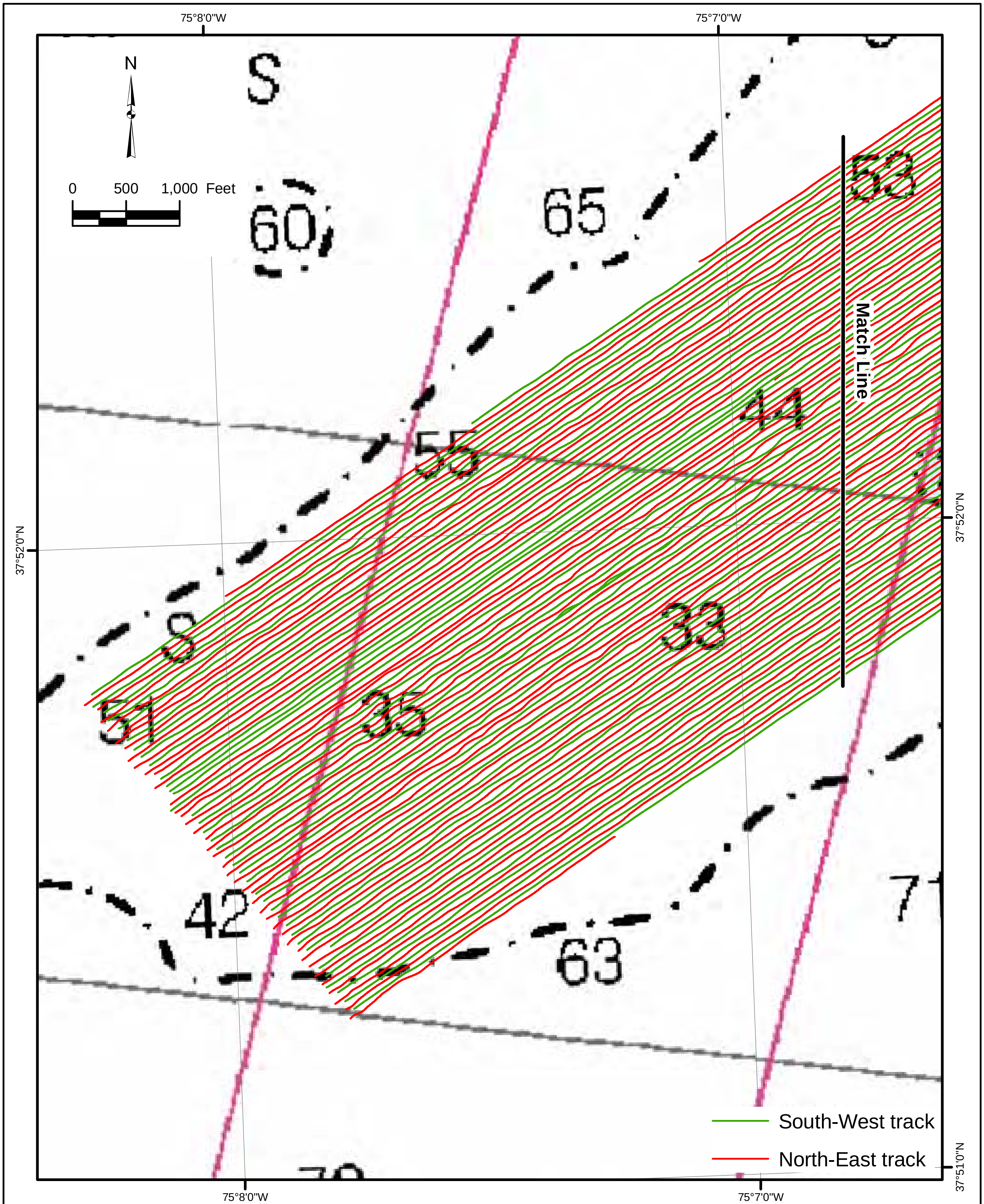


PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 1250 ft
SOURCE	NOAA, URS

\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB \mag_accoustic_anomolies\GIS_Projects\fig5_1_block_one_20090918.mxd

Location of Block One with Survey Lines on NOAA Chart 12210 (Part B)

PROJECT NO.	15299035
FIGURE NO.	5-1B



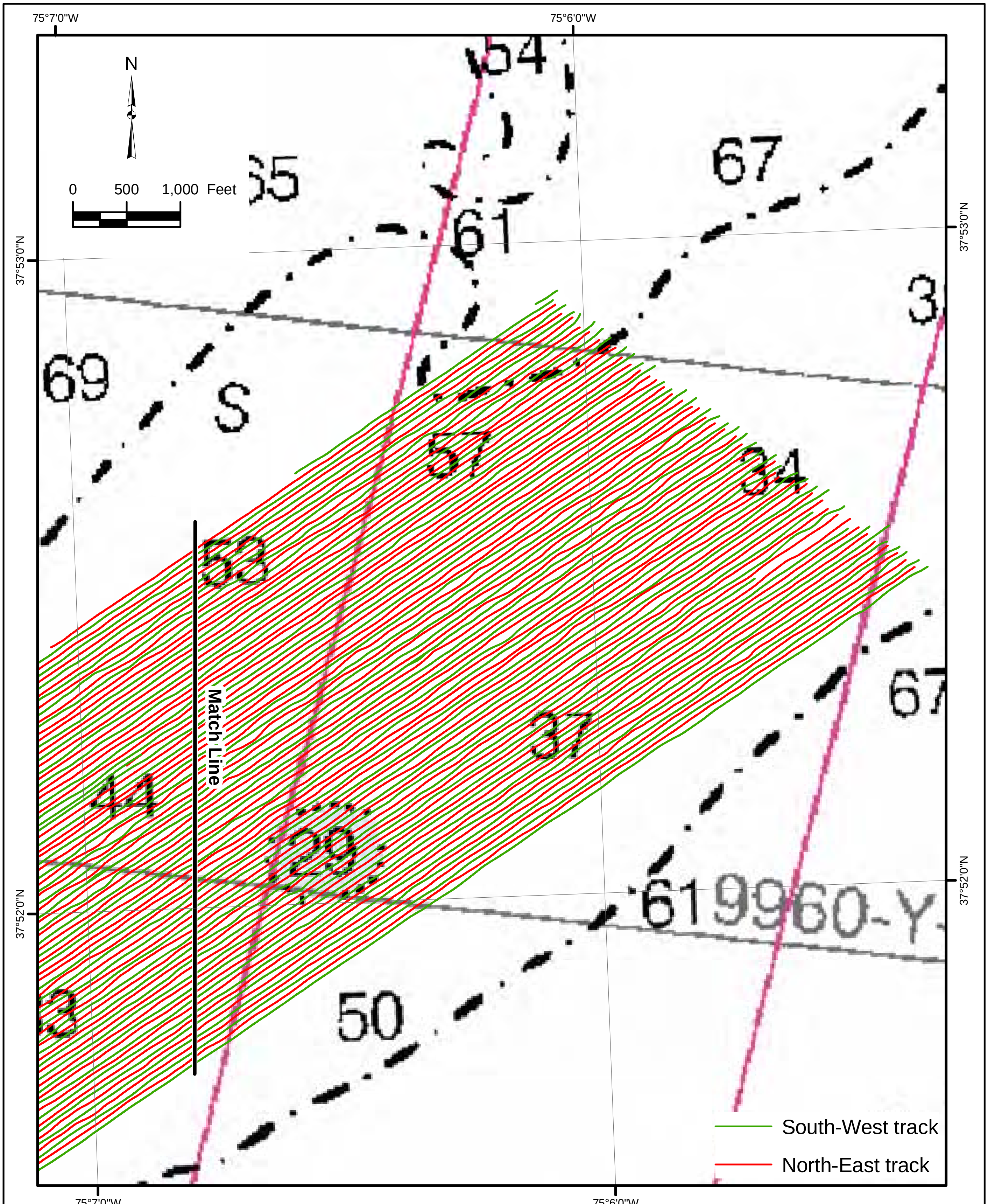
PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 1250 ft
SOURCE	NOAA, URS

\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB
\mag_accoustic_anomolies\GIS_Projects\fig5_1_block_one_20090918.mxd

Location of Block Two with Survey Lines on NOAA Chart 12210 (Part A)

PROJECT NO. 15299035

FIGURE NO. 5-2A

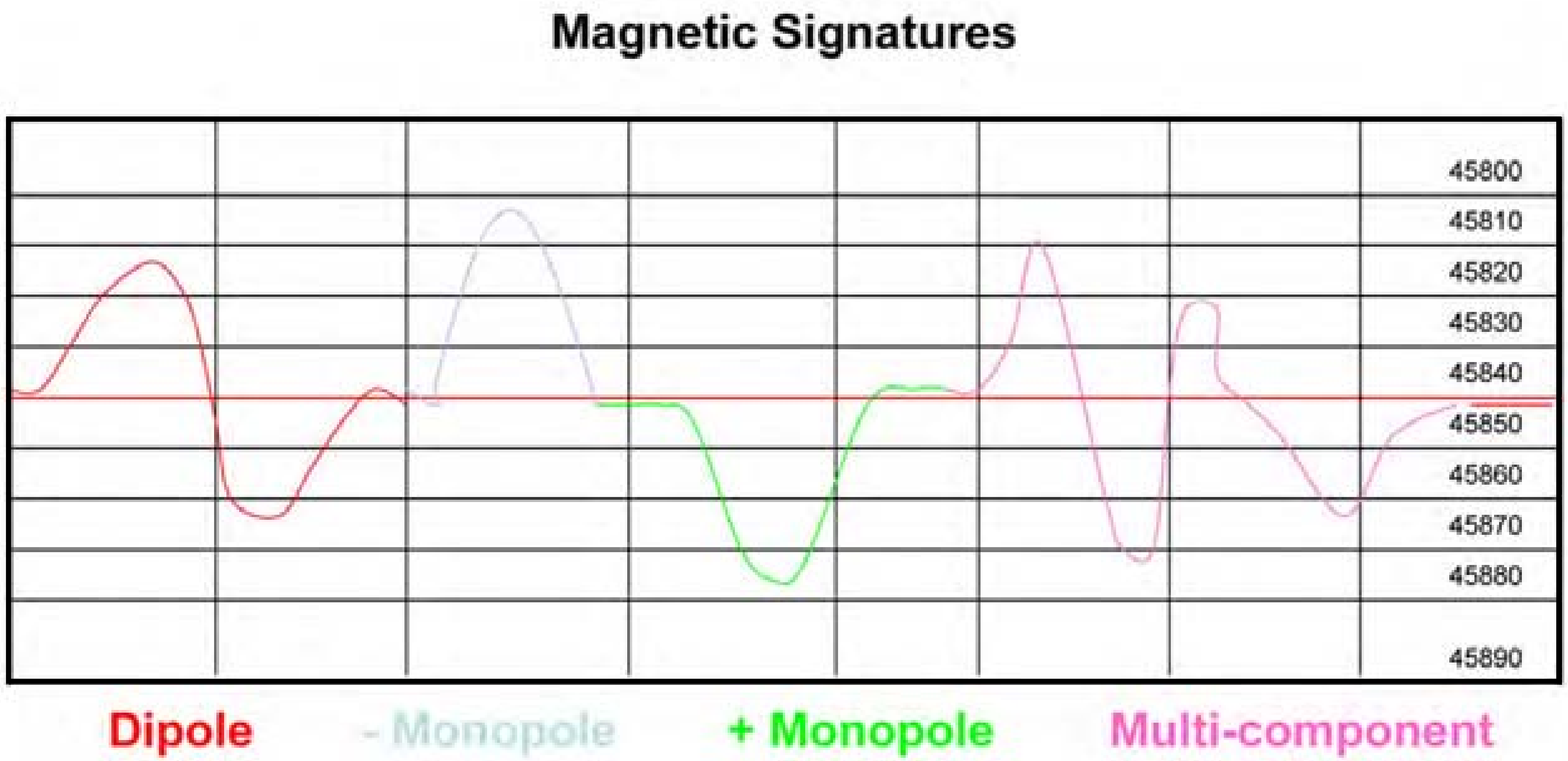


PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 1250 ft
SOURCE	NOAA, URS

\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB \mag_accoustic_anomolies\GIS_Projects\fig5_1_block_one_20090918.mxd

Location of Block Two with Survey Lines on NOAA Chart 12210 (Part B)

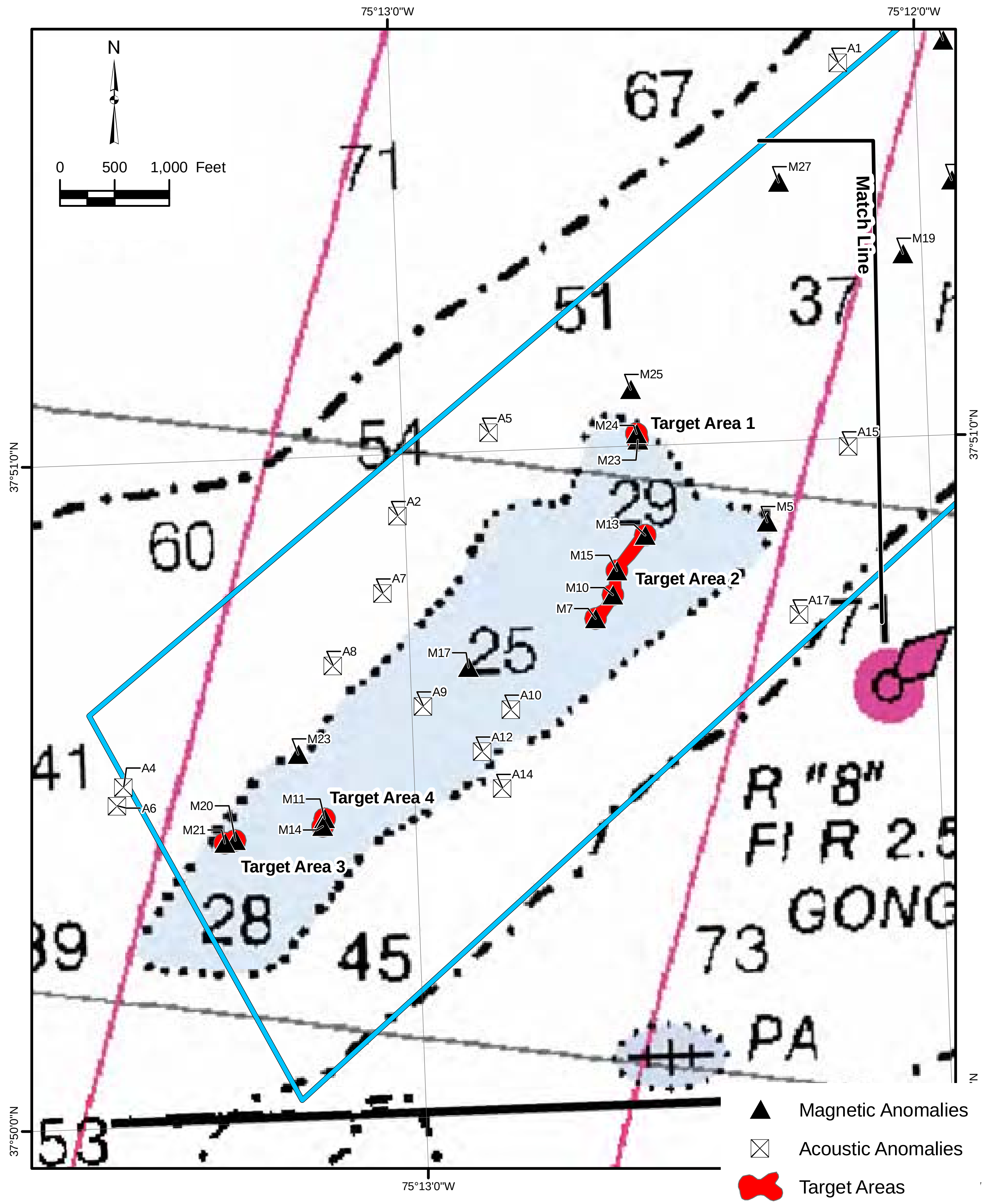
PROJECT NO.	15299035
FIGURE NO.	5-2B



PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	N/A
SOURCE	URS

Illustration Showing Four Magnetic Signature Types

PROJECT NO.	15299035
FIGURE NO.	5-3

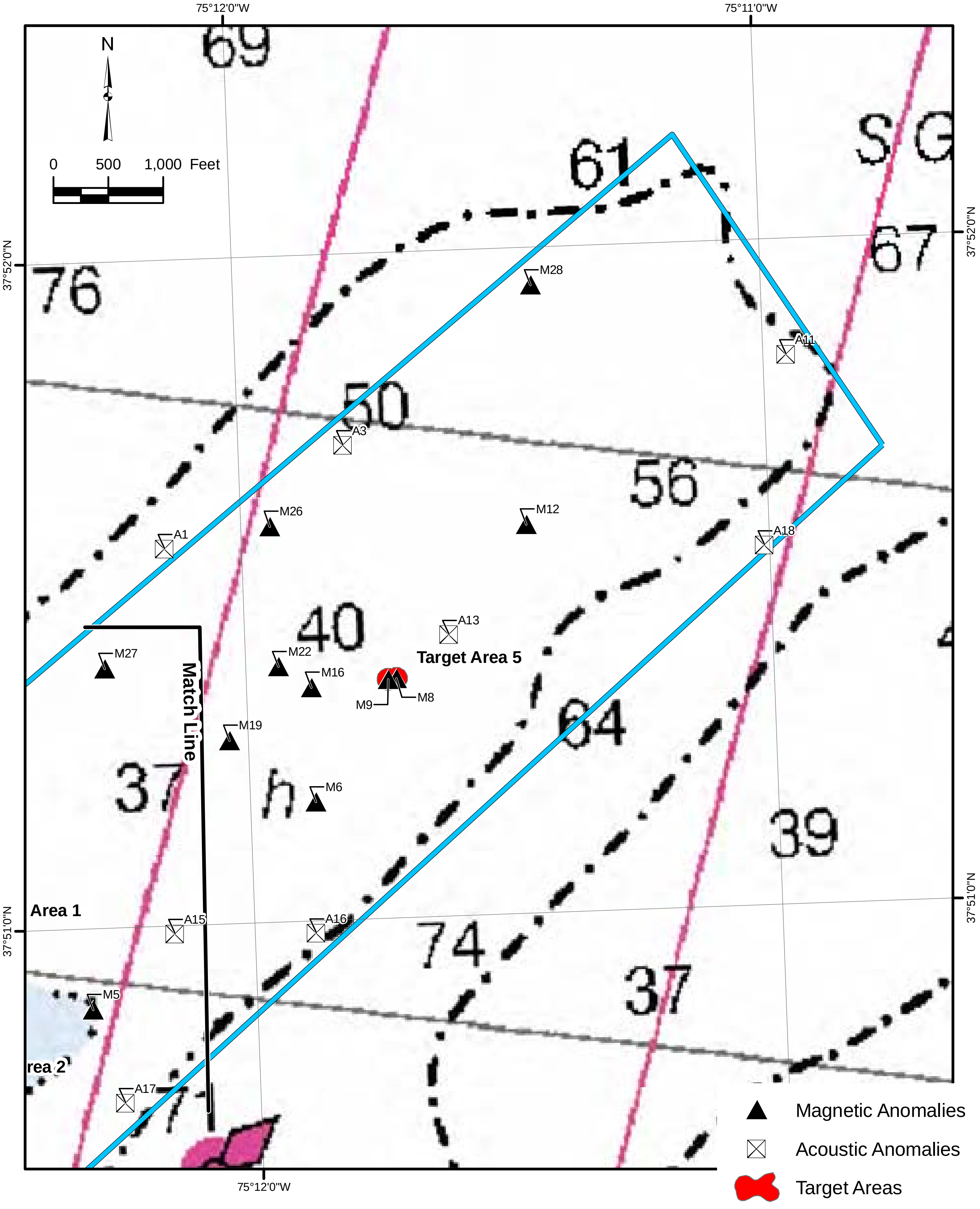


PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 1250 ft
SOURCE	NOAA, URS

\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB
\mag_accoustic_anomolies\GIS_Projects\fig6_1_block_one_20090918.mxd

Map of Block One with Magnetic and Acoustic Anomalies with Target Clusters (Part A)

PROJECT NO.	15299035
FIGURE NO.	6-1A



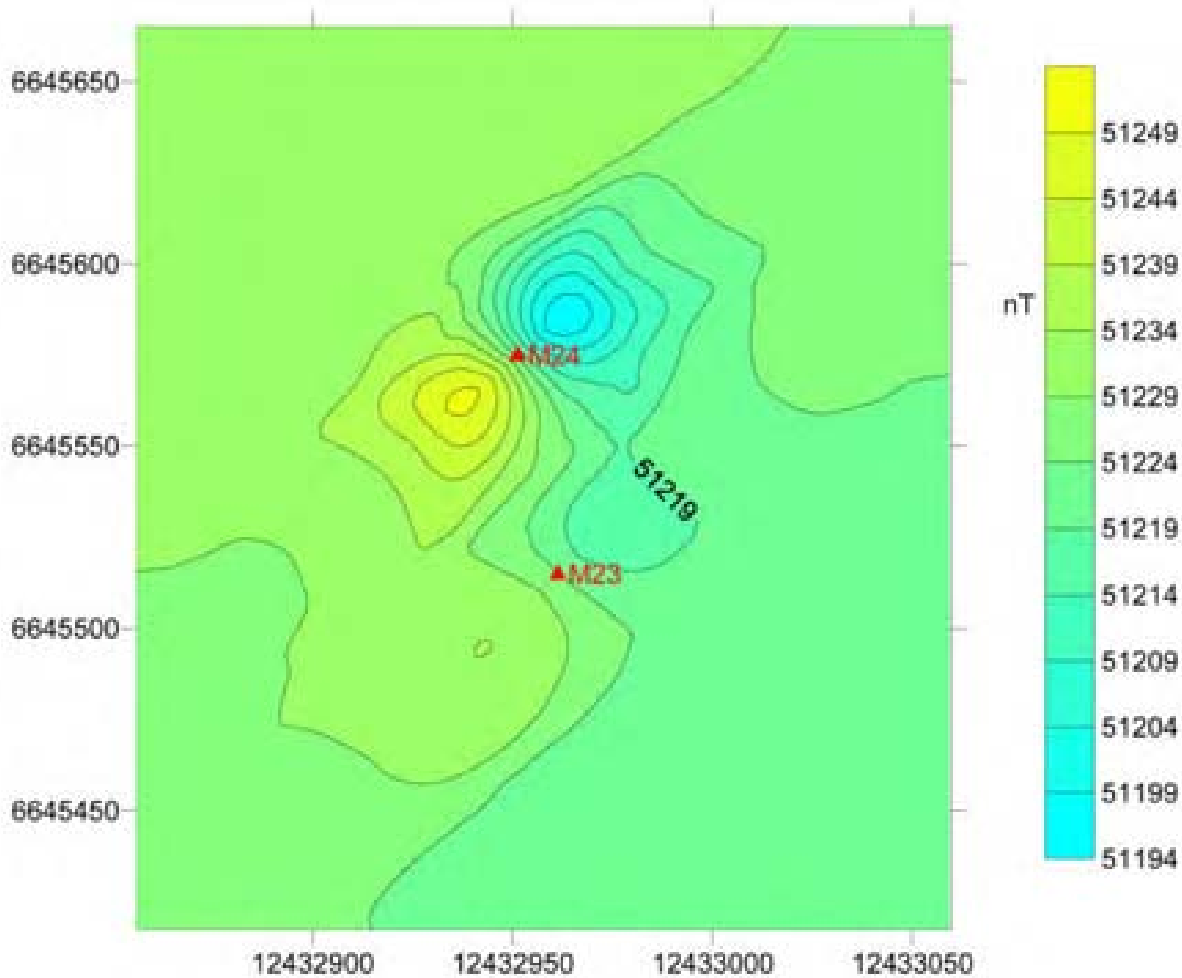
PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 1250 ft
SOURCE	NOAA, URS

\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB
\mag_accoustic_anomolies\GIS_Projects\fig6_1_block_one_20090918.mxd

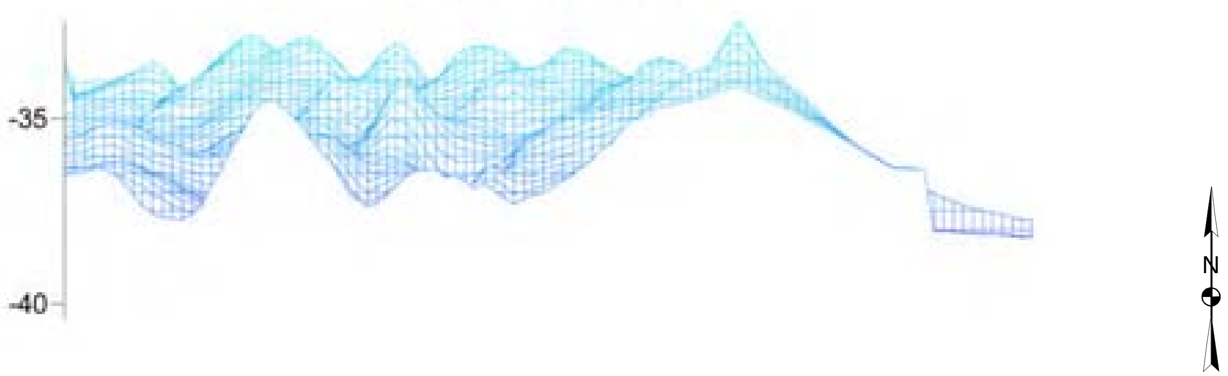
Map of Block One with Magnetic and Acoustic Anomalies with Target Clusters (Part B)

PROJECT NO.	15299035
FIGURE NO.	6-1B

Target One Magnetic Contours

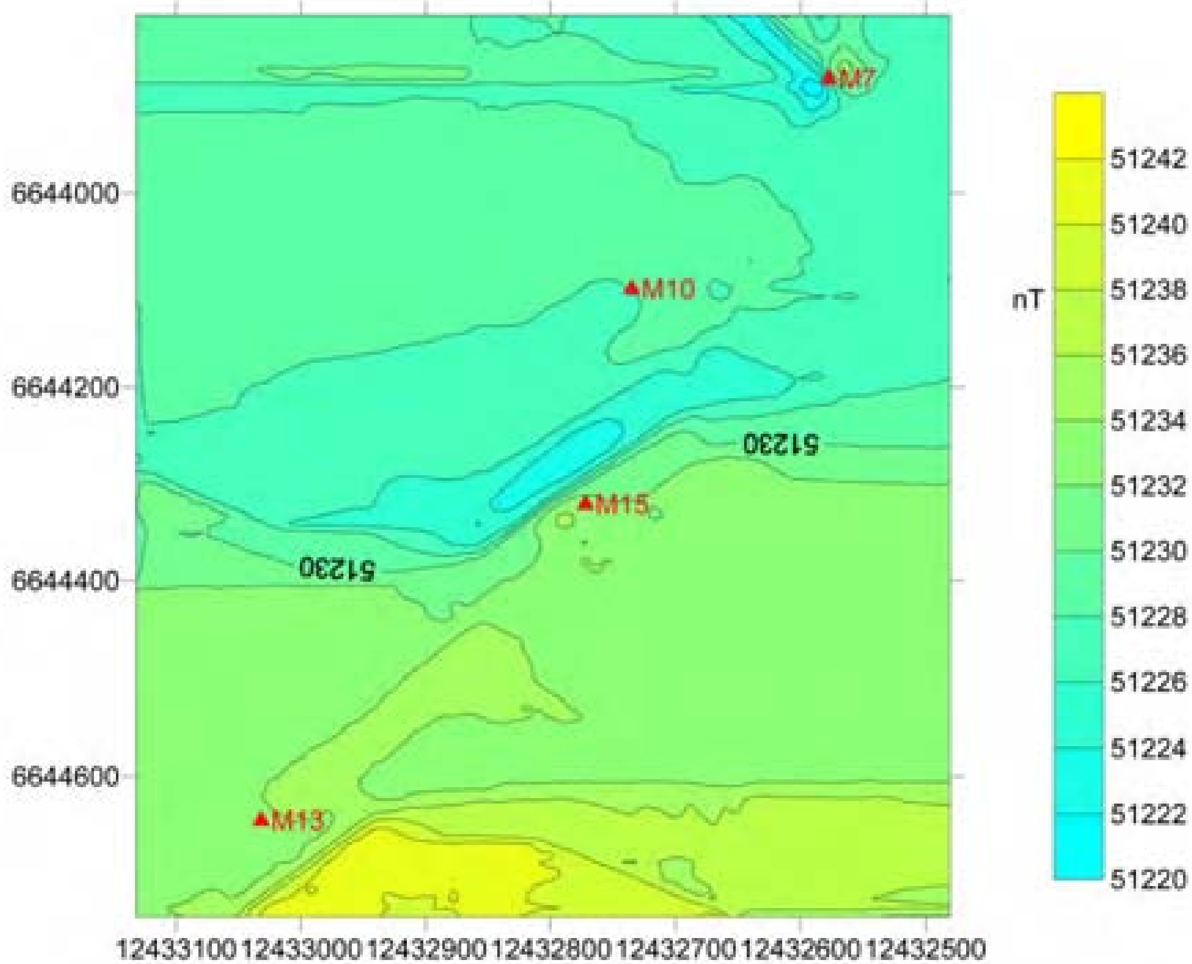


Target One Depth Contours

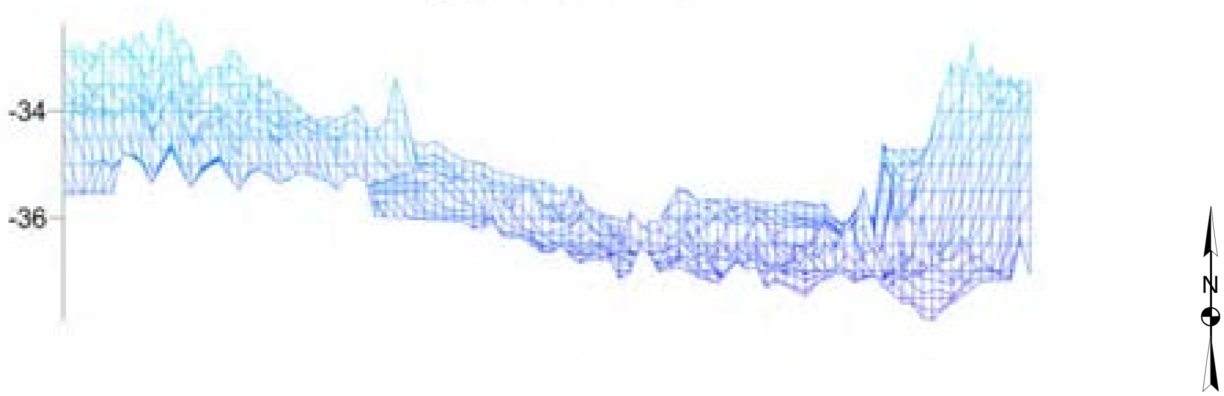


PROJECT	WFF SRIPP Offshore Sand Borrow Survey	Target One Magnetic and Depth Contour Maps	
SCALE	N/A		
SOURCE	URS	PROJECT NO.	15299035
		FIGURE NO.	6-2

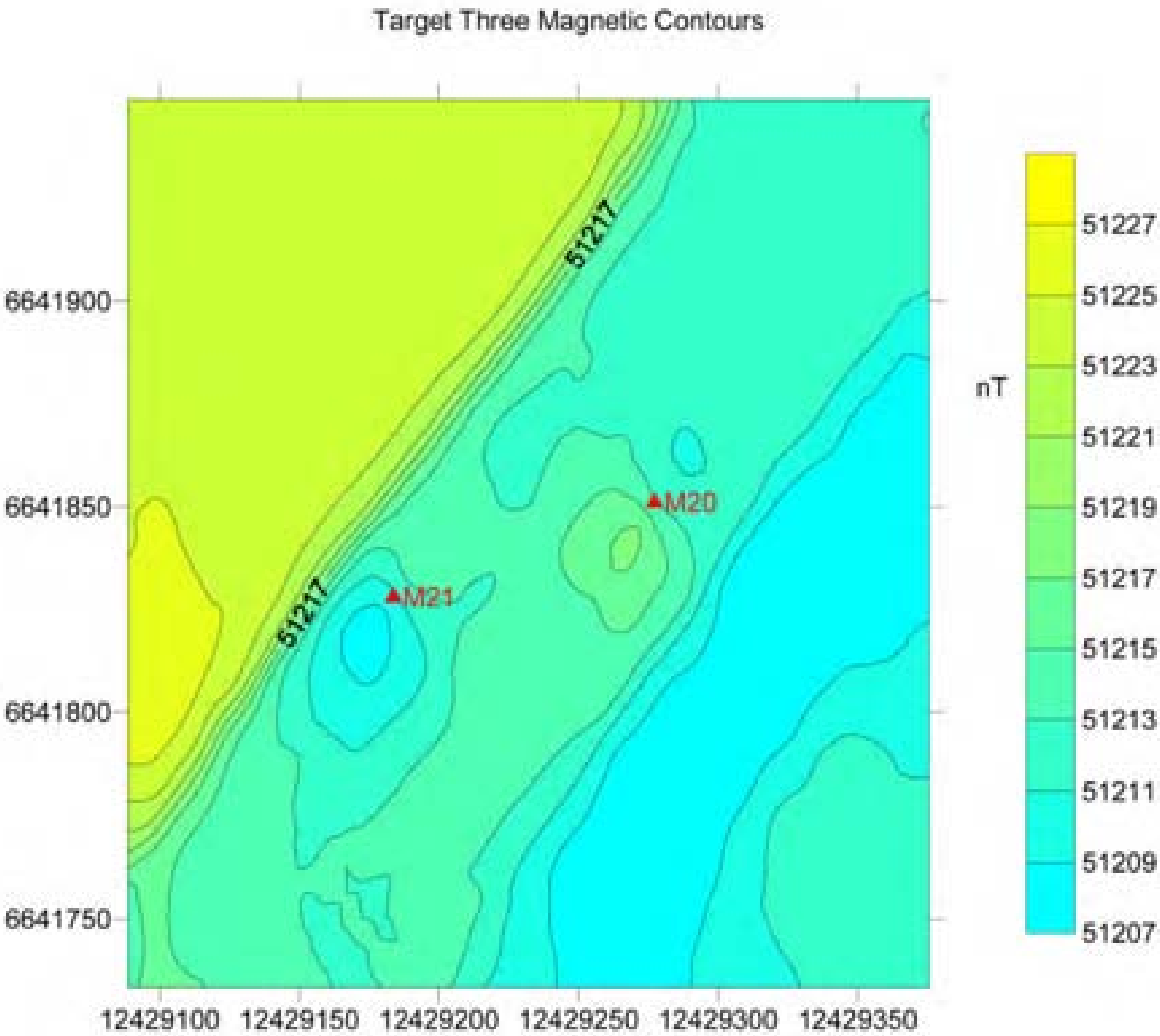
Target Two Magnetic Contours

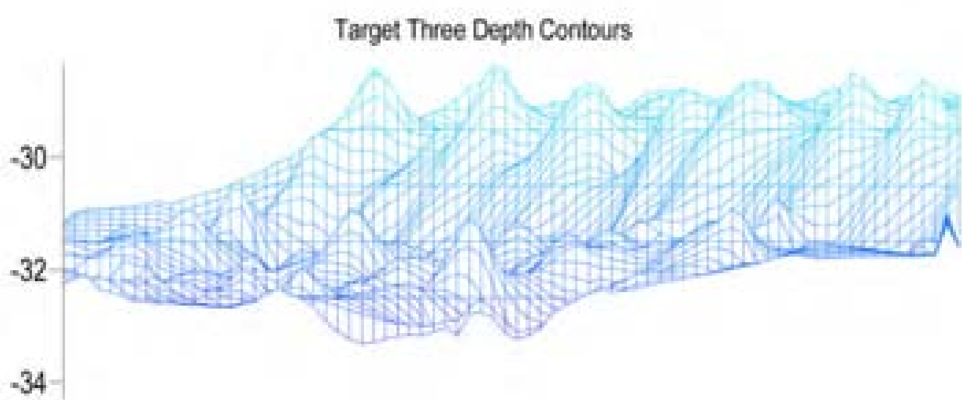


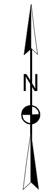
Target Two Depth Contours



PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Target Two Magnetic and Depth Contour Maps**	
SCALE	N/A		
SOURCE	URS	PROJECT NO.	15299035
		FIGURE NO.	6-3





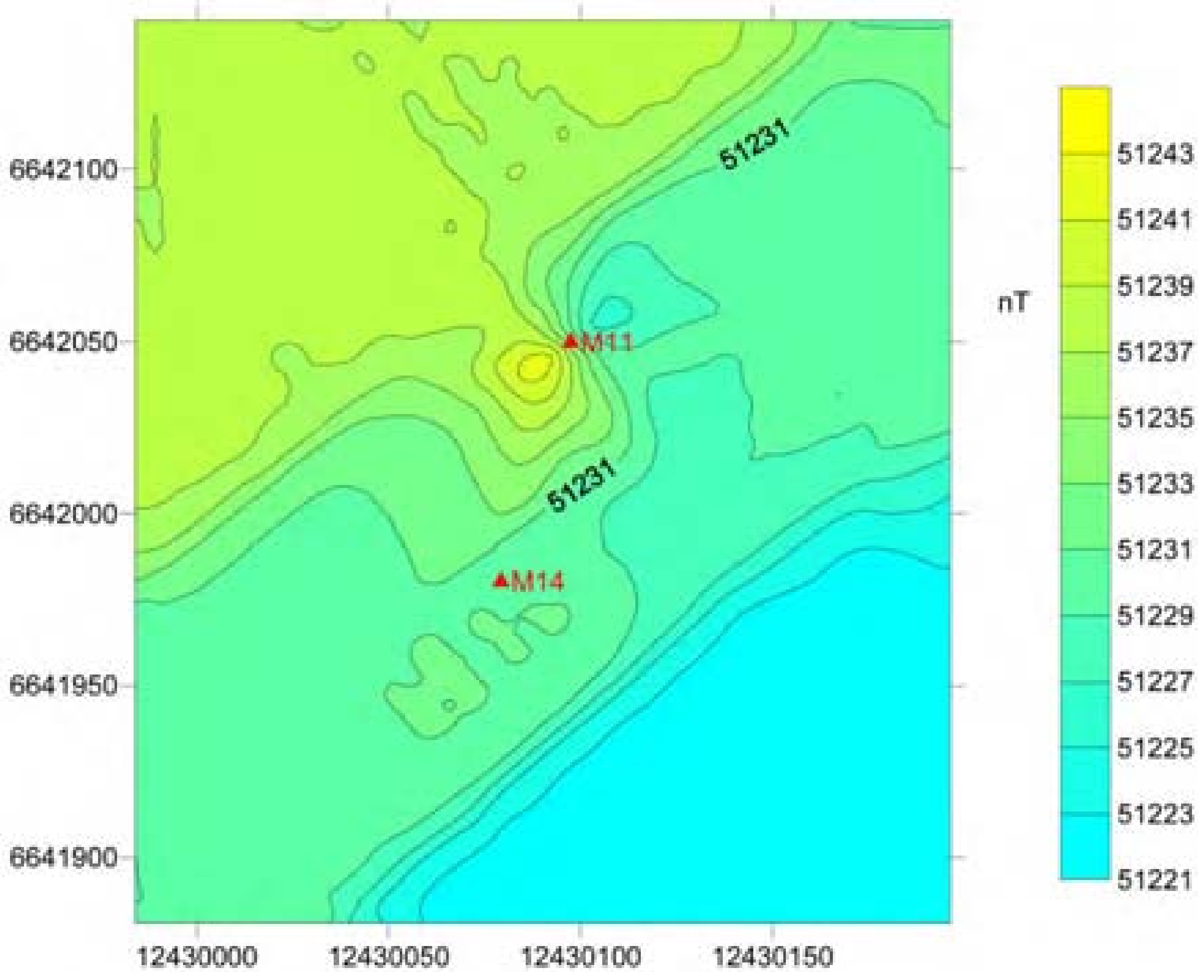


PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	N/A
SOURCE	URS

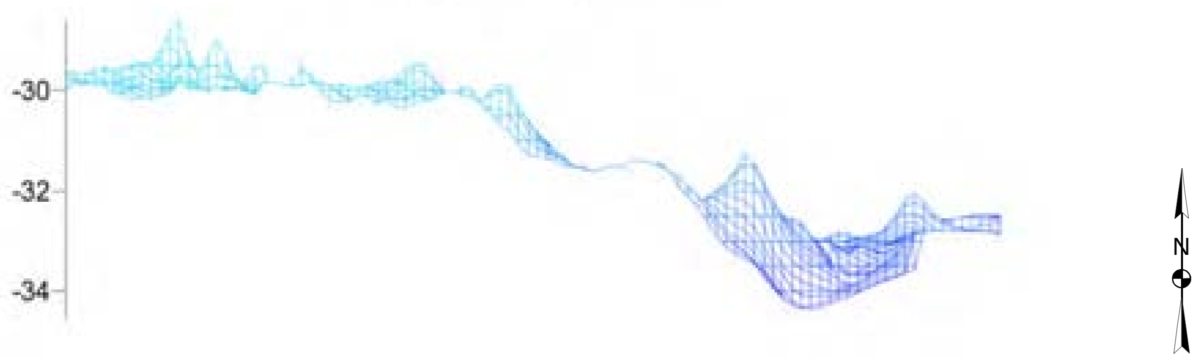
Target Three Magnetic and Depth Contour Maps

PROJECT NO.	15299035
FIGURE NO.	6-4

Target Four Magnetic Contours

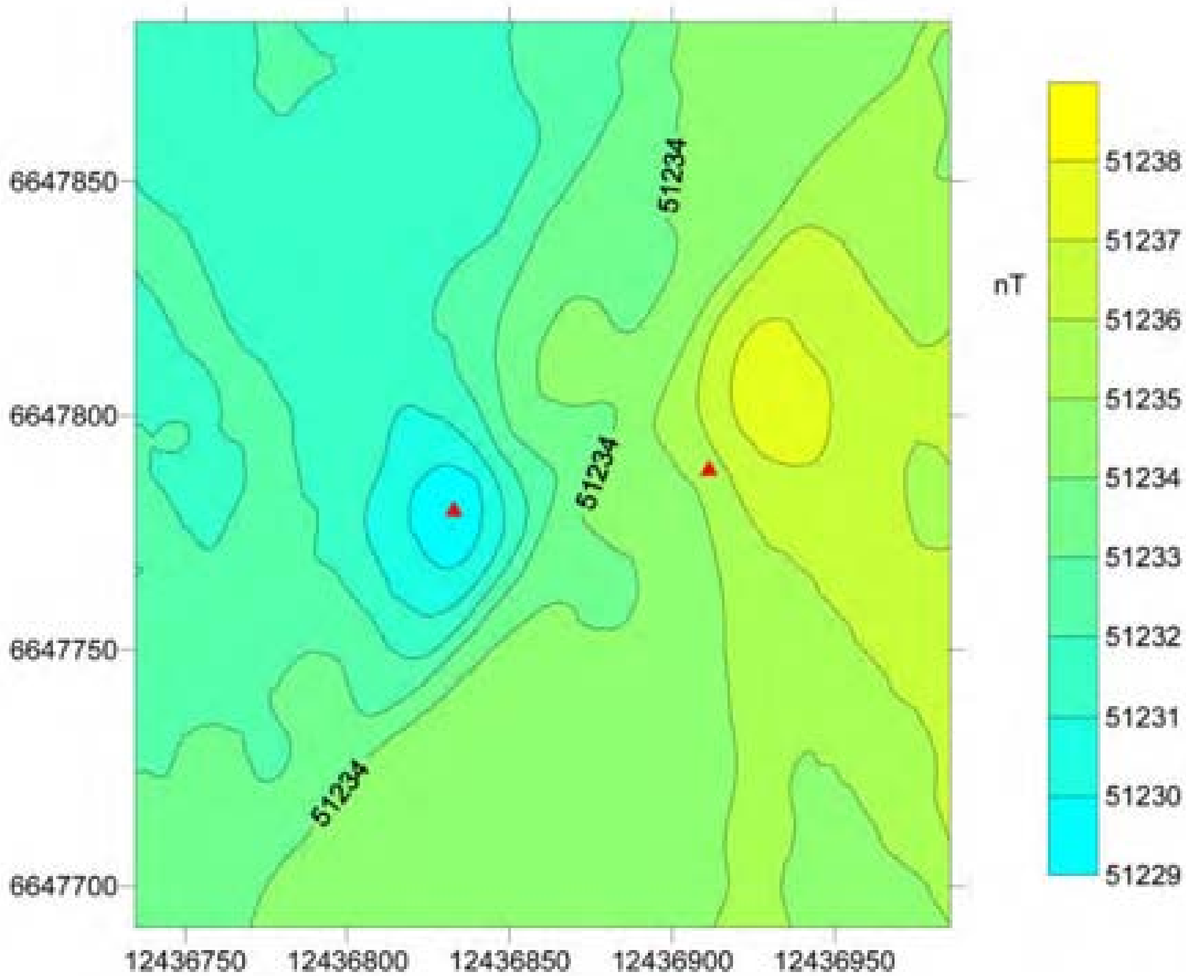


Target Four Depth Contours



PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Target Four Magnetic and Depth Contour Maps**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	URS	**FIGURE NO.**	6-5

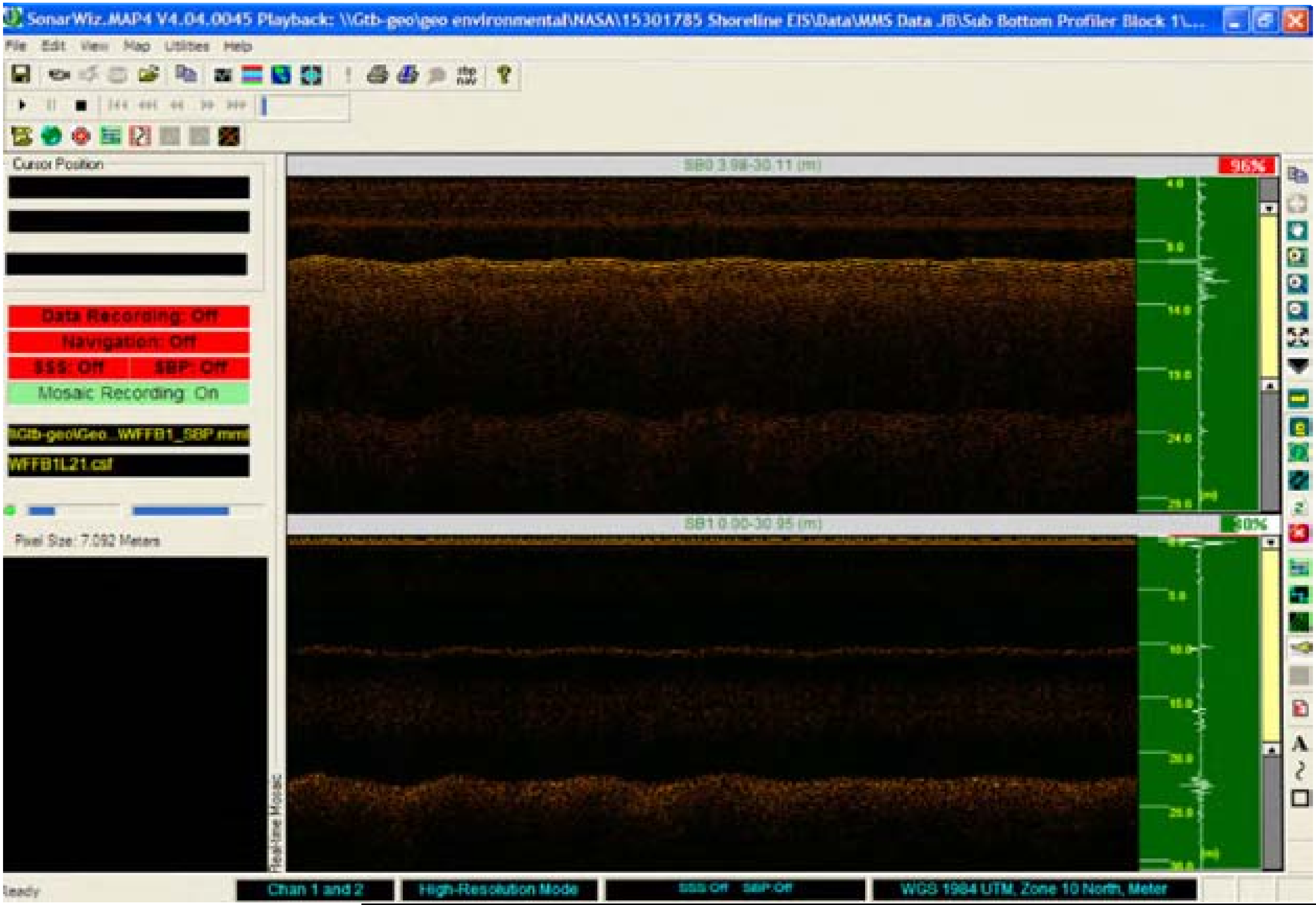
Target Five Magnetic Contours



Target Four Depth Contours

N

PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Target Five Magnetic and Depth Contour Maps**		
SCALE	N/A			
SOURCE	URS		**PROJECT NO.**	15299035
			FIGURE NO.	6-6



PROJECT WFF SRIPP Offshore Sand Borrow Survey

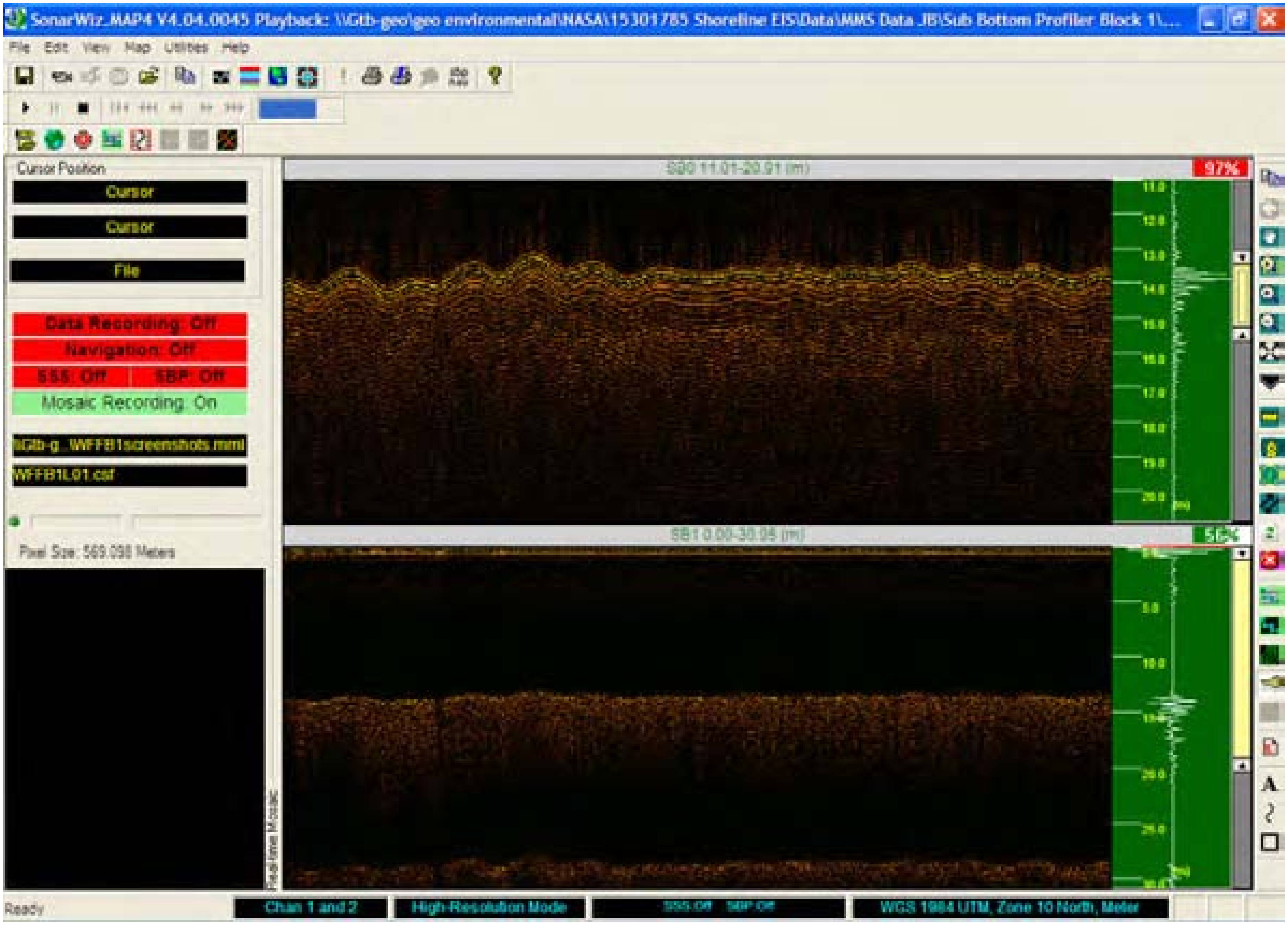
SCALE N/A

SOURCE URS

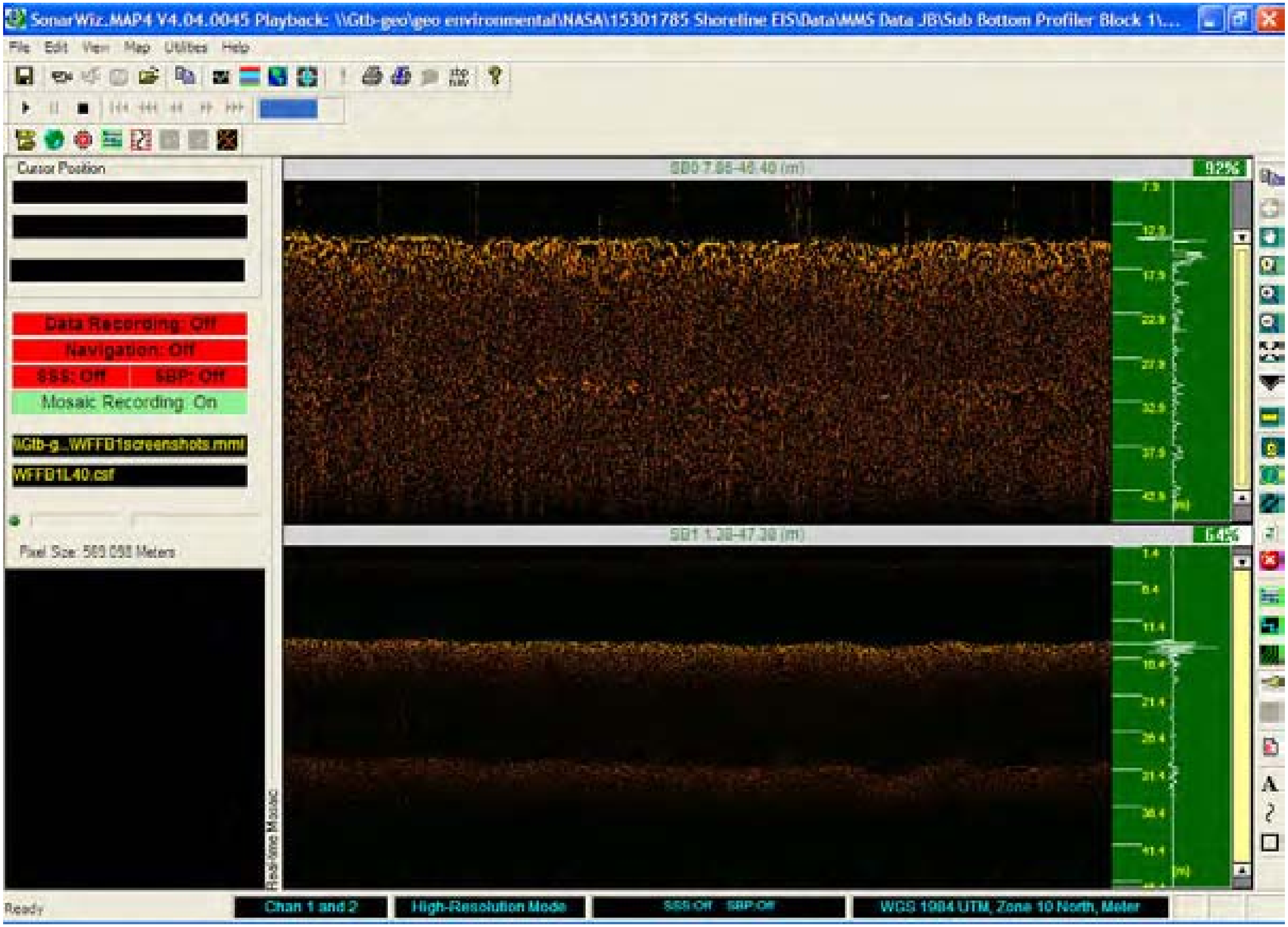
Sub Bottom Data of Line 20 in Block One Showing Sedimentary Structure and Acoustic Penetration

PROJECT NO. 15299035

FIGURE NO. 6-7



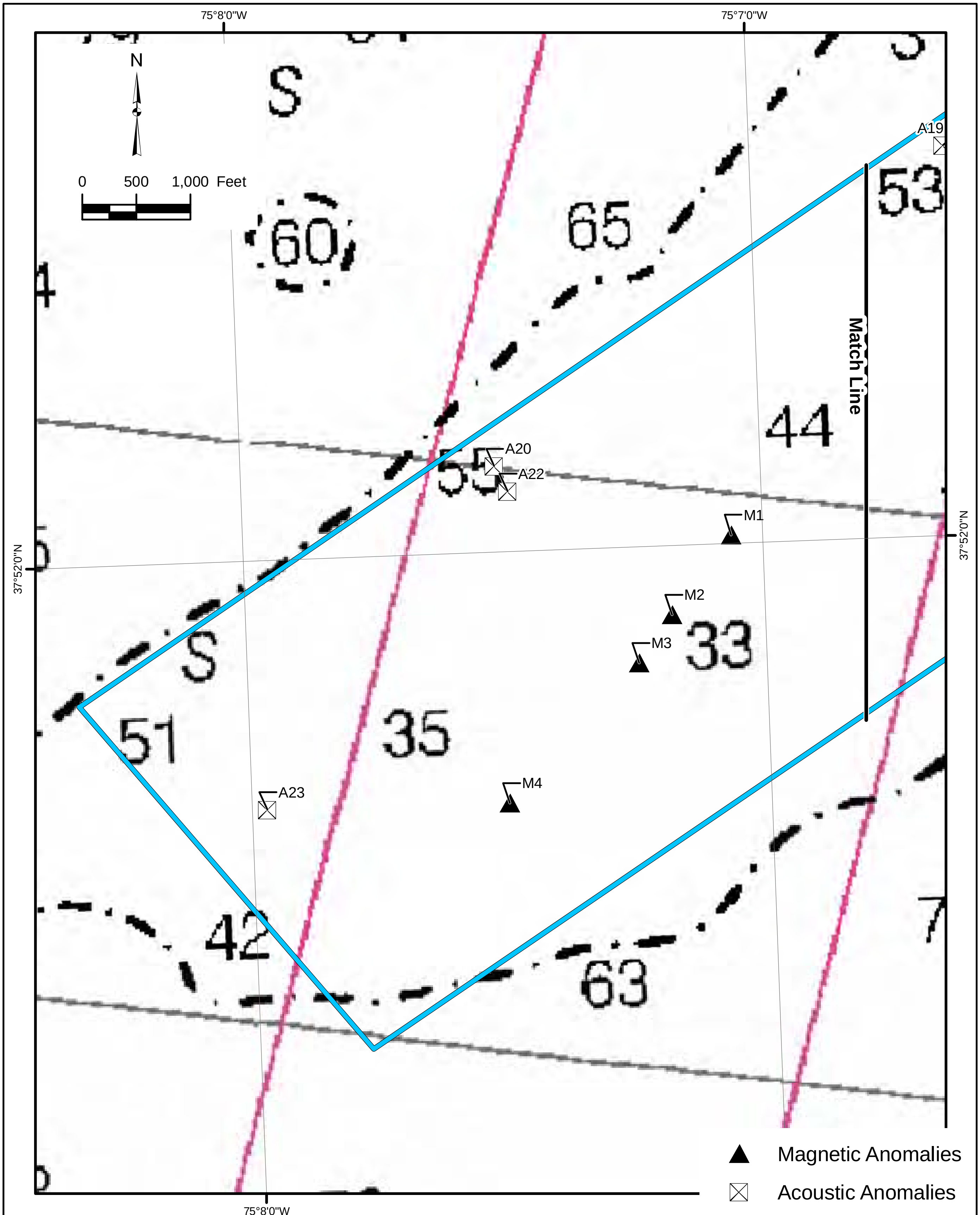
PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Sub Bottom Data of Line 01 in Block One Showing Sedimentary Structure, Acoustic Penetration and Surface Reflections**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	URS	**FIGURE NO.**	6-8



PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	N/A
SOURCE	URS

Sub Bottom Data of Line 40 in Block One Showing Sedimentary Structure, Acoustic Penetration and Surface Reflections

PROJECT NO.	15299035
FIGURE NO.	6-9

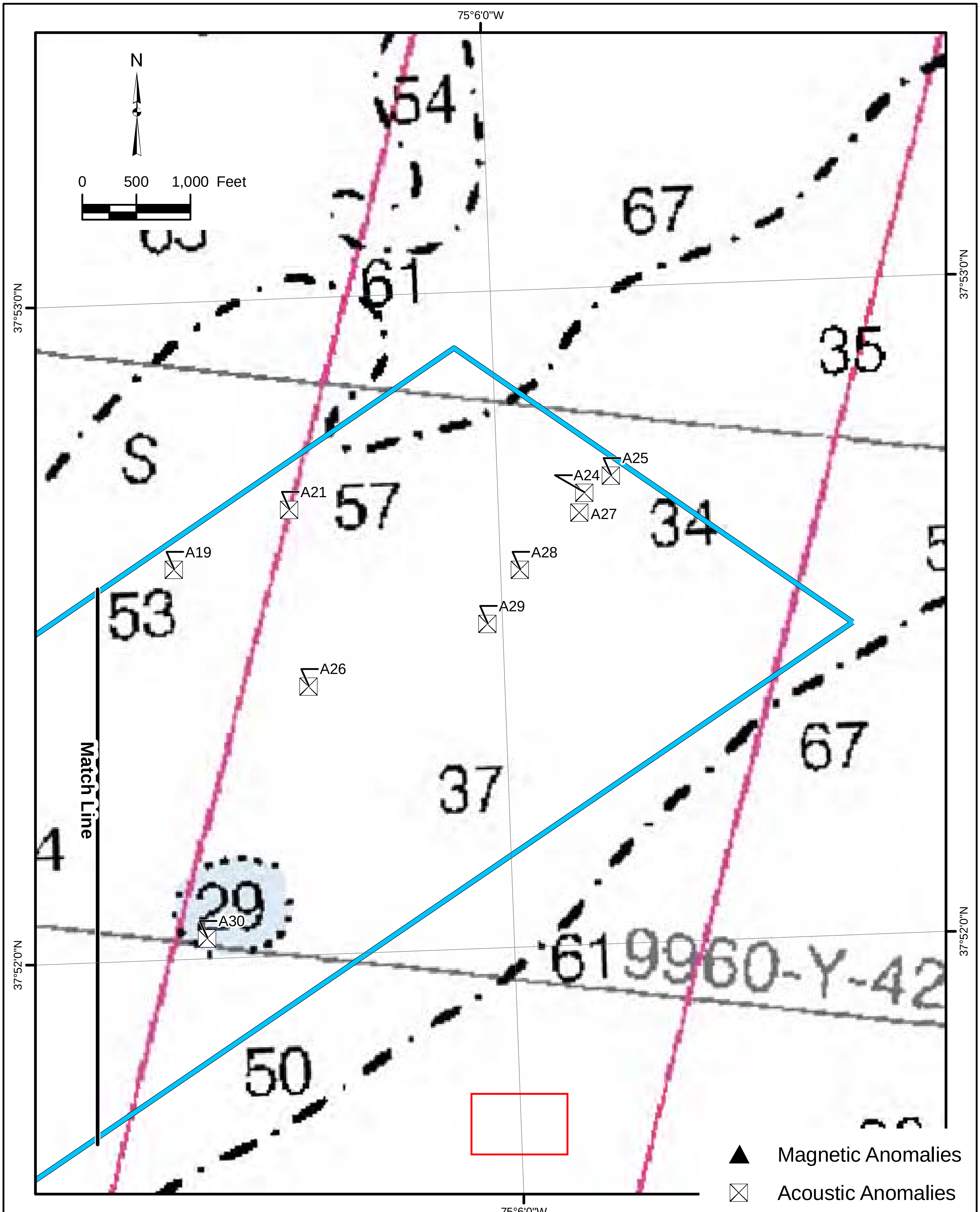


PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 1250 ft
SOURCE	NOAA, URS

\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB \mag_accoustic_anomolies\GIS_Projects\fig6_10_block_two_20090918.mxd

Map of Block Two with Magnetic and Acoustic Anomalies (Part A)

PROJECT NO.	15299035
FIGURE NO.	6-10A

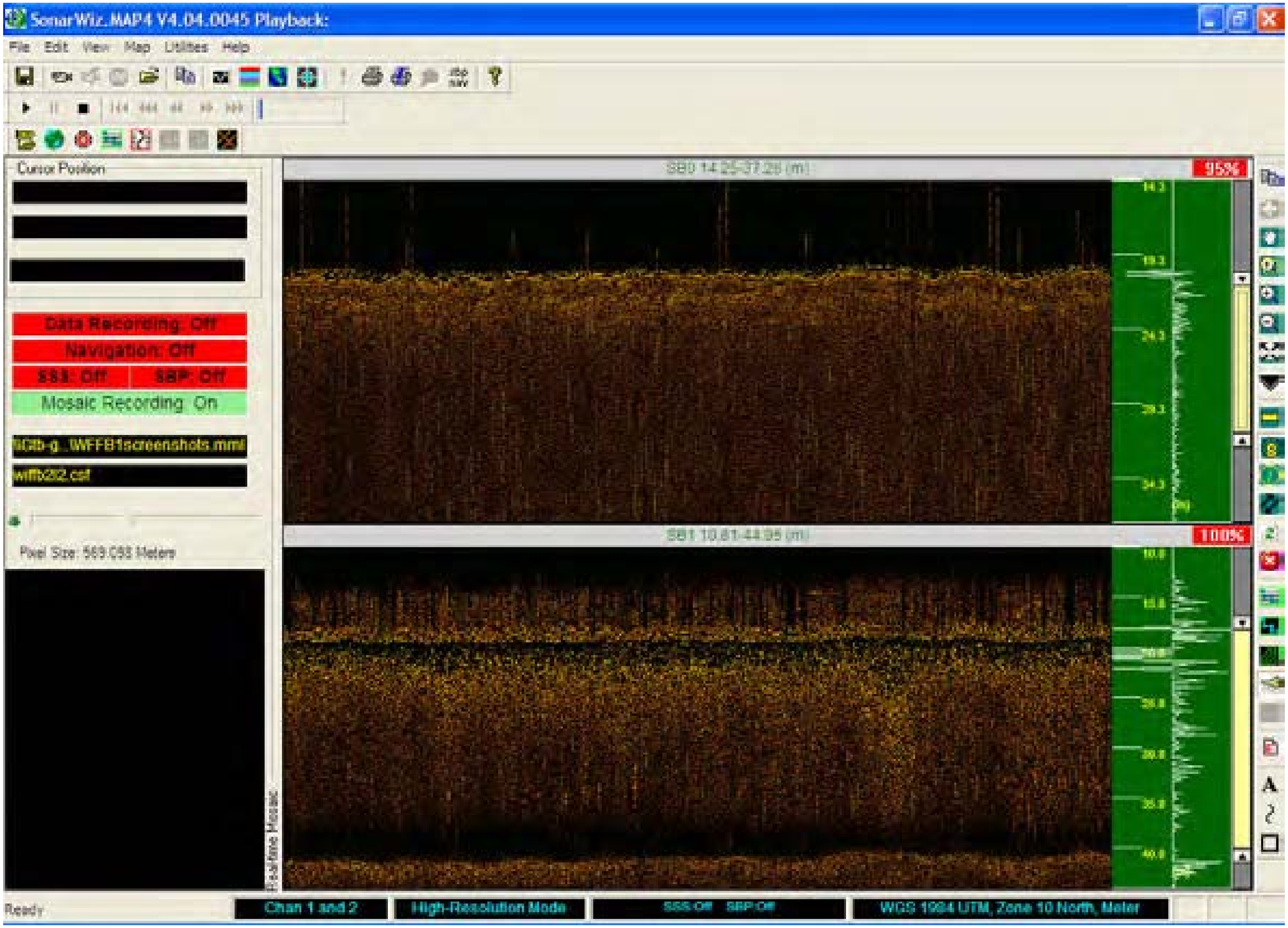


PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 1250 ft
SOURCE	NOAA, URS

\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB \mag_accoustic_anomolies\GIS_Projects\fig6_10_block_two_20090918.mxd

Map of Block Two with Magnetic and Acoustic Anomalies (Part B)

PROJECT NO.	15299035
FIGURE NO.	6-10B



PROJECT WFF SRIPP Offshore Sand Borrow Survey

SCALE N/A

SOURCE URS

Sub bottom data of Line 02 in Block Two Showing Sedimentary Structure, Acoustic Penetration and Surface Reflections

PROJECT NO. 15299035

FIGURE NO. 6-11

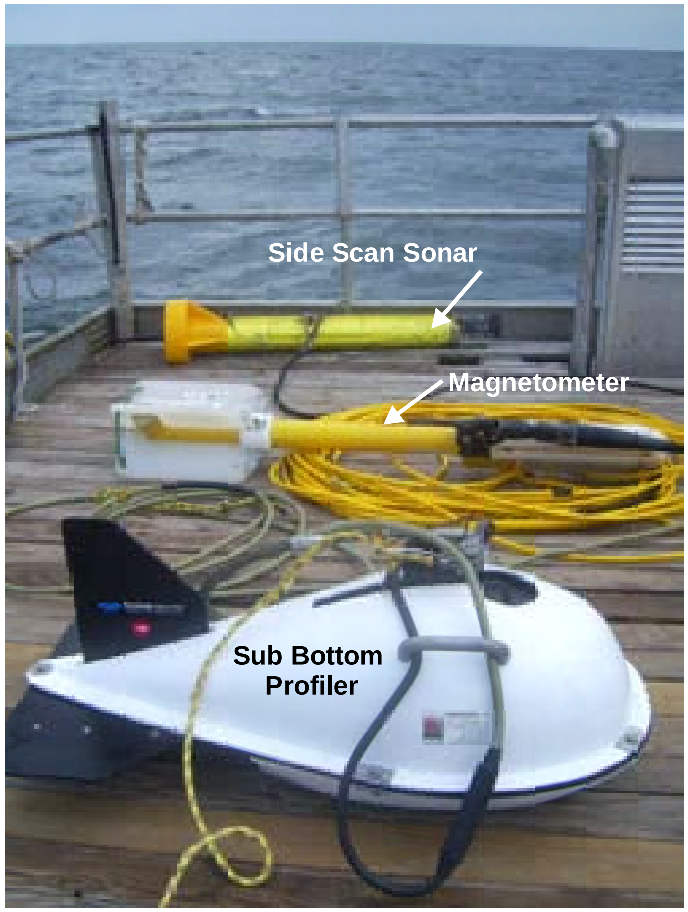


Plate 5-1. View of Survey Equipment

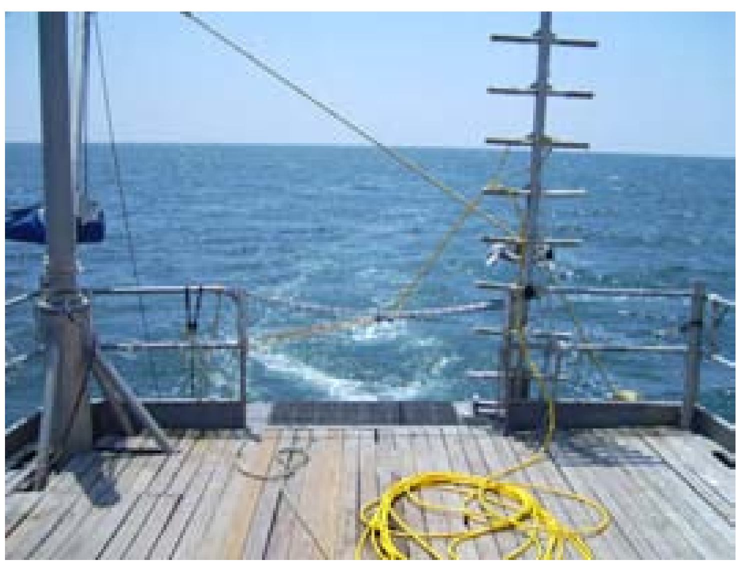
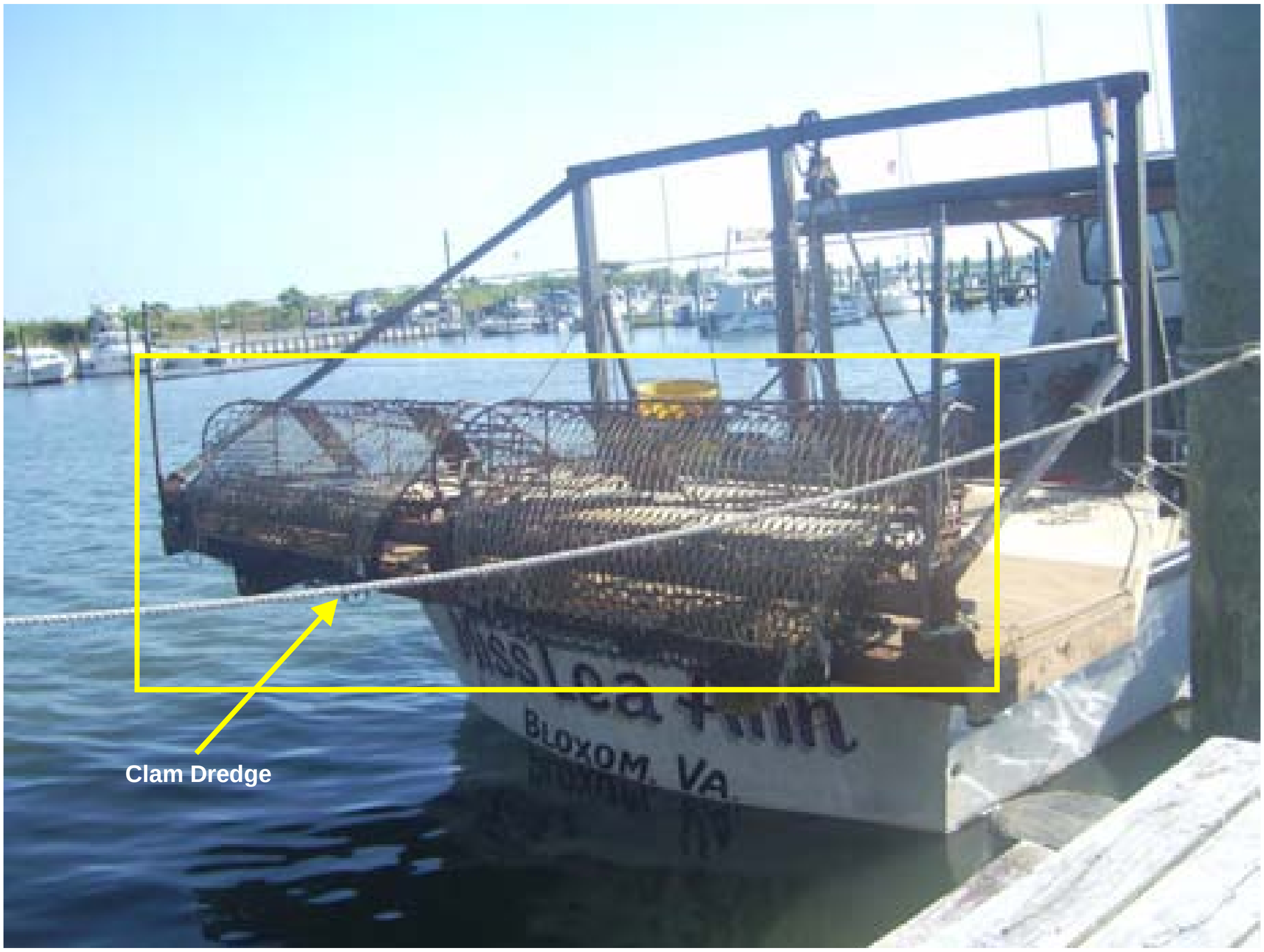


Plate 5-2. Overview of Survey Conditions

PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Project Photographs**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	URS	**PLATE NO.**	5-1 and 5-2



PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	N/A
SOURCE	URS

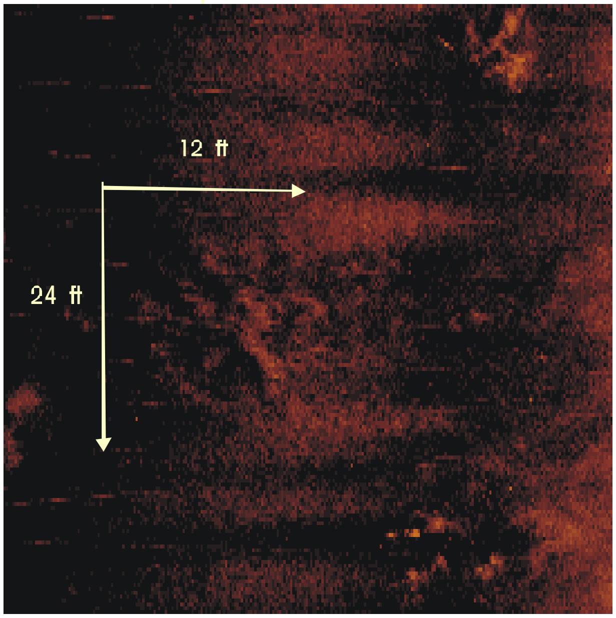
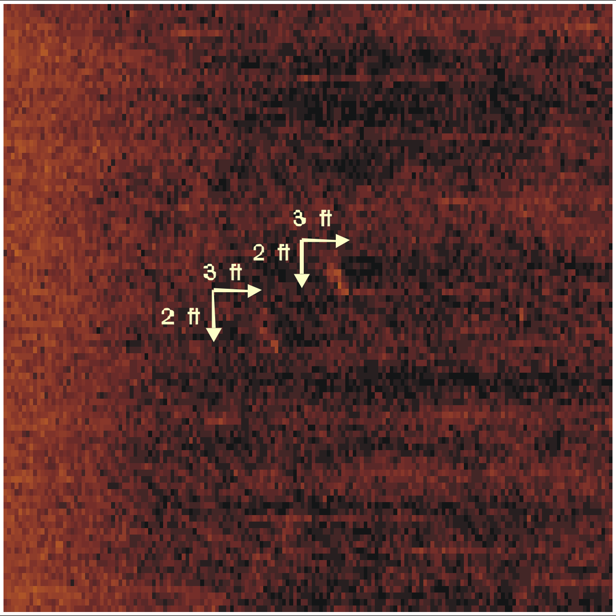
View of Clam Dredge Similar to Those Found in Survey Areas (Acoustic Anomaly Table 6-2)

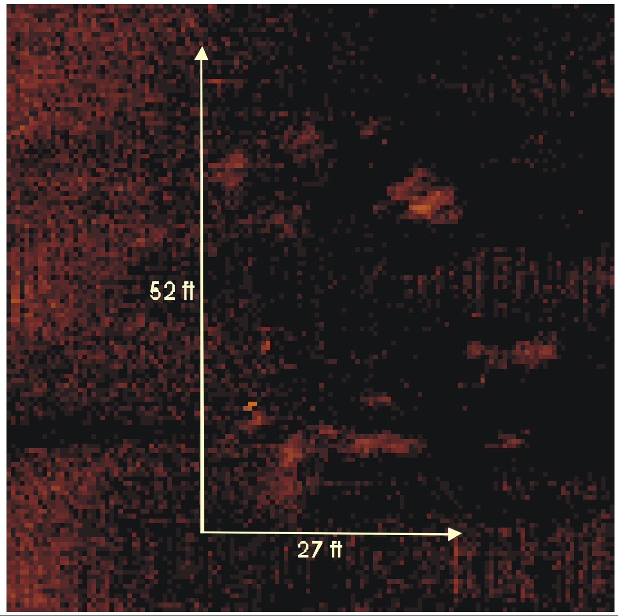
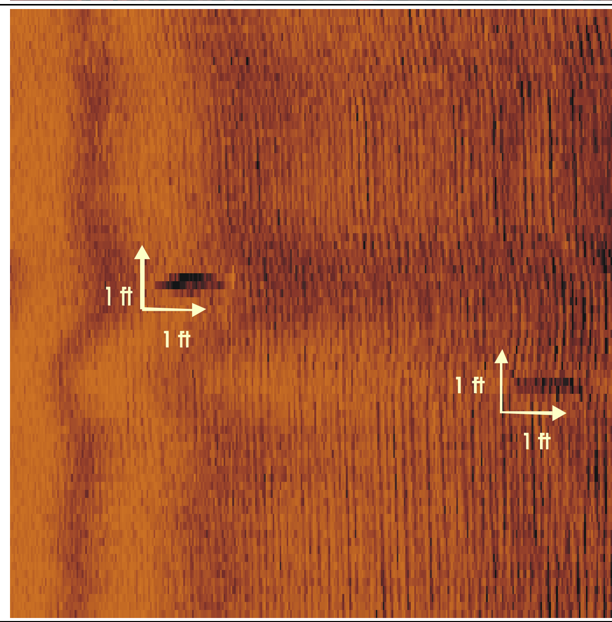
PROJECT NO.	15299035
PLATE NO.	6-1

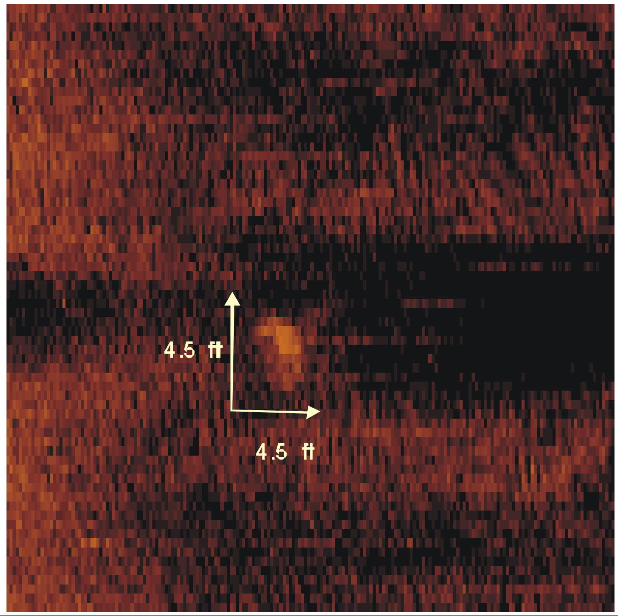
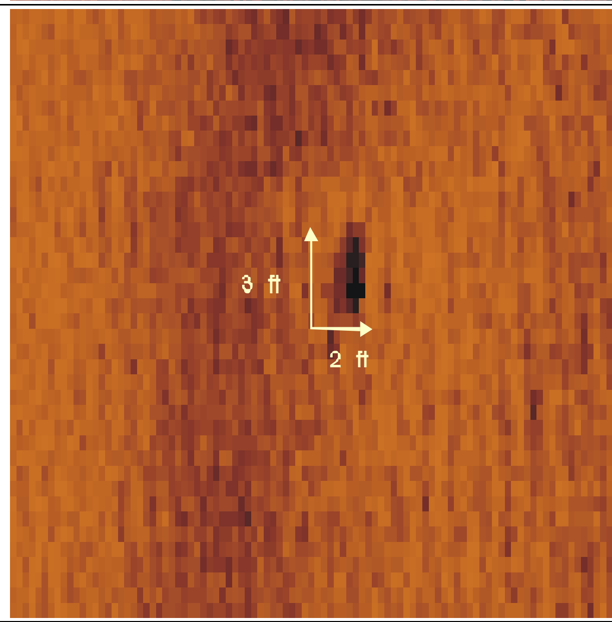
Appendix A:

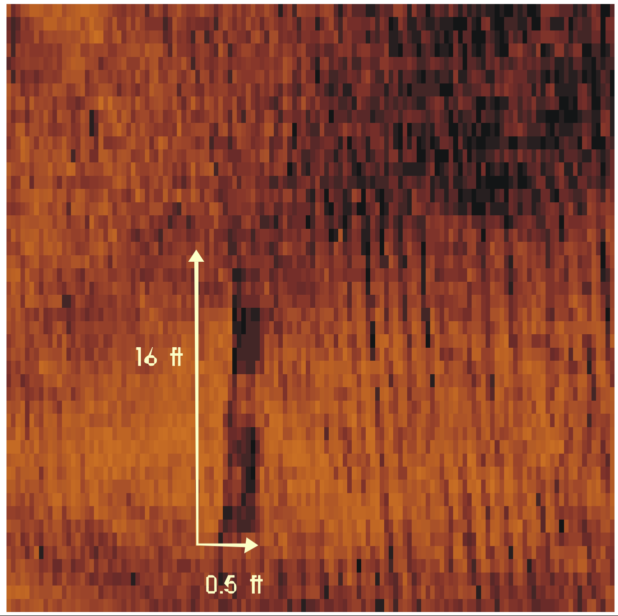
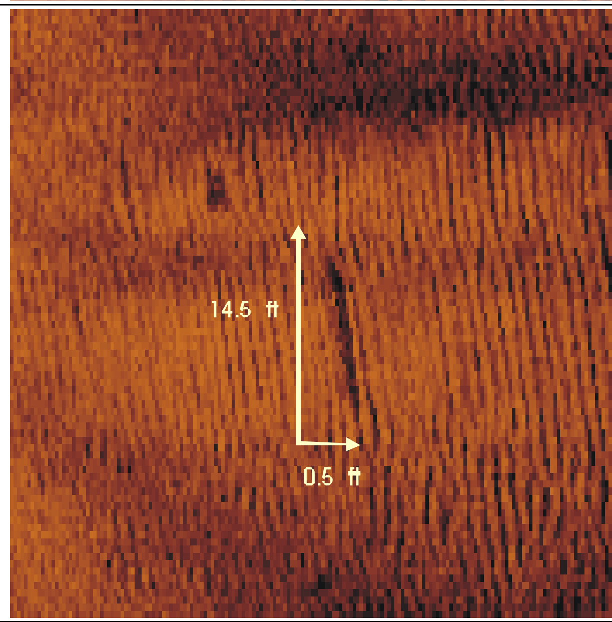
Side Scan Sonar Anomalies

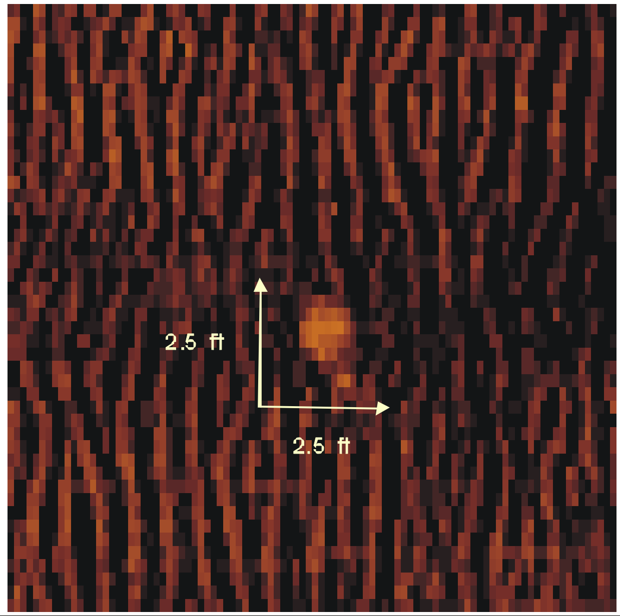
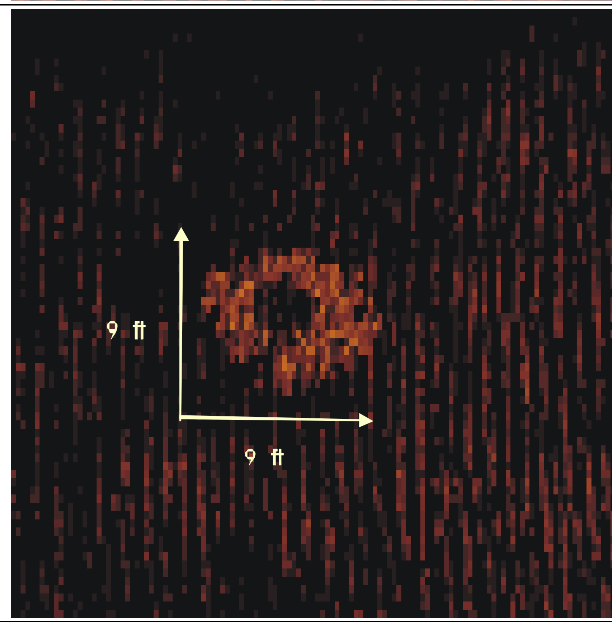
Side Scan Sonar Anomalies

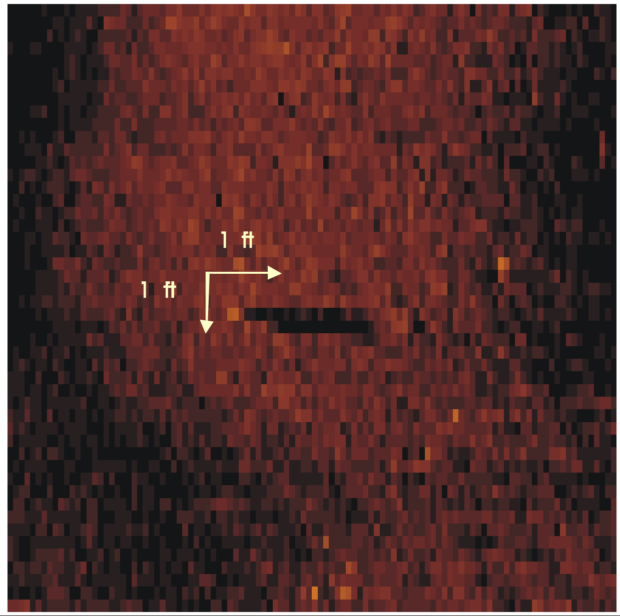
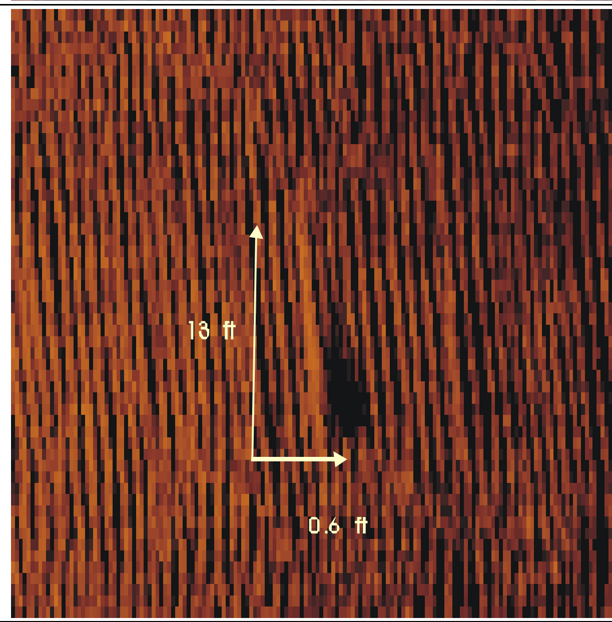
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A1	B1L7	24ft x 12ft x 3ft	
A2	B1L10(06)	2ft x 3ft x 1 ft (2 Pieces)	

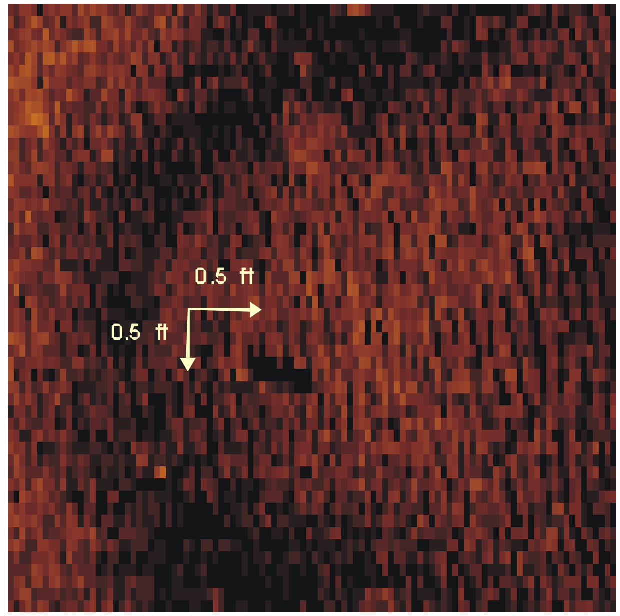
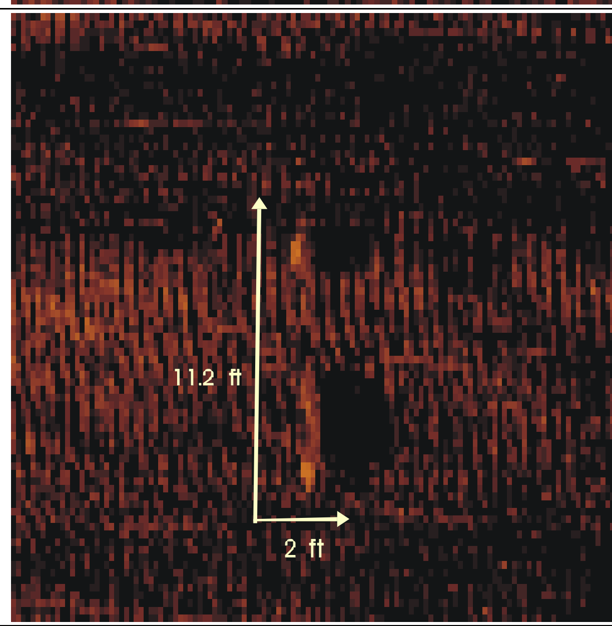
Anomaly Number	**Block/ Line**	**Dimensions L x W x H (Ft)**	**Image**
A3	B1L10(18)	52ft x 27ft x 2ft	
A4	B1L14(01)	1ft x 1ft x 2ft (2 Pieces)	

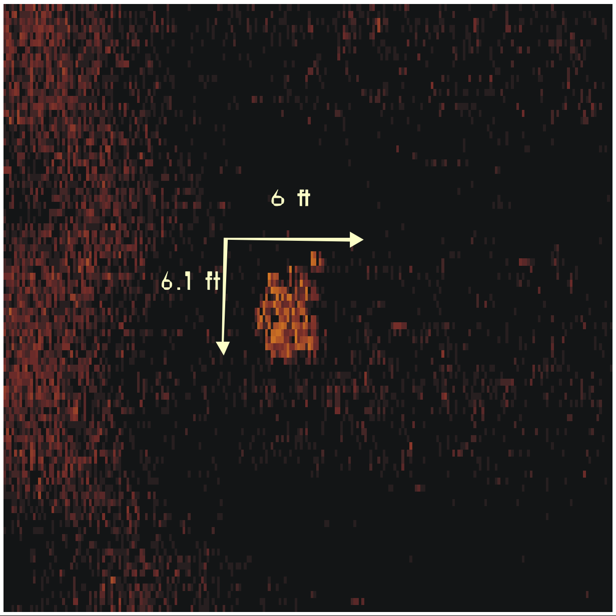
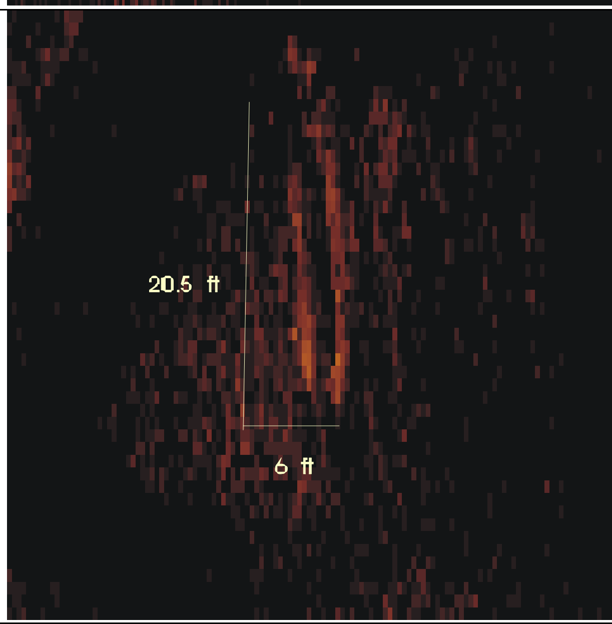
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A5	B1L15(17)	4.5ft x 4.5ft x 2ft	
A6	B1L17(00)	3ft x 2ft x 1 ft	

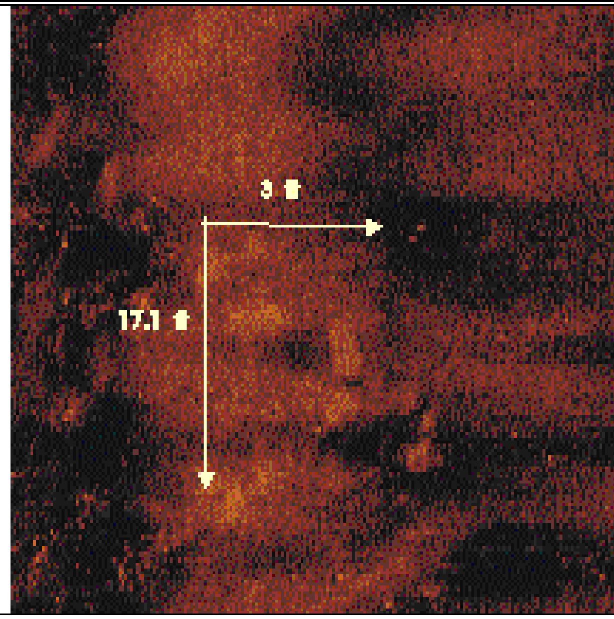
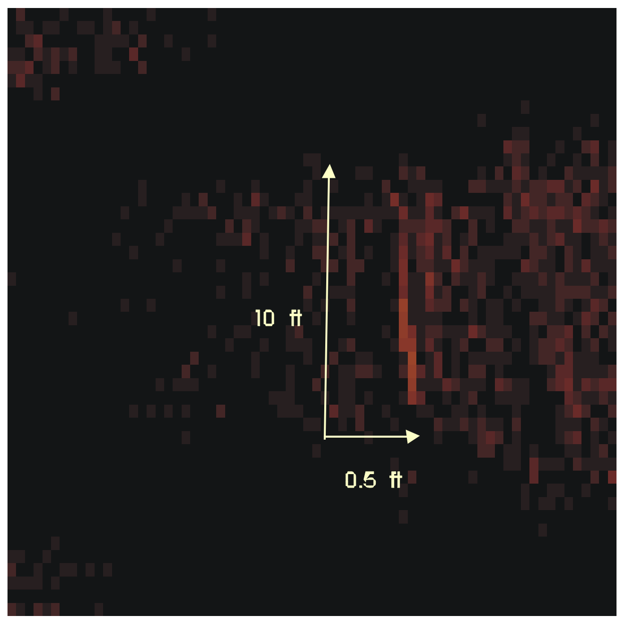
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A7	B1L19(05)	16ft x .5ft x 1.5 ft	
A8	B1L23(04)	14.5ft x .5ft x 2ft	

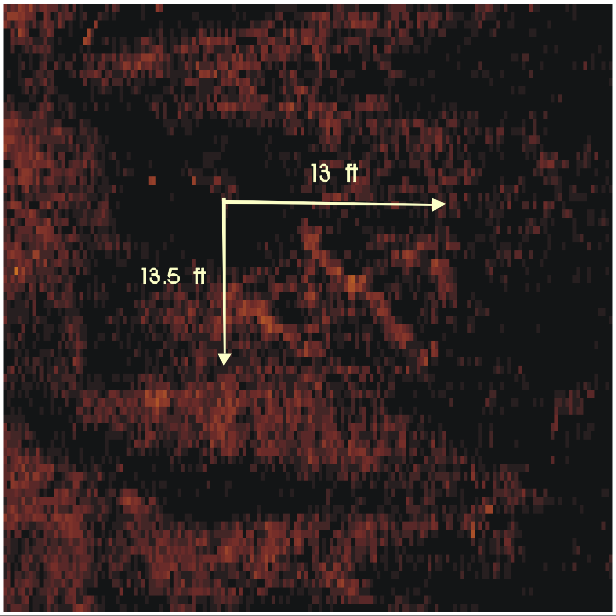
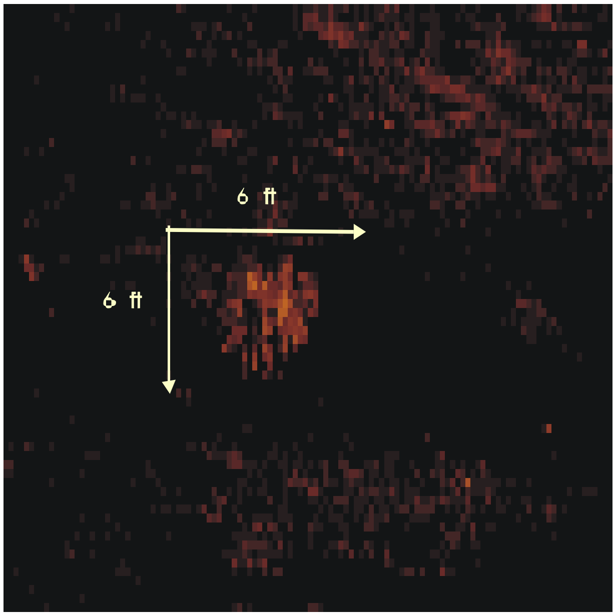
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A9	B1L44(20)	2.5ft x 2.5ft x 1 ft	
A10	B1L50(19)	9ft x 9ft x 2ft	

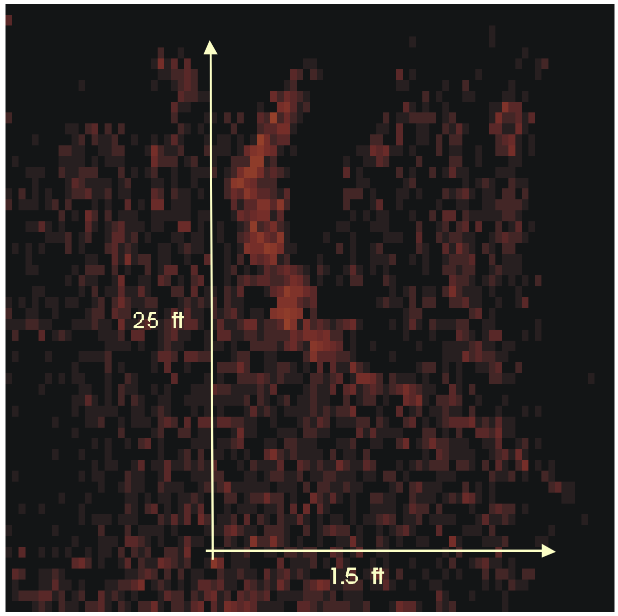
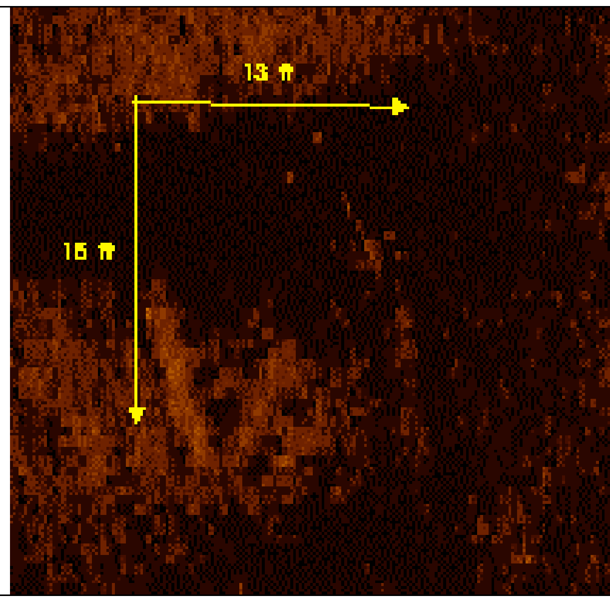
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A11	B1L59(50)	1ft x 1ft x 2ft	
A12	B1L59(69)	13ft x .6ft x 3ft	

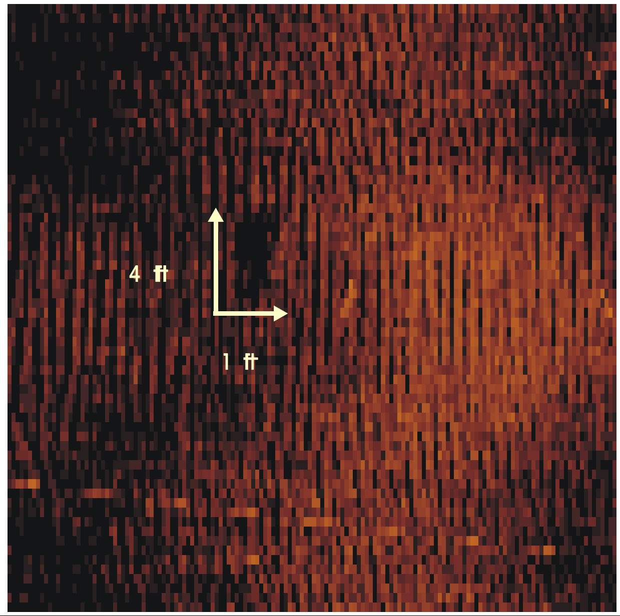
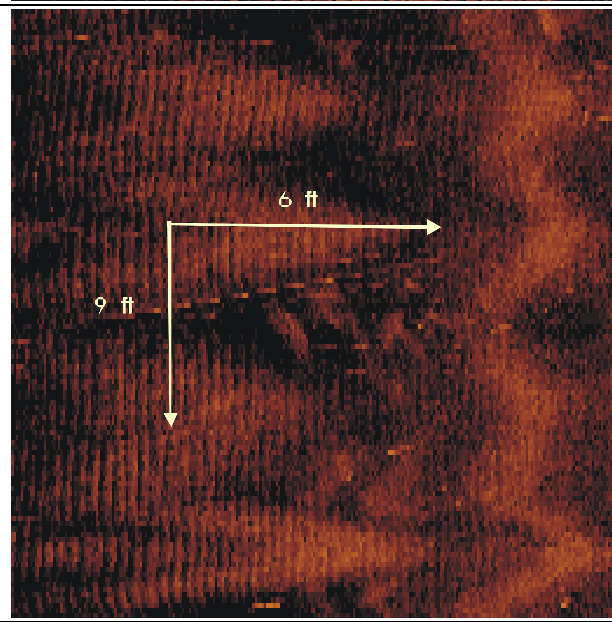
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A13	B1L59(153)	.5ft x .5ft x 2ft	
A14	B1L60(05)	11.2ft x 2ft x 1.5 ft	

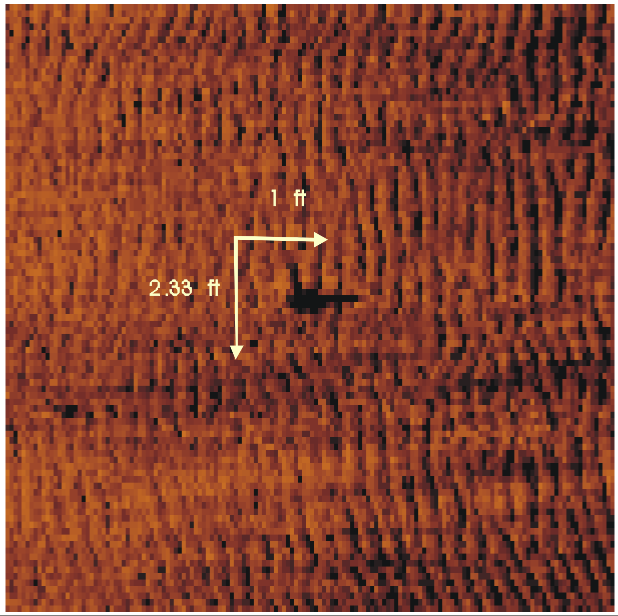
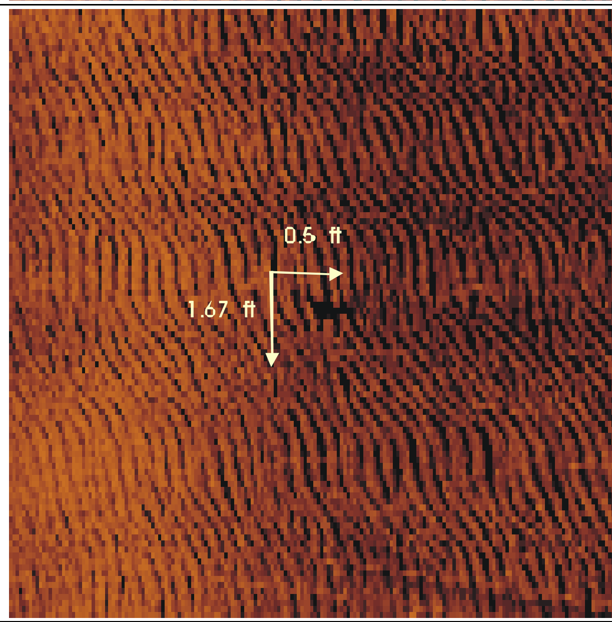
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A15	B1L61(13)	6.1ft x 6ft x 1 ft	
A16	B1L78(11)	20.5ft x 6ft x 3ft	

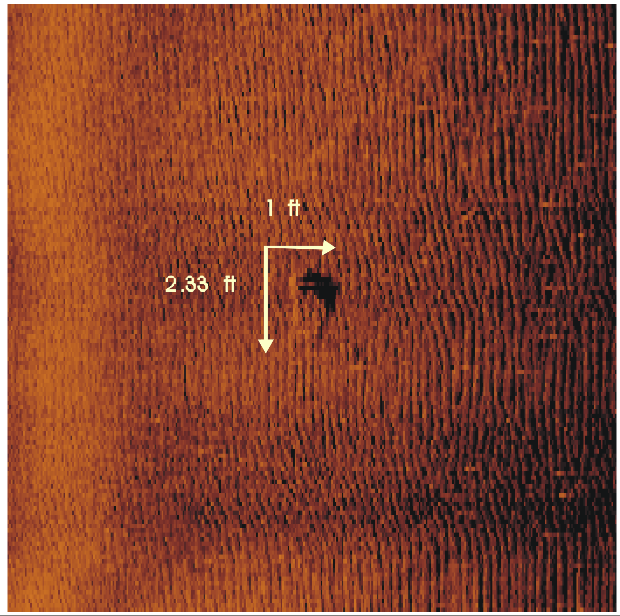
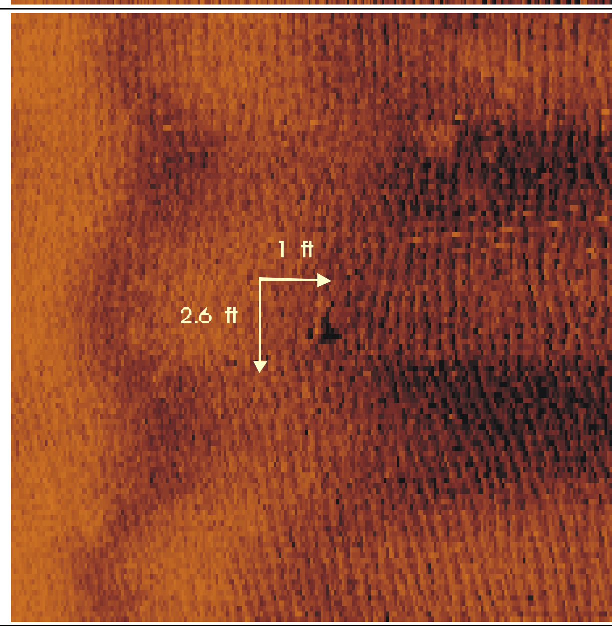
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A17	B1L78(15)	17.1ft x 3ft x 1 ft	
A18	B1L75(48)	10ft x .5ft x 2ft	

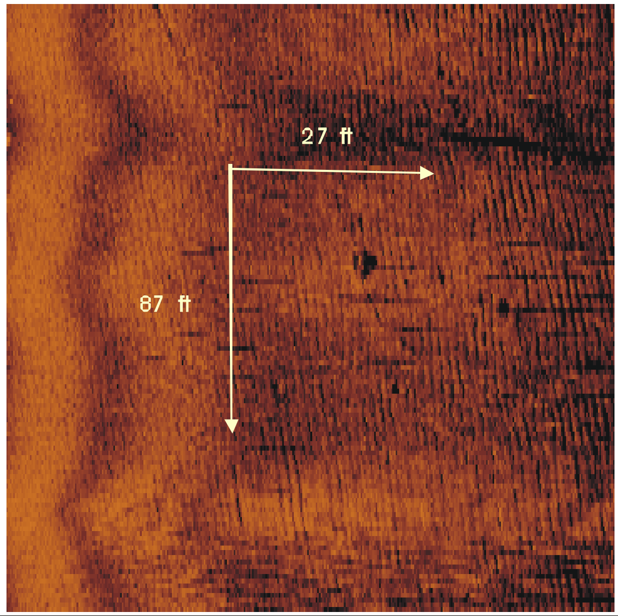
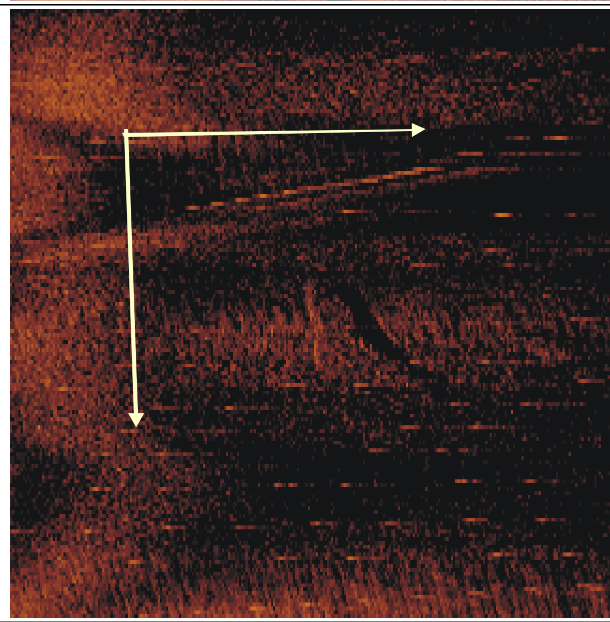
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A19	B2L4(04)	13.5ft x 13ft x 2ft	
A20	B2L6(14)	6ft x 6ft x 1 ft	

Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A21	B2L12(040	25ft x 1.5ft x 1ft	
A22	B2A22	15ft x 13ft x 2ft	

Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A23	B2L36(20)	4ft x 1ft x 1ft	
A24	B2L39(00)	9ft x 6ft x 2ft	

Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A25	B2L40(01)	2.33ft x 1ft x 2ft	
A26	B2L49(06)	1.67ft x .5ft x 1.5ft	

Anomaly Number	**Block/ Line**	**Dimensions L x W x H (Ft)**	**Image**
A27	B2L42(02)	2.33ft x 1ft x 2ft	
A28	B2L44(03)	2.6ft x 1ft x 2ft	

Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A29	B2L45(18)	87ft x 27ft x 2ft	
A30	L46		

Appendix B:

Qualifications of Investigators

Jean Bernard (J.B.) Pelletier has over 20 years experience in marine geophysics, nautical archaeology, marine and terrestrial remote sensing, remotely operated vehicle operation and maintenance, underwater photography and video, technical diving, and diving safety. He is URS' Lead Nautical Archaeologist and Marine Remote Sensing Specialist. He exceeds the Secretary of the Interior's Professional Qualification Standards for Archaeology. Mr. Pelletier is an expert in the use of side-scan sonar, sub bottom profilers, single-beam echo sounders, and marine magnetometers and gradiometers. He also has extensive knowledge of Hypack Max software for data collection and interpretation. He has served a wide array of Federal, State, and private sector clients including the: USACE; U.S. Navy; MMS; National Oceanic and Atmospheric Administration; Delaware, Rhode Island, Florida, and Maryland DoTs; Maryland Department of Natural Resources; Maryland Port Authority; and BP. He received his M.A. in History and his B.A. in Geological Sciences from the University of Maine.

Anthony Randolph has 15 years of experience in cultural resources management, and exceeds the *Secretary of Interior Standards for Archaeology* (36CFR Part 61). Mr. Randolph has extensive experience in the management and execution of archaeological investigations. He has managed reconnaissance and investigations on prehistoric, historic and maritime sites throughout the eastern United States, Caribbean, and Europe. He also has extensive experience as an archaeological conservator through positions at Mariners Museum, and the government of Portugal. He received his Masters Degree in Anthropology from Texas A&M University in 2003 and his Bachelor's Degree in Neuroscience/Anthropology from the University of Pittsburgh in 1993.

Bridget Johnson has a broad background in historic and archaeological research. She has extensive experience in data collection and management for archaeological and historical projects. Ms. Johnson has extensive experience conducting historic research on a variety of topics and regions throughout the United States. Specialized experience includes the creation of three dimensional models of archaeological sites both terrestrial and underwater, as well as the management of archaeological collections. She received her Masters degree in Anthropology from Texas A&M University in 2008 and her Bachelors degree in History and Archaeology from St. Mary's College of Maryland in 2006.